**Relations between Modern Mathematics and Poetry:
Czesław Miłosz; Zbigniew Herbert; Ion Barbu/Dan Barbilian**

by

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Abstract

This doctoral thesis is an examination of the relationship between poetry and mathematics, centred on three twentieth-century case studies: the Polish poets Czesław Miłosz (1911-2004) and Zbigniew Herbert (1924-1998), and the Romanian mathematician and poet Dan Barbilian/Ion Barbu (1895-1961).

Part One of the thesis is a review of current scholarly literature, divided into two chapters. The first chapter looks at the nature of mathematics, outlining its historical developments and describing some major mathematical concepts as they pertain to the later case studies. This entails a focus on non-Euclidean geometries, modern algebra, and the foundations of mathematics in Europe; the nature of mathematical truth and language; and the modern historical evolution of mathematical schools in Poland and Romania. The second chapter examines some existing attempts to bring together mathematics and poetry, drawing on literature and science as an academic field; the role of the imagination and invention in the languages of both poetics and mathematics; the interest in mathematics among certain Symbolist poets, notably Mallarmé; and the experimental work of the French groups of mathematicians and mathematician-poets, Bourbaki and Oulipo. The role of metaphor is examined in particular.

Part Two of the thesis is the case studies. The first presents the ethical and moral stance of Czesław Miłosz, investigating his attitudes towards classical and later relativistic science, in the light of the Nazi occupation and the Marxist regimes in Poland, and how these are reflected in his poetry. The study of Zbigniew Herbert is structured around a wide selection of his poetic oeuvre, and identifying his treatment of evolving and increasingly more complex mathematical concepts. The third case study, on Dan Barbilian, who published his poetry under the name Ion Barbu, begins with an examination of the mathematical school at Göttingen in the 1920s, tracing the influence of Gauss, Riemann, Klein, Hilbert and Noether in Barbilian's own mathematical work, particularly in the areas of metric spaces and axiomatic geometry. In the discussion, the critical analysis of the mathematician and linguist Solomon Marcus is examined. This study finishes with a close reading of seven of Barbu's poems.

The relationship of mathematics and poetry has rarely been studied as a coherent academic field, and the relevant scholarship is often disconnected. A feature of this thesis is

that it brings together a wide range of scholarly literature and discussion. Although primarily in English, a considerable amount of the academic literature collated here is in French, Romanian, Polish and some German. The poems themselves are presented in the original Polish and Romanian with both published and working translations appended in the footnotes. In the case of the two Polish poets, one a Nobel laureate and the other a multiple prize-winning figure highly regarded in Poland, this thesis is unusual in its concentration on mathematics as a feature of the poetry which is otherwise much-admired for its politically-engaged and lyrical qualities. In the case of the Romanian, Dan Barbilian, he is widely known in Romania as a mathematician, and most particularly as the published poet Ion Barbu, yet his work is little studied outside that country, and indeed much of it is not yet translated into English.

This thesis suggests at an array of both theoretical and specific starting points for examining the multi-stranded and intricate relationship between mathematics and poetry, pointing to a number of continuing avenues of further research.

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INTRODUCTION

Making sense of a conundrum

Stéphane Mallarmé ¹

Ca și în geometrie, înțeleg prin poezie o anumită simbolică pentru reprezentarea formelor posibile de existență. [...] Pentru mine poezia este o prelungire a geometriei, astfel încât, rămânând poet, n-am părăsit niciodată domeniul divin al geometriei.

Dan Barbilian ²

$$ds^2 = \sum_{i=1}^n \sum_{j=1}^n g_{ij} dx_i dx_j$$

³

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¹ One hundred years ago, in 1914, “Un coup de dés jamais n’abolira le hasard” (A throw of the dice will never abolish chance) was first published (posthumously) in the precise form specified by Mallarmé. Written in 1897: Mallarmé, *Oeuvres complètes*, 67–68. Translation by Keith Bosley in Mallarmé, *Mallarmé: The Poems*, 289.

The number/were it to exist/other than as agony’s scattered hallucination/were it to begin and end/emerging but denied and cover when appearing/at last/by some profusion spread in scarcity/were it to amount/to evidence of the total however small/were it to light up/chance.

² Barbilian once remarked that in 1914 ‘the door opened’ for him to a humanist mathematics, see chapter 5: Barbu, *Poezii*, 326. This citation comes from an interview in 1927. See chapter 5: Barbu, *Pagini de proză*, 39–40.

As in geometry, I understand through poetry a particular symbolism for representing the possible forms of existence. [...] For me poetry is a prolongation of geometry, so that, while remaining a poet, I have never abandoned the divine domain of geometry.

³ A generalised non-Euclidean (Riemannian) distance metric, in its modern form c. 1914, as developed by a series of mathematicians including Gauss, Riemann, Klein, Ricci and others, and Einstein in his theory of relativity. See chapters 1 and 5.

I was first introduced to symbolist poetry as part of my French Honours course at Otago University in Dunedin. Reading it for the first time not only awakened me to the expressive possibilities of the poetic text, but also to the then serendipitous and inexplicable link to mathematics, the subject in which I was concurrently completing an Honours degree in Science. I did not then articulate what it was that appealed to me equally in both fields, but it related to the process of intellectual discovery, a process made more manifest in the case of French poetry by the issues of nuance, interpretation and translation, and which in mathematics found expression in first the identification and formulation, and then solving, of a puzzle. In hindsight it was the qualities, shared between mathematics and poetics, of suggestiveness and inference that were alluring, along with two visions of the world that sometimes intersect, and at other times or from other perspectives, remain very separate.

This thesis sets out to explore the basis underlying these reflections, showing three levels of poetic engagement with mathematics through the twentieth-century writings of Nobel literature laureate Czesław Miłosz (1911-2004) and nationally highly-regarded poet Zbigniew Herbert (1924-1998), both of them Polish, and the Romanian mathematician and writer of poetry and poetics, Dan Barbilian (1895-1961). In a different manner across all three cases, and indubitably in the case of Barbilian, any dialogue of mutual exclusivity between the two fields is called into question. The varying cultural backgrounds are pertinent, and I have deliberately selected these three writers because they come from Central European countries in which I have lived and worked.

Chapter One of this thesis examines the nature of mathematics, and concentrates on the development of mathematical concepts in the period running approximately from the late-nineteenth century to mid-twentieth century in Europe, situating this within an intellectual and social milieu in order to inform a later examination of the extent of cross-fertilisation of overall concepts and specific methods among poets and mathematicians.

I have chosen this particular period since it coincides with significant changes in approaches to mathematics, and the radical challenges of Modernism and early Post-Modernism as they affected literature and arts. The far-reaching and transformative changes in thinking and attitude that these movements occasioned had a profound impact across multiple fields, and hitherto-entrenched fundamental beliefs about permanence, knowability and singularity were brought into question. In some respects, this uncertainty is described as a sense of ‘anxiety’, or a loss of knowing where one’s discipline fits into the world. The history of modern mathematics, which is still relatively new, is slowly recognising the influence of

socio-cultural issues, and recent studies now demonstrate that mathematical developments are affected by time and place. Broadly, it is becoming increasingly difficult to deny that mathematics as a field is subject to external cultural factors in how it develops, in the same way as are other science and arts fields.

Although mathematics has traditionally been, and continues to be, viewed by many as an apex of abstract thought, and of stable, deterministic and reliable semiotics and knowledge, this viewpoint is in fact challenged from several perspectives. From a purely mathematical standpoint, of particular import was the steady development from the seventeenth-century rationalist and ‘common-sensical’ basis towards abstraction. Another case in point concerns the rise of non-Euclidean geometries, which provide multiple, but consistent, models of space that match neither the visible world nor common understandings of reality. Twentieth century mathematics developed an introspective quality, and a number of emerging sub-fields examined the nature and purpose of mathematics, its relationship with truth, and how these issues could best be represented or understood. The place of the imagination and intuition in mathematics comes under discussion, along with its potential subjective and culturally specific qualities, also whether mathematics is an invention or discovery, and the edifice of mathematics as a ‘system of connections’ or complex arrangement of cumulative knowledge.

In anticipation of the case studies, the chapter closes with some brief outlines of the specifics of mathematical specialisations and cultures in Poland and Romania during this period.

Building on concepts of mathematics introduced in Chapter One, Chapter Two begins to examine a somewhat scattered array of theoretical discussions that have potential application to the relationship between mathematics and poetry, and draws together some of these various strands of existing scholarship. While neither a clearly delineated nor holistic specialism, there is however a small body of work that, in various ways, looks at potential intersections between mathematics and poetry. There are also a number of less fruitful trails, which I nonetheless outline. The more established field of literature and science is one such example, where care needs to be taken to differentiate between Anglophone and Continental-European culture, as the common starting assumption in English that the two fields are fundamentally different, is far less pronounced and less accepted elsewhere.

Another ‘false trail’ in the relations of mathematics and poetry, or at very least distracting from the central issue, is an understanding of mathematics as fundamentally about symbols. While mathematical ideas are almost always represented in common symbolic form

or notation, the emphasis in this thesis is on the nature of the mathematical ideas that underlie that writing form, and not the notation itself. Mathematics extends deeper than equations or diagrams, much as music transcends the notation on the page.

The versification of mathematics and the not infrequent use of mathematical imagery in poetry date back to ancient rhetorical traditions. In modern literary tradition, some of the Symbolist poets – particularly the French and Russians – were notably attracted to mathematics, seeing in it a potential ordering or determining principle for all existence, emanating from their shared recognition that it could serve as a representation of eternal truth and aesthetic beauty. (As discussed in Chapter One, however, mathematics was not necessarily seen in that way by modern mathematicians.) While not a focus of this thesis, a mathematical aesthetic and its potential for a universal language of representation also features in Anglophone poetry, notably that of Emily Dickinson in the United States.

In 1960s France, a group of poets and mathematicians, some of them directly influenced by the Bourbaki group of formalist mathematicians established in the 1930s, took the case of mathematically ‘inspired’ poetry to an extreme, when they set out to construct a new form of literature directly based on modern theories of the axiomatic foundations of mathematics. For this group, Oulipo, mathematical language and systems held a potential not otherwise present in literature.

The traditional Platonic view of mathematics, which regards it as the discovery and expression of a fixed external reality, consequently sees mathematical language as formalised, symbolic, precise and endeavouring to exclude human subjectivity. Poetry on the other hand is concerned with imagination and creation; its language is fundamentally ambiguous, and allows for rich and varied interpretations of meaning, depending on individual circumstance and context. Put differently, poetry is multiple, plural and particular, whereas mathematics is univocal and universal.

However, mathematics and poetry have in common their precise attention to language through measure and form; counting; rhythm; metre; repetition and sequencing; form and layout on the page, and concision of expression. Syntax provides for an experimentation with the rules of how symbols and words can be combined, on a level that can be separated from intrinsic meanings. Both fields represent or create an idealised abstract system of knowledge and intellectual experience, where the nature of truth, meaning and the question of how they should best be expressed, their correspondence with the real world, and the role of imagination and invention are important.

Inherent in this presence or absence of an historical, human context, the striving towards a universal absolute, and how to express or represent, but not limit, the ineffable, is metaphor. Metaphor describes, represents or suggests one thing in terms of another, and is a concise image that allows for great interpretation, while depending critically on context, inference and implication. The concept of metaphor can also be applied to mathematics, where metaphor can be seen as a ‘mapping’ (in the mathematical sense) of inferences, or – in the terminology of 1950s category theory, which I return to in the conclusion – as ‘morphisms’. Some mathematicians see metaphor in their fields as an accumulation of cultural references, or as an array of what similar concepts mean to various practitioners, or – as remarked by the Romanian mathematician and linguist Solomon Marcus – as a totality or layering of human interactions. In all these cases, the *process* of inference is made evident, through the mathematical features of deduction, demonstration and proof.

What emerges from this first section of the thesis is a combination of imagination and discovery, of certainty and uncertainty, and of experimental and accepted conventions of expression. These are considerations that are important, in differing ways, to all three of the poets discussed in the case studies.

Chapter Three takes as its starting point an explicit reference to non-Euclidean geometry in a poem by Czesław Miłosz. Non-Euclidean geometry is interesting in this case, in that it is an aspect of modern mathematics that is made evocative through physics, and hence becomes known (if just barely) outside its specialist mathematical origins. Miłosz presents a ‘typical’ case in that he has latched on to a phrase in mathematics, without any technical background. Miłosz, who lived first through the Nazi then the Soviet occupation of Poland, was in many respects a political poet and was convinced that human ethics should be central to poetics. With no training in either mathematics or science, he was mistrustful of all forms of science that have moved away from an anthropocentric viewpoint, a phenomenon that he considers to have begun with Copernicus and Galileo, then continued by the European Renaissance rationalists, through to Newton, then Darwin, and eventually manifesting itself in the twentieth-century influence of science on, and its appropriation by, Fascist and Marxist cultural theorists.

For Miłosz, Einsteinian relativity was science’s saving grace. He admired Einstein for his early condemnation of the Holocaust, and his moral stand against both Fascism and Marxism, and consequently he developed an incomplete understanding of relativistic space

and time inseparable from the role of the human observer or participant, and the simultaneous conflation of the macro- and microscopic worlds.

Milosz approaches relativity entirely through its scientific and then popular application, and certainly not its mathematical basis. Indeed, he makes little distinction between science and mathematics, finding mathematics largely abhorrent, and antithetical to humanism. His specific references to non-Euclidean geometry are consequently ambiguous at best, and far removed from its mathematical origins. His ‘mathematical poetics’ are therefore slight, being essentially a description in poetry of his concerns about science.

Chapter Four focusses on the case of another outstanding modern Polish poet, Zbigniew Herbert, who like Milosz held concerns about rationalism in society, particularly Marxist rationalism. But Herbert is far more open than his compatriot to the intricacies and apparent contradictions inherent in modern mathematics. At first glance his poems depict mathematics as a cold and amoral form of statistical counting and measuring. Yet while consistently wary, Herbert is able to appreciate mathematics as a structural concept of the universe; and although his formal mathematics training appears largely acquired through his study of Rationalist philosophers such as Descartes and Spinoza, he similarly engages with modernist mathematical concepts such as uncertainty, multiplicity and even the precision and exactness of classical mathematics and the determinism inherent in universal structures.

Mathematics is far from a central concern of Herbert’s, but the (deliberately) selected poems in this chapter nonetheless demonstrate a wide range of engagement by him with various mathematical concepts. In doing so, Herbert demonstrates a deeper awareness than Milosz of the special features that mathematics has to offer poetry. Read in this light, a significant number of his poems reveal a quality additional to the usual analysis, which is rife with the ambiguity, tension and even allure of a mathematical way of thinking.

Chapter Five is in many respects the main case study, in that it examines the work of someone who was at the same time a practising mathematician and poet, highly regarded moreover in both fields, and who took a conscious interest in their interrelationship. The Romanian mathematician Dan Barbilian studied at Göttingen at a time when it was one of the world’s leading centres of modern mathematics. Most notably, Carl Friedrich Gauss had first established Göttingen’s reputation in mathematics, and by the 1920s when Barbilian was there, Gauss had been succeeded by Bernhard Riemann, Felix Klein, David Hilbert and Emmy Noether. Between them, these mathematicians played very significant roles in the

development of modern geometry, the foundations of mathematics, and modern algebra. Barbilian frequently admitted his debt to their work and legacy, and as a result developed a marked preference for mathematics grounded in a highly abstract and axiomatic approach, which contained within it a sense of universal and transcendent knowledge as its ultimate purpose.

In his poetics, Barbilian argued that poetry should always aim towards disembodied epistemological high-points, by means – in a heavily Symbolist fashion – of a form of pure language. His poems, published under the name Ion Barbu, were critically acclaimed in Romania for their innovation. Those selected for analysis in this chapter demonstrate a repeated use of discrete images whose interpretation depends on a juxtaposition or layering approach to meaning, with much required of the reader to exercise qualities of imagination, deduction and extrapolation. Mathematically, the method resembles the axiomatic approach of group theory in algebra, in that elements are repeated in differing permutations, but within a tight structure and heavily formalised process of suggestion. In that respect, they hark back to the axioms of Euclid and of Hilbert. The poems are rich with internal cross-references that make most sense as a collected body, and as such – with effort – provide an essential insight into how mathematics and poetics can relate to one another.

The three case studies as a deliberate series demonstrate a cumulative development of the relationship between mathematics and poetry: from an arguably very tenuous and superficial (but common) approach to mathematics, through to one more intricate, and culminating in a case where there is a deep balance between mathematician and poet.

The concluding chapter of this thesis examines the range of perspectives offered by each case study, against the backdrop of the various theoretical ideas raised in Part One. All three poets were survivors of totalitarian regimes. Herbert and Miłosz share a belief that the moral imperative inherent in poetry demands that a stand be made against totalitarianism, be it Fascist or Marxist, as the poets considered that both ideologies denied the centrality of humanity and both individual and collective responsibility in society. For Miłosz certainly, and Herbert to a lesser degree, anything that mathematics has to offer society should be subsidiary to that primary consideration. Barbilian in many respects reverses this prioritisation in his call for a ‘mathematical humanism’ that requires mathematics to be the basis of all intellectual training, and one in which anthropocentrism should be explicitly avoided.

These are issues that inform some of the very tentative conclusions of the thesis. As becomes steadily apparent, there is no one model, nor framework, and certainly no ‘formula’

to describe the relationships between mathematics and poetry. There are, however, a number of indications of where next to take the discussion. One of the most fundamental areas is that of language, and translation, and in this respect the ‘creative transposition’ and theories around intersemiotic translation of Roman Jakobson are particularly interesting. On the purely mathematical side, the post Second World War development of category theory holds promise. In hindsight, this is not so surprising as while category theory (as a distinct field) postdates the poetry of all three case studies, its origins lie very firmly in the abstract algebra established at Göttingen, and it furthermore has clearly tracable links with the rise in formalist linguistics and work in mathematical logic, the latter to which the Polish mathematicians made such contributions. Most tellingly, as a field in its own right, category theory is fundamentally about abstract relations between potentially diverse objects.

PART I
THEORETICAL DISCUSSION AND LITERATURE REVIEW

CHAPTER ONE

The Nature of Mathematics:

‘Why are numbers beautiful? [...] I know numbers are beautiful’⁴

Abstract

The nature of mathematics and its historical development are less explored than the nature and history of poetry. This chapter therefore outlines the historical context and describes some of the mathematical concepts whose development was particularly pronounced during the first half of the twentieth century, as they pertain to the three main case studies and subsequent discussion. In large part a literature review, this chapter draws on recent works in the still relatively developing field of the history of modern mathematics.

Introduction

What is mathematics? According to the *Oxford English Dictionary*, it is:

[sense 1] Originally: (a collective term for) geometry, arithmetic and certain physical sciences involving geometric reasoning, such as astronomy and optics; *spec.* the disciplines of the quadrivium collectively. In later use: the science of space, number, quantity, and arrangement, whose methods involve logical reasoning and usually the use of symbolic notation, and which includes geometry, arithmetic, algebra and analysis; mathematical operations or calculations.⁵

To begin with a dictionary definition is fraught with problems, but I have done so deliberately, as this definition encapsulates what many – including at least one of the poets in the case studies – consider to be mathematics. But it fails to capture so much more of the essence of what mathematics is capable of meaning and of suggesting. This is an issue that is central to this thesis, as the nature of mathematics is interpreted in differing ways by various people over time.⁶ The following chapter considers these matters, by outlining certain concepts and periods in mathematics as they inform the later discussions in the thesis as a whole.

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⁴ Paul Erdős, c. 1992. See note 59.

⁵ “Mathematics, N.” The *quadrivium* – astronomy, arithmetic, geometry and music – together with the *trivium* of grammar, logic and rhetoric, formed the mediaeval Seven Liberal Arts.

⁶ The question, albeit in many respects unanswerable, of ‘what is mathematics’ is addressed in many recent histories of the subject, see for example Stedall, *The History of Mathematics*.

Evolution of mathematics

In 2006, Mathematician Christine Keitel published an historical account of the development of mathematics, particularly in Europe.⁷ Beginning with an accepted origin of mathematics dating from the period of the Neolithic revolution, she notes the early characteristics of mathematics linked to the development of social organisation and dissemination of knowledge, particularly as related to agriculture and the counting and measuring of crops. Such knowledge was expressed through both ritual and symbol. The urban revolution and consequent focus on street and city design brought with them domain-specific systems of symbols, then in Ancient Greece, mathematics became more or less synonymous with basic geometry, emerging as one of the seven liberal arts and what Keitel describes as:

a theoretical system [...] as the queen of sciences, and as a universal divine mental force for mankind.⁸

Keitel's point is that already by the classical period, mathematics was acquiring an intellectual characteristic divergent from its earlier focus on practical application. She writes:

It is this distinction between *mathematics as the queen*, as a science of formal symbols, notations, definitions, concepts, rules, as elements of a formal universal language with an unambiguous grammar, providing algorithms, reasoning procedures and logical argumentation, hierarchies as elements of formal routines, as an ideal system of connections of concepts in theorems, networks, models and holistic theories, mathematics as a science of formal systems [...] that is opposite to mathematics as a simple technique or real problem solving tool [...] (emphasis in original)⁹

Perhaps the first person to describe this new higher status for mathematics was the semi-mythical Pythagoras (c. 570 BC – c. 495 BC). He, and the movement that followed him (the *Mathematikoi*), are in part responsible for the quasi-religious aura which became attached to mathematics, which Keitel observes subsequently appealed to the medieval Christian church, and contributed to the 'hermetical' character of the mathematical community in the later history of European mathematics.¹⁰ Euclid (c. 330 BC – c.260 BC) on the other hand, is best remembered for his particular style of logical and concise argument and expression that is the basis for the modern mathematical method, and which has been adopted by many other

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⁷ Keitel is currently Professor of Mathematics Education and a Vice-President at the Freie Universität Berlin.

⁸ Keitel, "Perceptions of Mathematics," 83.

⁹ Ibid., 83–84.

¹⁰ Equally, however, the Pythagoreans' belief that the universe can be understood through mathematics also underpins the scientific revolution. 'Hermetism' in mathematics and poetry is particularly relevant to the third case study, on Dan Barbilian, in chapter 5.

disciplines today. Euclid collected and unified the available geometrical knowledge of the time giving a ‘clear theoretical representation’ to what was eventually recognised as *Euclid’s Elements* and used as a standard school text well into the twentieth century.

From the Middle Ages until the 17th century, geometric figures and numbers were valued for their symbolic character but, as Keitel remarks, this was largely due to supposed spiritual and decorative properties, and in Europe the techniques of mathematics itself scarcely advanced.¹¹ However, the systematic skill of book-keeping was developed, and the Renaissance saw a flowering in scientific and classical scholarship as well as artistic and cultural endeavours, with a well-known exemplar being Leonardo da Vinci. Keitel also observes that around this time, the increase in global exploration meant that earlier mathematical developments in non-European cultures, particularly Indian, Arab and Chinese, were introduced to and rapidly assimilated by Renaissance scholars and practitioners in Europe.

In the 17th century, René Descartes (1596-1650) developed his concept of ‘rational man’, as well as developing algebraic methods and expounding a belief that mathematics should be easily understandable as part of ‘common sense’ (*le bon sens pour tout le monde*).¹² He was also one of the first to merge algebra and geometry by way of his ‘universal method’. Shortly after, Gottfried Wilhelm Leibniz (1646-1716) propounded his view that mathematics, rational argumentation and calculation could solve all the problems of the world, issuing his challenge, ‘*calculamus!*’¹³ Arab-Indian systems of connotation, ciphers, decimal fractions and formal solutions for practical problems added to a sense of mathematics as a universally applicable tool in trade and commerce, and mathematical textbooks were produced and distributed in schools across Europe.

In Europe in particular, specialisation and professionalization of mathematical knowledge developed into the 18th and 19th centuries, at the same time that many national and state education systems were established. With the development of industry and technology in the 19th and 20th centuries, mathematics became indispensable to scientific advancement, and it was also applied to quasi-natural and social sciences, such as Marxist economic socialism.

Significant changes occurred in mathematics around the late-nineteenth and early twentieth centuries. The mathematics historian Jeremy Gray notes a major transformation in

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¹¹ This was not the case elsewhere, with considerable advances in mathematics in China, India and the Islamic world. An excellent work in English on non-Western mathematical culture is Katz, *The Mathematics of Egypt, Mesopotamia, China, India, and Islam*.

¹² Keitel, “Perceptions of Mathematics,” 86.

¹³ Ibid.

the ‘ontology’ of mathematics around 1900, especially in geometry and analysis.¹⁴ Most mathematical societies in Europe were founded in the late nineteenth and early twentieth centuries, from the London Society in 1865 to the Italian Society in 1922. The first International Congress of Mathematics was held in Zurich in 1897, followed by Paris in 1900 where David Hilbert delivered what was to become a landmark address in the mathematics community, setting out a number of key problems for modern mathematicians.¹⁵

In 2001, the British mathematician and Fields medallist Michael Atiyah described some major trends in 20th-century mathematics, remarking that while a number of significant new concepts developed during the nineteenth century, many came to fruition only in the twentieth.¹⁶ Atiyah comments, for example, on the significant change inherent in the development from the linear nature of Euclidean geometry, to the more general and fundamentally non-linear approach of Riemannian geometry, which was adopted on a wide scale only in the 20th century. Similarly, he compares the use of classical geometry in the work of Newton (1642-1727) with the modern attempts by Hilbert (1862-1943) to formalise mathematics on an algebraic basis.¹⁷ Atiyah argues that classical geometry is more about spatial intuition and that algebra, given its sequential operations, has on the other hand a definite time-based element to it. Modern algebras were part of an attempt to unify some diverging branches and styles of mathematics. Atiyah concludes that the first half of 20th century mathematics focussed on specialisation, and the second half on unification.¹⁸

In 2002 US science historian Joan Richards examined the development of geometry and its place in public consciousness over the nineteenth century, looking at its relationship with the physical world and subsequent moves towards more abstraction.¹⁹ She comments that in almost all ancient civilisations (Sumerian, Babylonian, Chinese, Indian and Aztec), geometry had been synonymous with the study of space. In the West, that tradition dates from Euclid’s *Elements* which, as already mentioned, is particularly important not only for its content per se, but for the manner in which Euclid presented and ordered the disparate and accumulated knowledge of the time. In particular, Euclid related his geometric terms directly to spatial objects (or ideals of them, such as points and lines), and he also presented axiomatic, self-evident truths which, along with his postulates, have set an ongoing model for the structure of

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¹⁴ Gray, *Plato’s Ghost*, introduction. As I discuss further in chapter 5, the same holds of globalisation in abstract algebra.

¹⁵ Ibid., 36. By contrast, the St Petersburg Academy of Sciences (not mathematics per se) was established in 1724. David Hilbert is discussed in more detail in chapter 5.

¹⁶ Atiyah, “Mathematics in the 20th Century.”

¹⁷ At this point Atiyah raises the case of Nicolas Bourbaki, see note 52.

¹⁸ These are all issues recognised in the case studies.

¹⁹ Richards, “The Geometrical Tradition.”

argumentation.²⁰ Richards argues that David Hilbert's *Grundlagen der Geometrie* (The Foundations of Geometry), published in 1899, marked a breaking of the connection between geometry and space, turning the study of geometry into abstract algebra, where internal structure and not a description of observable space, was paramount.

This was not an abrupt change. Descartes had already begun related work in the seventeenth century, and Newton and Leibniz had been deeply engaged in discussions around geometric versus symbolic and algebraic approaches to calculus. Richards observes that during the nineteenth century the wider context of mathematics was changing. In France, Augustin-Louis Cauchy (1789-1857) had devised an abstract and rigorous method of analysis that eventually led to the abandonment of the hitherto staunch ('synthetic') belief that all mathematical symbols were tightly related to sensory objects. On the teaching side, French mathematics moved away from its role as an essential basis for other, supposedly higher, disciplines, and developed as a field in its own right. As a result it became more specialised and its general accessibility was reduced. In Germany too, mathematics became more abstract, focussing on pure mathematics.

Non-Euclidean geometry is a mathematical concept that features in all three of the case studies, and the consequences of its discovery and development on attitudes towards mathematical truth are very significant.²¹ Richards notes that interest in alternatives to Euclid's parallel postulate had arisen in the middle of the eighteenth century, but consequential theorems were not clearly formulated until the early-nineteenth century, with the work of Gauss (1777-1855), Lobachevsky (1792-1856) and Bolyai (1802-1860). Riemann (1826-1866) brought in the concept of 'metric', by which Euclidean geometry is singled out for its particular distance function that, according to Riemann, was distinctive for its relationship to actual experience in our real world.

Richards comments that non-Euclidean geometry 'burst into European consciousness' in the 1860s, as evidenced in subsequent theoretical developments in mathematics and physics.²² At the same time, she argues that the concepts soon entered the world of fiction:

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²⁰ Alice Jenkins is Professor of Victorian Literature and Culture at Glasgow University, and currently working on a project examining the place of Euclidean geometry in wider Victorian British culture. Observing the centrality of Euclidean geometry in British mathematical education, she remarks that, like mathematics in general, it is rarely studied in cultural history. She notes in particular the Platonic view, prevalent at the time, that geometry gave access to a 'transcendent realm', and the deep attachment to Euclidean deductive reasoning. Jenkins, "Genre and Geometry."

²¹ I discuss the development of non-Euclidean geometry in more detail in chapter 3.

²² Richards, "The Geometrical Tradition," 464.

she points to Edwin Abbott's 1882 *Flatland*, and works by Charles Hinton and H. G. Wells, all of which incorporate notions of multi-dimensional worlds.

Mathematical historians John Fauvel and Jeremy Gray agree with (or perhaps identified) this timing. In a short two-page section, "Influences on Literature", in their extensive *History of Mathematics*, they remark that non-Euclidean geometry became 'a fashionable topic of conversation' at the end of the nineteenth century, suggesting that this may have been because, like relativity later, 'it says something about the physical space in which we live and move and have our being.'²³ Fauvel and Gray note for example that in *The Brothers Karamazov* (1880), Dostoevsky assumed that his readers would understand the allusions to non-Euclidean geometry, and (even if Ivan Karamazov is slightly confused between elliptic and hyperbolic models) that parallel lines might meet.

Brian Rotman repeats the claim that non-Euclidean geometries attracted attention, particularly from artists, in the second half of the nineteenth century.²⁴ Similarly, Solomon Marcus notes a growing emergence of 'fashionable' references to metaphorical four-dimensional space in literature and art.²⁵

In 2010 Amir Alexander published a book examining the extent to which semi-mythical stories about individual mathematicians may have obscured a broader and more socio-analytical approach to the history of mathematics. In the chapter titled "The Poetry of Mathematics", Alexander concentrates in particular on non-Euclidean geometry, commenting that until that point geometry had been the core of mathematics, for it had seemed incontrovertibly true. In words that evoke much of the feeling of that time, he contends:

More than any other mathematical achievement, non-Euclidean geometry embodies the profound transformation in the character and understanding of the field that took place in the nineteenth century [...] mathematics was unmoored from its foundations in physical reality and cast adrift in conceptual space.²⁶

The advent of non-Euclidean geometry was indeed a significant event affecting perceptions of and the overall nature of modern mathematics, and it is an essential concept to bear in mind over the course of all three case studies in this thesis.

I have concentrated so far on academic works by professional mathematicians or historians of science. More popular histories of mathematics are also of interest, for they give

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²³ Fauvel and Gray, *The History of Mathematics*, 538. The similarity in language of these claims suggests they may all derive from this same source.

²⁴ Rotman, "Mathematics," 162–163.

²⁵ Marcus, "Reza Sarhangi Ed., Bridges," 156.

²⁶ Alexander, *Duel at Dawn*, 14.

a sense of the mathematics, and an understanding of the nature of mathematics, that might have been readily accessible to contemporary non-specialists, including poets.

In 2002 William Berlinghoff published a readable and concise overview of mathematical history ‘over the ages’. His three- to five-page entries on specific periods and fields set out mathematical themes of general interest; he asserts that abstraction was the dominant theme in early 20th century mathematics and that Euclid gave not only mathematics but much of western scholarship a method and process for the formulation of logical argument.²⁷

Like Berlinghoff, David Berlinski in 2006 published a short, popular history of mathematics. Regarding non-Euclidean geometries, Berlinski argues that the abstract mathematical developments themselves were not obviously astounding: it was more the physicists who ‘inherited the weird’.²⁸ (In other words, it was the implications for and applications to the ‘real world’ that were odd.) Berlinski looks at how mathematicians achieve certainty, arguing that the rigorous method of proof has a specific intellectual structure to it and – affirming points made already – that Euclid’s method of concise proof and the logical sequence and structuring of ideas have continued to the present day, albeit in a much extended manner, that in its own right constitutes a major branch of mathematics. Berlinski also discusses Gödel’s work in the 1930s on incompleteness and undecidability, a concept I return to in the case studies, in particular chapters 4 and 5. In this context, Berlinski contends that a major consequence of Riemannian (non-Euclidean) geometry was that his concept of the manifold introduced the notion of space-in-itself, not embedded in external space and with no external observer. In addition, Riemann’s coordinate system meant that an intuitive understanding of space was no longer necessary.

These works together build up a picture of mathematics that was initially a practical tool of counting and measuring, which soon developed into a system of logical and abstract thought, appreciated as such outside the field itself.²⁹ The twentieth century brought with it a characteristic mathematics that was less intuitive and less obviously related to reality than had earlier been supposed, and which raised questions about the nature of mathematical truth itself,

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²⁷ Berlinghoff, *Math through the Ages*, 55, 128.

²⁸ Berlinski, *Infinite Ascent*, 58.

²⁹ In Chapter 2 I discuss the “two cultures” debate between science and the humanities, and in particular as it has been taken up in the academic field of literature and science. In his delineation of “two cultures” of mathematics, Timothy Gowers is playing on this debate, in his case arguing that contemporary mathematicians are (still) sometimes split between seeing the central aim of mathematics as to solve problems, and others that it is to build and understand theories. He concedes that individual mathematicians may fall into one or other type, but that as a whole the discipline needs both. Gowers, “The Two Cultures of Mathematics.”

together with a growing appreciation that mathematics was not necessarily the unitary set of facts that might have been inferred from Euclid's *Elements*.

Historiography of mathematics

In 2004 mathematician Leo Corry edited a special issue of *Science in Context*, examining the history of modern mathematics.³⁰ ('Modern' describes the period covering the last third of the nineteenth century to the first half of the twentieth.) Most of the submissions originated from a 2001 conference that looked at new and recent directions in the discipline of history of mathematics. In his introduction Corry contends that the development of the history of modern mathematics, as a discipline, is relatively recent, dating from the final quarter of the twentieth century. He observes that mathematical historians appear to feel that they should apologise for not being active research mathematicians themselves, but the growth of specialisations within the field means this is becoming increasingly less feasible. Furthermore, Corry wonders whether mathematics may well be intrinsically difficult for its historians, given the challenge of remaining comprehensible to non-specialists. He also observes that mathematical history is not widely read even by mathematicians themselves.³¹

In a series of publications during the 1990s, Corry looked at Thomas Kuhn's theory of scientific revolutions, discussing its applicability to mathematics and the resulting implications about fallibility and socio-cultural influence.³² Corry notes that although Kuhn's agenda is disputed within the history of science, it has never been systematically applied to mathematics. Some would claim that there are no revolutions in mathematics, but Corry, however, argues that Kuhn's theory gives rise nonetheless to some interesting ideas for the history of mathematics. He notes for example that it focuses thinking around how mathematics may have changed, and the particular role in this of society and the scientific community.³³

Compared with other areas of science, Corry contends that mathematical knowledge is particularly cumulative: there would be few cases of mathematical 'facts', or a 'body of knowledge', being found later to be erroneous and hence discarded. At the same time, what

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³⁰ Leo Corry is a mathematics and science historian at Tel Aviv University.

³¹ Corry, "Introduction: The History of Modern Mathematics - Writing and Rewriting."

³² Corry, "The Kuhnian Agenda and the History of Mathematics."

³³ I do not discuss Kuhn in any great detail in this thesis, but his writings are of course relevant. His arguments around "revolutions" are, for example, in conscious contradistinction to Karl Popper's theory of scientific method that was based on falsification, or that a scientific theory might best be tested by continually demonstrating counter-examples to be false. Popper also had a significant influence also on the Hungarian philosopher of mathematics Imre Lakatos, who argued that a mathematical theorem is never ultimately true; just that a counterexample has not been found. See Lakatos, *Proofs and Refutations*; Thornton, "Karl Popper." Refer also notes 54 and 281.

one could argue in line with Kuhn is that there have been changes in the ‘images’ of mathematics, by which Corry means the large ideas and guiding principles that play a role in selecting which directions might be later progressed, and how the body of knowledge is interpreted and understood. It is this latter interpretation, rather than the former, that Corry perceives as giving rise to potential revolutions in mathematics.³⁴

The *Science in Context* special issue includes a number of articles addressing specific areas within the field of mathematical history, many of which touch on the issue of socio-cultural influence. Amy Dahan Dalmedico, for example, analyses the political-social context behind the development of mathematical engineering in the former Soviet Union.³⁵ She takes a group of Soviet mathematicians working in a state-controlled programme during the 1950s and 1960s and demonstrates that their work with its focus on industrial production was very different from what was being done in France or the US. While the details of Dahan’s study are peripheral to the present research project, her conclusion explicitly challenges the notion that mathematical content is universal, arguing that it is, in fact, very specific to local and national context.

Dahan’s case study concentrates on industrial-use mathematics. Moritz Eppe, in comparing Vienna and Princeton, examines advances in a specific area of topology during the 1920s, and demonstrates that also in pure mathematics, geographical location has an effect on developments in scholarship.³⁶ Eppe observes that in this case, the end discovery – knot theory – was very similar in both places, but the mathematical background and approach was quite different. In another context, David Rowe addresses the issue of place in his examination of the richness of scholarship around Felix Klein and David Hilbert at Göttingen in the period 1895-1920.³⁷ Rowe concludes that the oral culture at Göttingen may have been more influential than written texts, particularly in the early development of Einstein’s theories of relativity.³⁸

This points to the role of the individual in mathematics. For example, calculus in the hands of Newton and Leibniz perceivably share the same ideas, but developed in radically

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³⁴ Hallyn, on the other hand, notes that the theoretical physicist, Niels Bohr (1885-1962), affirms a principle of correspondence in history of science, meaning that an earlier theory must be contained in the one that replaces it. This is in contradistinction to Kuhn, who posits continuity and progress only in normal times, and not when there is a “paradigm shift”. Hallyn, *The Poetic Structure of the World*.

³⁵ Dahan Dalmedico and Gouzevitch (associate author), “Early Developments of Nonlinear Science in Soviet Russia: The Andronov School at Gor’kiy.”

³⁶ Eppe, “Knot Invariants in Vienna and Princeton during the 1920s: Epistemic Configurations of Mathematical Research.”

³⁷ Rowe, “Making Mathematics in an Oral Culture: Göttingen in the Era of Klein and Hilbert.”

³⁸ Göttingen was a major centre of modern mathematics, see Chapter 5.

different guise. Mathematics is very much influenced by individuals' modes of thought, yet strangely universal for all that, and this lends weight to the Platonic ideal of mathematics.

In this same issue of *Science in Context* Jeremy Gray examines how broader underlying social themes might be pertinent to the history of mathematics. He posits the notion of anxiety as a feature of abstract mathematics, arguing that this modernist concept entered mathematics in the 19th century, and suggests that mathematics not only absorbed anxiety from the wider social context, but developments in mathematics and science, particularly physics, enhanced that feeling in the first place.

Gray observes that multidimensional geometries became generally accepted only in the mid to late 19th century, and the work of Bolyai and Lobachevsky was initially treated with caution, particularly due to its implicit rejection of an *a priori* (Euclidean) truth in mathematics. He also comments that this period was characterised by self-questioning about the nature of proof itself, and a growing awareness of shoddy mathematical argument, inaccuracies and poor standards of proof across many mathematical publications. There was a sense in the mathematical community of disorder creeping in to the field.

At this time, mathematics and physics were beginning to diverge through specialisation and mathematics had to find alternative ways of securing itself, since experimental physics was no longer there as 'proof'. Gray suggests that Hilbert's axiomatic geometry was part of a push towards more logical rigour, but the consequence of his method was that mathematics became less intuitive and obvious. He then considers the work of the German mathematician Oskar Perron, who in 1911 challenged the notion that while few members of the public were interested in mathematics or understood it as well as other branches of science, it was nonetheless considered utterly reliable. Perron argued that in fact mathematics was not reliable, and used Euclid as a particular example to demonstrate his point. That said, Perron went on to contend that uncertainty was not necessarily bad, and that to arrive at new mathematical discoveries, intuition and imagination were essential.³⁹ Gray concludes his article arguing for more attention to be paid to cultural themes in mathematical history, in addition to the development of specific mathematical ideas.⁴⁰

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³⁹This discussion is strongly pursued in the case studies, chapters 3-5. There was another important development at this time; namely the Intuitionism of the Dutch topologist and mathematical philosopher L.E.J. Brouwer (1881-1966), which rejected some widely accepted logical precepts such as "excluded middle" (i.e in propositional calculus, that for any statement A, 'A or not A' is always true). Intuitionism genuinely introduces a form of uncertainty – what is true, depends on what one believes. It ran counter to Hilbert's formalism and while a revolt, it failed to spark a full revolution.

⁴⁰ Note also Gray's full-length work on non-Euclidean geometries, Gray, *Janos Bolyai, Non-Euclidean Geometry, and the Nature of Space*.

He expands upon these ideas in editing a 2006 collection of essays about modern mathematics and culture, in which his own particular contribution examines the extent to which modern mathematics is part of cultural Modernism, with its focus on form and radical understandings of space and time, and how its history could be approached.⁴¹ He argues that the history of mathematics is well worth viewing from a modernist perspective, but concedes that the field thereby becomes enormously complex, encompassing areas in philosophy, linguistics and, potentially, psychology, and concludes therefore that work in the field is inevitably going to be piecemeal.

In 2008 Gray published a full-length book on Modernism in mathematics. Taking the period 1890-1930, he posits that in society generally there was a widespread, complicated and anxious relationship with the day-to-day world. Gray cites the French poet Guillaume Apollinaire who in 1912 argued that ‘real resemblance’ was no longer important – the important thing was truth, which can only be hinted at. As for Modernism in mathematics Gray argues that developments are more part of a ‘single cultural shift’ than due to any particular change in a specific branch, but changes developed most strongly where the separation between mathematics and physics was most advanced. This was the case for example at Göttingen, Berlin and Cambridge, where research in mathematics was being done for its own sake and not for its scientific application.

Gray discusses the German mathematical historian Herbert Mehrtens’s argument of a modern/counter-modern dialectic operating in modernist Europe which sets Hilbert’s axiomatic abstraction and Bourbakian rationalism against the intuition of Klein, Poincaré and Weyl. He goes on to argue that the wider field of science in general is ‘highly intellectually constrained’ whereas Modernism in mathematics developed to such a degree that it was ‘liberated’, and anything possible.⁴² He notes the establishment from the mid-19th century onwards of the various professional mathematical societies and first international congresses, and enthusiasm of the ‘general educated public’ for non-Euclidean geometry, including (special) relativity, around 1900 to 1914.⁴³

As to any specific framework of influence, Gray says it is ‘hard to see’ where a mathematician might draw specific inspiration from say cubism, and he sees Modernism as more of a ‘convergent evolution’ across disciplines. He likens this to the manner in which species develop similar adaptations in response to a particular environmental factor, but where

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⁴¹ Gray, “Modern Mathematics as a Cultural Phenomenon.”

⁴² Gray, *Plato’s Ghost*, 31.

⁴³ *Ibid.*, 37–38. That said, Eddington’s later support in the 1920s for general relativity (postulated in 1915), also influenced its acceptability.

the adaptations themselves are not directly influenced species-to-species. That is, two separate species may more or less simultaneously adapt to a common external factor, and in comparable ways, but it is not necessarily the case (as is sometimes mistakenly assumed) that the change in one species directly influences the other.

Again in 2012, Gray repeats his call for mathematical historians to move away from a ‘worn-out mode’ of the history of ideas, and to look at the place of science in society, arguing that historians of science have clearly adopted this approach, but that it is still not yet embedded within mathematics. But a philosophical approach rarely appeals to practising mathematicians. Mathematics is not just about proving and deducing statements from axioms, or a ‘sterile’ and ‘reductionist’ approach. The challenge from modernist mathematicians is to ‘capture the essence’ of the subject.⁴⁴ Discussion of syntax, axiom systems and semantics became more prominent, and the idea of mathematics as a “formal” language offered a connection to linguistics. Gray concludes that modernist mathematics is abstract:

having little or no outward reference, placing considerable emphasis on formal aspects of the work, and maintaining a complicated – indeed, anxious – rather than a naive relationship with the day-to-day world.⁴⁵

While the social study of mathematics has become more significant, the challenge is to keep in play technical mathematics. A socio-cultural approach to mathematics history has in recent years become more widespread. Eleanor Robson and Jacqueline Stedall’s 2009 history of mathematics, for example, takes a deliberate socio-geographic and cultural approach.⁴⁶ Many of its entries focus on mathematics in a particular time and place, and issues of modernism and abstraction are well covered. That said, the editors concede that their approach is still relatively novel.⁴⁷

Later I will look at a considerable volume of work by a major Romanian scholar of mathematics and poetry, Solomon Marcus, who also incorporates a socio-cultural approach into his work, and which is particularly relevant to the study of Dan Barbilian in chapter 5. In 2003 Marcus gave an informal interview sharing his views on the nature of mathematics – what a full understanding of it comprises and what it is capable of – noting in particular its cultural and historical embeddedness. In describing his own relationship with mathematics, Marcus remarks that he discovered mathematics relatively late, in the final year of high school, and that it was non-Euclidean geometry and its contrast with the ‘intuitive perception of the world’

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⁴⁴ Gray, “History of Mathematics and History of Science Reunited?,” 180–181.

⁴⁵ *Ibid.*, 180.

⁴⁶ Robson and Stedall, *The Oxford Handbook of the History of Mathematics*.

⁴⁷ This assessment is repeated in Stedall, *The History of Mathematics*.

that fascinated him.⁴⁸ He argues that this fascination is not easily developed in the contemporary school system (non-Euclidean geometry being introduced only at tertiary level). He outlines the shortcomings in high-school mathematics teaching, namely ‘the absence of ideas, replaced by procedures’, insufficient attention to historical aspects, poor links to other disciplines and an overall neglect of mathematics viewed ‘as a cultural enterprise’.⁴⁹

He comments that while the popularisation of science is successful, it nonetheless alters the fundamentals of scientific knowledge by means of descriptions that can be very different from pure research. What really is required is for mathematics to be recognised as part of a cultural dimension, with regard to its aesthetic and historical aspects. He notes the argument of Alexander Grothendieck, the algebraic geometer associated with Bourbaki, that the roles of university researcher and teacher should be separated, and while agreeing to some extent, argues that teaching should not be reduced to popularisation. Marcus’s belief in the importance of culture in mathematics goes to the heart of this thesis in its focus on interdisciplinarity. He remarks:

My belief is that apparently heterogeneous fields strongly interact, there is a unity of human knowledge and human creativity; if you don’t take into consideration this fact, you risk getting a fragmentary representation of reality.⁵⁰

Marcus also links his discussion to the use of symbolic language in mathematics, a topic to which I will return. In this interview, he describes as impoverished the viewpoint that mathematics consists only of symbols: mathematical thinking should be separable from mathematical symbolism, with the latter ‘born just from the need to develop the mathematical way of thinking’.⁵¹

In summary, historiography has been applied relatively late to mathematics and its history: traditional histories of mathematics have focussed primarily on delineating a chronological development of main ideas in association with major individuals associated with them; an approach possibly matching an assumption of mathematics itself as ‘pure’. However, recent studies in the history of mathematics that address explicit socio-cultural perspectives include, for example, the influence of geographical location or political environment on the direction of developments in a particular branch of mathematics. As for modern mathematics in particular, scientific-historical trends towards considering broader social developments are

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⁴⁸ Froda, Moisl, and Ghika, “Interview,” 110.

⁴⁹ Ibid., 110–111.

⁵⁰ Ibid., 113.

⁵¹ Ibid., 112.

very much applicable, with a small body of recent research explicitly examining issues of Modernism as they apply to mathematics, including issues of *zeitgeist*, or anxiety, and the focus on form as much as content.

All this said, the history of mathematics arguably remains a minority interest both within and outside the mathematical community itself. Practising historians of mathematics comment that mathematics is a difficult area in which to write history, partly because of the specialised nature of mathematics itself, suggesting that few practitioners can realistically develop a deep understanding of more than their own subfield, and from the point of view of a mathematical historian, it is also less and less feasible to be an active practising mathematician.

Mathematical truth and language

Implicit in the emphasis on the effect of cultural surroundings on mathematics, and the multiple nature of modern mathematics, is the question of mathematical truth itself. The search for unified mathematical fundamentals is associated in particular with the mathematician David Hilbert, and the French group Bourbaki. Nicolas Bourbaki is the pseudonym for the French group of mathematicians who set out in the 1930s to create a new text-book of mathematics, with – they argued – a new format based on greater clarity of structure than had hitherto been the case in mathematics texts. Their aim was to produce a definitive work, and Bourbaki holds a particular place in the development of modern mathematics precisely for its explicit focus on style, and for its part in attempts to describe the foundations of mathematics.

Their approach, on the surface of it, implies that there is a single body of mathematical truth, and this view was a driving force for mathematics during the first half of the twentieth century. The discoveries of Gödel in particular served as a real challenge, and later developments showed that the truth or falsity of fundamental assertions depends on the axiomatic foundations and the models constructed to embody them.

Leo Corry examines this issue in his discussion of ‘eternal truth’ in mathematics, observing that a belief in ‘eternal mathematical truth’ had been part of mathematics since its inception, and that many continue to believe this, and even more to behave as if it is so. He remarks that Hilbert, for example, did acknowledge the historical conditioning of certain fundamental beliefs; and sets this against the 1930s Bourbaki project which he considers was inherently absolutist. Corry contends that while Bourbaki viewed mathematics as an historically developing project, their purpose was to bring this to some kind of ultimate conclusion, whereby the systematic axiomatic and structural method being adopted would ensure a final ‘truth’ about mathematics:

Bourbaki actively put forward the view that their conception of mathematics was not only illuminating and useful for dealing with the current concerns of mathematics, but that this was in fact the ultimate stage in the evolution of mathematics, bound to remain unchanged by any future development of this science. In this way, they were extending in an unprecedented way the domain of validity of the belief in the eternal character of mathematical truths, from the body to the images of mathematical knowledge.⁵²

Such an ‘ultimate stage’ had already been pointed to by Russell and Whitehead with the *Principia Mathematica*, and reflects similar contemporary beliefs, not least Marxist, concerning science. Corry observes that while Bourbaki considered their work to be a natural extension of Hilbert’s method, and to some extent it may have been so, he emphasises that Hilbert always held to the ‘historically conditioned’ character of certain, fundamental mathematical beliefs. This awareness of inherent historical conditioning appeared lost in the Bourbaki project.

In 2010, an interdisciplinary symposium was convened at Cambridge specifically to address issues of truth in mathematics, asking whether mathematics is an intellectual game constructing and tackling invented problems, or acts of discovery exploring ‘an independent realm of mathematical reality’.⁵³

Mathematician Timothy Gowers examines how the words ‘discovery’ and ‘invention’ are used by mathematicians, and concludes that it seems to depend on the amount of ‘control’ one has over the lines of argument.⁵⁴ Broadly, ‘discovery’ is applied when there is more or less one route to take, and the mathematician follows it, whereas ‘invention’ is used more commonly when there are many avenues to pursue, and the mathematician chooses one. Hence, Newton and Leibniz ‘invented’ calculus, whereas the quadratic formula was ‘discovered’. Complex numbers tend to be either, and non-Euclidean geometries were more often ‘discovered’ although some would say ‘invented’. A simple (albeit not easy) proof may be discovered, and a more complicated and lengthy one possibly invented.

Taking another approach to truth and knowledge in mathematics in the same collection, mathematician Roger Penrose examines the ongoing question as to whether the mathematical world is constructed or has an independent existence, asking what kind of access we have to

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⁵² Corry, “The Origins of Eternal Truth in Modern Mathematics: Hilbert to Bourbaki and beyond,” 258. Also Corry, “Nicolas Bourbaki and the Concept of Mathematical Structure.”

⁵³ Polkinghorne, *Meaning in Mathematics*, introduction, 1. (This discussion circumvents, presumably deliberately, the dispute around an external mathematical, “Platonic” reality.)

⁵⁴ Gowers, “Is Mathematics Discovered or Invented?” Gowers is a Fields medallist, and Rouse Ball Professor of Mathematics at Cambridge. The distinction between discovery or invention was earlier discussion by Karl Popper, see note 33.

that mathematical world, and what part does consciousness play.⁵⁵ Another mathematician, Marcus du Sautoy, comments that in mathematics the more one puts in, the more one gets out.⁵⁶ (This is an important observation for the present thesis, as it is equally true of poetry.)

Du Sautoy quotes G.H. Hardy's *A Mathematician's Apology*:

A mathematician, like a painter or a poet, is a maker of patterns. If its patterns are more permanent than theirs, it is because they are made with *ideas*. [...] Beauty is the first test: there is no permanent place in the world for ugly mathematics (emphasis in original).⁵⁷

Hardy's view about an intrinsic 'beauty' in mathematics is a common one: it is one element lying behind Mallarmé's and Valéry's attraction to mathematics and, I would suggest, inherent in Pythagoras's early elevation of mathematics to a spiritual level, later accepted in the Middle Ages in Europe to the extent that mathematics itself almost – temporarily – sank into obscurity. I discuss Mallarmé in greater detail in chapter 2, particularly his planned "book" that would describe the mysteries of the world in a mathematical language. The Hungarian mathematician Paul Erdős (1913-1996) also spoke of an imaginary book, held by God, in which the most beautiful mathematical proofs were already written.⁵⁸ He associated this somewhat Platonist view with a belief in the beauty of mathematics:

Why are numbers beautiful? It's like asking why is Beethoven's Ninth Symphony beautiful. If you don't see why, someone can't tell you. I *know* numbers are beautiful. If they aren't beautiful nothing is.⁵⁹

This question of beauty in mathematics is something that I return to in the next chapter, as several mathematicians, including Russell, go on to make the direct comparison with beauty and an aesthetic value in poetry.⁶⁰ Another issue that arises equally in poetry as in mathematics is language. Whether mathematics is true or descriptive of a truth, leads to the issue of how that truth is described, hence language. As discussed already, mathematics changed significantly in the late nineteenth and early twentieth centuries, both in the nature and breadth of problems, and also in the manner of its writing and presentation. Much of this relates to

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⁵⁵ Penrose is Emeritus Rouse Ball Professor of Mathematics at Oxford and has written a number of semi-popular works about mathematics and mathematical philosophy.

⁵⁶ Du Sautoy is a former Professor of Mathematics and now Simonyi Professor for the Public Understanding of Science at Oxford. He spoke in Wellington, as a guest of the Royal Society of New Zealand, at the end of 2014.

⁵⁷ Du Sautoy, "Exploring the Mathematical Library of Babel," 19–20.

⁵⁸ Erdős worked in combinatorics and probability theory, and also mathematical history. He was Jewish and left Hungary for the United States in the 1930s. He died in 1996 at a mathematics conference in Warsaw. See Schechter, *My Brain Is Open*, 10.

⁵⁹ Devlin, *The Math Gene*, 140.

⁶⁰ In 2014 University College London performed brain scans on mathematicians, and identified brain activity that responded to "beauty" in mathematics in the same way as others have an emotional response to music or art. Gallagher, "Mathematics: Why the Brain Sees Maths as Beauty."

the longstanding issue of whether mathematics describes an external pre-existing reality (a Platonic approach), or whether it creates its own reality. The question then arises as to whether mathematics is a means – some would hope approaching a perfect one – of describing this external reality; or whether mathematics is an entirely self-contained system of writing and semiotics. Intermediate approaches arise; for instance concerning the extent to which mathematics might be intuitive, and the imaginative approach of its practitioners.

This in turn leads to questions about the extent to which natural and mathematical language can adequately express the full possibility of ideas; whether language in mathematics creates and shapes knowledge in certain directions, and what is implied and excluded by mathematical sign (semiotic) systems. In 2000 mathematician Brian Rotman published *Mathematics as Sign*, exploring semiotics in mathematics. Drawing on the work of French postmodern writers such as Gilles Deleuze and Félix Guattari, he examines alternative views of linearity, including non-Euclidean thinking, in mathematics and counting, stating:

As the sign system whose grammar has determined the shape of Western culture's technoscientific discourse since its inception, mathematics is implicated, at a deeply linguistic level, in any form of distinctively intellectual activity. Indeed, the norms and guidelines of the "rational" – that is, the valid argument, definitional clarity, coherent thought, lucid explication, unambiguous expression, logical transparency, objective reasoning – are located in their most extreme, focused, and highly cultivated form in mathematics.⁶¹

Rotman's work is taken up by Vicki Kirby, who researches language in various contexts. Referencing Rotman, her 2003 paper addresses the particular issue of mathematical language.⁶² Kirby comments that the non-alphabetic symbols integral to mathematics have received little attention by humanities scholars otherwise interested in 'texts', and modes of writing, and posits that this suggests an ongoing assumption that mathematical writing has some kind of special a priori truth and foundation. She argues that in fact mathematical writing can be as subject to similar philosophical investigations as other areas of language, and that it has not received such attention is perhaps largely due to the relative inaccessibility of the discipline. In an implicit reference to preceding discussions by mathematicians such as Hardy and Erdős on beauty, Kirby wonders whether the human and emotive aspects attributed to ordinary language could still well be present in mathematics, but that the linear system of constructing formulae and equations obscures this. She furthermore draws on Rotman's work to question whether alphabetic language is mistakenly viewed as self-sufficient in its sign systems, and resistant to a natural incorporation of mathematical symbols. Kirby also asks why diagrams, graphs and

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⁶¹ Rotman, *Mathematics as Sign: Writing, Imagining, Counting*, 1.

⁶² Kirby, "Enumerating Language: 'The Unreasonable Effectiveness of Mathematics.'"

other pictorial representations are considered peripheral to the writing of mathematics. Her conclusion is that mathematics still maintains a subconscious Platonic sense that it is about discovering an external truth, as opposed to its writing being a creative act in itself.

To what extent this might equally be an issue in ordinary, or at least poetic, language is not explicitly examined by Kirby or Rotman. In practice, it may be an issue of semantics. The meaning that mathematicians ascribe to symbols, in effect, has to be constructed by each individual *de novo*; whereas the conceptions within them demand a semiotic representation.

The notion that mathematical creativity may be embedded in and even dependent on, language, is raised by New Zealand mathematics educator Bill Barton, who looks at how mathematics is expressed in various natural languages, including Māori and other Polynesian languages. He argues that while English is the dominant language for (modern) mathematics, the ideas behind certain mathematical verbal expressions differ across other languages. Of particular import to the current discussion, he considers that mathematical creativity may be embedded within language, and that new ideas or interpretations of old ideas may lie hidden in minority languages.

Drawing on George Lakoff and Rafael Núñez's *Where Mathematics Comes From*,⁶³ Barton argues that mathematics 'emerges from communication', to the extent that how mathematical ideas are communicated through natural language is an essential part of the creation of mathematical ideas. Metaphors and how they are understood across different cultures becomes particularly important. While acknowledging the various points of view around the foundations of mathematics, Barton notes that mathematics is generally held to be founded on discourse among humans in facilitating everyday life, and that such needs have clearly shaped the development of the discipline. Barton concludes that while language enables mathematical creativity, at the same time there is a risk of 'mindlocks' in the sense that assumptions about linguistic terms, including the vast array and range of metaphors in language, as well as norms in grammar and syntax, can limit certain potential avenues of thought.⁶⁴ Barton is explicitly raising the issue of metaphor, which is critical to the present thesis.

The 1990 International Congress of Mathematicians included a paper from the Russian mathematician, Yuri Ivanovich Manin, "Mathematics as Metaphor". In this, he discusses mathematics as a language, albeit specialised, and argues that nonetheless it can, like literature, incorporate human intuition, emotion and creativity. Regarding mathematical truth, Manin

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⁶³ See chapter 2 on Lakoff and Núñez.

⁶⁴ Barton, *The Language of Mathematics*, 91–97.

cites French mathematician Henri Poincaré (1854-1912), who in 1902 addressed the long-standing issue of whether mathematics was essentially anything more than a collection of tautological transformations of basic (synthetic) truths, concluding that creativity in mathematics lay in the free choice of initial hypotheses and definitions that were later constrained by comparisons with deductions from the observable world.

Manin contends that because language is symbolic, there will always be physical restrictions on how much and what information can be directly retained by an individual. The role of metaphor for Manin is as an aspect of language that is not ‘speakable’ but about possibility, and ‘the joining of like to unlike such that one can never become the other’.⁶⁵ He comments therefore that mathematics is a metaphor in the sense that one learns, and is creative, through re-thinking what the symbols initially purport to say. He likens this creative act of individual interpretation to reading literature.

Looking at the (then relatively recent) phenomenon of artificial translation, Manin argues that its shortcomings are due to the absence of human intuition and emotion, despite the highly mathematical nature of treating semantics and syntax within automatic translation software. He comments that scientific papers are still written in a mix of technical, mathematical and ordinary language, in order to convey the ‘human’ side of what is being described.

Lastly, and on a practical note, Manin questions the emphasis placed on proof in mathematics, particularly in teaching. In Manin’s view, rigorous proof is just one – valuable, and at times essential – aspect of mathematics, but there are other values such as ‘beauty’ and ‘understanding’, which he does not believe should necessarily be subordinated to rigid rules of proof. His suggestion in this context is that mathematics could be presented with a greater emphasis on its creative aspects as opposed to the rote learning of theorems and proofs.

In fact, emphasis on proof is particularly pronounced in the French and Russian approaches to mathematics teaching, and arguably less so in the anglophone schools, which is a factor relevant to the final section of this chapter. The next chapter returns to many of the issues raised throughout this one, but first I turn to some specifics of the geographical mathematical context in which the poets in the three case studies were directly operating.

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⁶⁵ Manin, “Mathematics as Metaphor,” 1666.

Mathematics in Poland and Romania

I began this chapter with Christine Keitel's outline of mathematics in Europe, in which Euclid was a central and founding figure. In 1992, the European Congress of Mathematics in Paris revisited the legacy of Euclid, but also addressed issues of political influence:

Mathematicians have had to face an image of Europe that has fluctuated in time and in space. Sometimes an ideal to construct, sometimes the reality of an efficient network of specialists. At times this image has served as a foil for other solidarities, of nationality for example, and at times, on the contrary, as a support for the reconstruction of local scientific communities. Political and economic leaders have, in their turn, used mathematics equally as varied; a means of rapid calculation, and organizing metaphor, a method useful for technological production, a model for codifying arguments, or the incarnation of an ideal of reason.⁶⁶

Poland

The question of the political and economically slanted use of mathematics is of particular concern to the Polish poets examined in this thesis, and Poland's general political history is critical to its story of mathematics.⁶⁷ Until the late eighteenth century Poland had been a relatively progressive state: it recognised a number of different ethnic and linguistic groups, had some very old universities, and in 1791 issued one of the world's first constitutions. In 1773 Poland was also one of the first countries in Europe to introduce a national school curriculum, which included mathematics.⁶⁸ This ended abruptly in 1795, when Poland was taken over and partitioned between the Russian, Prussian and Austro-Hapsburg Empires, ceasing to exist as an independent state for 123 years until the end of the First World War.

Education during the period of partition depended to some extent on the respective imperial rulers, but in all three regions education in the Polish language and to Polish nationals was significantly restricted and many mathematicians studied abroad, in some form of exile.⁶⁹ Polish nationalists looked to France as an intellectual model, in part because it was not one of the three occupying powers, and also due to the influence of the (new) *grandes écoles*.

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⁶⁶ Congrès européen de mathématiques, *L'Europe mathématique*, 537.

⁶⁷ For a standard history of Poland see Davies, *Heart of Europe*.

⁶⁸ Davies, *God's Playground*, 228–231.

⁶⁹ A small number of histories of mathematics in Poland have been published. The first monograph, *Pół wieku matematyki polskiej, 1920-1970*, was published in 1973 by the Polish set theorist Kazimierz Kuratowski. An abbreviated version in English is Kuratowski, *A Half Century of Polish Mathematics*. Equally useful are Zofia Pawlikowska-Brozek, "On mathematical life in Poland"; Roman Duda, "*Fundamenta Mathematicae* and the Warsaw school of mathematics" and Jim Ritter, "The limits of European mathematics: centres and peripheries" all in Congrès européen de mathématiques, *L'Europe mathématique*, 207–218, 289–301, 479–498. See also Żelazko, "A Short History of Polish Mathematics"; Duda, "On the Warsaw Interactions of Logic and Mathematics in the Years 1919–1939."

Many future Polish professors of mathematics trained in France, including the geometer Franciszek Sapalski (1791-1838), who studied under Cauchy and Poisson, and on return to Poland in the early nineteenth century wrote the first Polish textbook on descriptive geometry and thus created much of the field's Polish-language terminology, based directly on the French. Polish university students were also taught from textbooks by Lacroix, Cauchy, Biot and Lagrange, in Polish translation. Similarly, secondary school textbooks in arithmetic and elementary geometry were translated from the French.

For a time in the early nineteenth century there were some active science societies, particularly in Warsaw, Kraków and Lwów. But after a Tsarist crackdown many were disbanded, including the University of Warsaw in 1832. Some Polish organisations that had been closed under occupier repression were eventually re-established in Paris, including the scientific societies: from 1870 the Parisian Society of the Exact Sciences had a large Polish membership, then in 1879 the Polish Society of Sciences in Paris (*Towarzystwo Nauk Ścisłych w Paryżu*) was established, publishing scientific papers by Poles in Poland as well as elsewhere in Europe. The journal was taken over under various names, within Poland, often continuing to publish in French.

In 1888 the Polish algebraist Samuel Dickstein established *Mathematical and Physical Papers*, publishing on probability, differential geometry and analytic functions, as well as the history of mathematics. In 1889 the Kraków-based Academy of Sciences and Letters established the *Bulletin international*, still publishing in foreign languages, largely French and German, as well as in Polish.

In Warsaw, the Tsarist hold began to weaken, and in 1897 Dickstein established the journal *Wiadomości matematyczne*, which also focused on history of mathematics. The Warsaw Scientific Society was established in 1903, with the specific aim of teaching, encouraging and bringing together Polish work in the pure sciences and mathematics, in the Polish language. A Warsaw Mathematics and Natural Sciences Faculty was established in 1907, and with the withdrawal of the Russians in 1915 Warsaw University reopened and soon became politically and creatively exuberant, attracting poets as well as mathematicians.

Wacław Sierpiński (1882-1969), Zygmunt Janiszewski (1888-1920) and Samuel Dickstein (1851-1939) were among the first mathematics staff of the new Warsaw University. Janiszewski had studied topology in Göttingen and Paris (under Lebesgue and Poincaré), Sierpiński was a set theorist from Kraków and then Lwów. Early students included Szolem

Mandelbrojt (1899-1983, uncle of Benoit Mandelbrot) and Alfred Tarski (1901-1983), along with Kazimierz Kuratowski, the author of the first history of Polish mathematics.⁷⁰

The period following Polish independence in 1918 was very fruitful for Polish mathematics, as it was in many areas of culture, and the Warsaw School of Mathematics was very active. Tarski was a key member in logic and universal algebra, and Sierpiński in set theory. The Warsaw School also worked closely with the Lwów School (in what is now Ukraine), and there were many personal connections between the two. Lwów had a strong focus on mathematical logic, and key members included Stefan Banach (1892-1945, who made advances in, *inter alia*, algebra, functional analysis and set theory) and Stanisław Mazur (functional analysis, algebra).

In 1917 Janiszewski set out what in effect became a programme for future Polish mathematics, arguing for concentration on a few (at the time) relatively obscure fields where Poles might build up expertise, namely set theory, topology, mathematical logic and some foundations of mathematics. Along with his mathematical colleagues in Warsaw and Lwów, Janiszewski established the journal, *Fundamenta Mathematicae*, which first appeared in 1920 and was the first mathematical journal in the world to specialise in such narrow fields. In 1921 the editor of the *American Mathematical Monthly* commented favourably on the periodical; and Lebesgue was also complimentary. In 1936 the major Polish literary journal *Wiadomości Literackie* took notice, remarking that the 25th issue of *Fundamenta Mathematicae* was a great day for Polish mathematics. (The item is, unsurprisingly, short, with little mathematical content.)

By the 1930s the Polish Mathematical Society had further enhanced its specialisation plans, and devised a scheme whereby Lwów might concentrate on applied mathematics and Warsaw on pure. But then came the Second World War, which impacted profoundly on Polish life, specifically targeting intellectual culture. Many Polish intellectuals, especially Jews, were killed and others fled. Szolem and Benoit Mandelbrojt left for Paris and the US, never to return, and in 1939 Tarski also left for the US, where he developed his major work on relational algebra.⁷¹

In 1944 the large mathematical library in Warsaw was destroyed, and by the end of the Second World War Poland had lost around fifty per cent of its mathematicians, by death or emigration, and on top of this suffered a student generation gap, many of whom had been killed or had missed out on education under the occupation.

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⁷⁰ See note 69.

⁷¹ In this work, Tarski was particularly interested in the relational logic of C.S. Peirce (1839-1914), who is discussed in more detail in Chapter 2.

Romania

Even more than in Poland, the history of mathematics in Romania is a relatively unexplored area, but a small group of mathematical researchers have investigated the topic, noting in particular the influence of the French system on Romanian mathematics.⁷² The study of mathematics was introduced into Romanian high schools in the 18th and 19th centuries, with the first Romanian-language text-book published in 1777.⁷³ The Universities of Iași and Bucharest were established at this point, with higher mathematics teaching offered by Romanian graduates of the Sorbonne. These early teachers rarely had doctoral degrees.⁷⁴ These factors contribute to the observation that as a whole the ‘Romanian intellectual tradition’ dates back to 18th and early 19th centuries, when students began to travel to France and Germany, bringing back ideas from there.⁷⁵ Mircea Becheanu of the Romanian Mathematical Society remarks that Romania has long looked to French culture as a major influence, and the adherence to French systems is also in part a reaction against the influence of the large empires surrounding Romania, notably the Russians and Prussians.⁷⁶ (Bucharest was in the late 19th and early 20th centuries termed the ‘Paris of the East’.)

George Șt Andonie wrote one of the first histories of mathematics in Romania, in 1981 while the country was still under Socialist rule. Șt Andonie remarks that from a relatively limited base, a major change in the status of Romanian mathematics occurred around 1900.⁷⁷ In 1878, Spiru Haret (1851-1912) had graduated from the Sorbonne with a doctoral thesis on celestial mechanics, drawing largely on the work of Poisson and Lagrange; and the following

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⁷² See Constantinescu, “Simion Stoilow.” Constantinescu was Professor in Algebra at ETH (Eidgenössische Technische Hochschule) in Zürich. His article led to an interesting reaction from its reviewer at the American Mathematical Society: Brazilian mathematical historian Ubiratão D’Ambrosio took particular exception to what he considered a politically-motivated attack on the then socialist government in Romania. D’Ambrosio counts that of the article’s 19 pages, 5 of them are:

devoted to criticizing the Romanian Government [...] One may ask whether papers like this should be published in mathematical journals, and whether they do good or harm to the community as a whole and to international cooperation. Should mathematics be treated as culturally and politically free? The reviewer is convinced that it should not, hence ideological and cultural components intervening in the production of mathematics should be investigated and explicitly exposed.

D’Ambrosio, “Simion Stoilow by Corneliu Constantinescu (review).” As the case studies later demonstrate, this may be an opinion with which Barbilian had some sympathy, given his apparent avoidance of political engagement, but is less likely the case for Miłosz and Herbert.

⁷³ Șt Andonie, *Istoria științelor în România*. It is interesting to note that this period of the establishment of mathematics in Romania coincides with the modernist period in mathematics generally, particularly Europe, as discussed at length by Gray in Gray, *Plato’s Ghost*.

⁷⁴ Iacob, “The Solid Foundations of Tradition.” Caius Iacob is Head of Mechanics in the Mathematics Faculty at Bucharest University.

⁷⁵ Reid, “Appeal for Romanian Science,” 22.

⁷⁶ Saul, “Mathematics in a Small Place,” 563–564. Mark Saul is a US mathematics teacher who in 2002 visited Romania to examine the incorporation of higher mathematics into the high-school curriculum. While there he met Mircea Becheanu, a professor in algebra at Bucharest University and deputy chair of the Romanian Mathematical Society.

⁷⁷ Șt Andonie, *Istoria științelor în România*.

year, in 1879, David Emmanuel (1854-1941) likewise had graduated from the Sorbonne with a doctoral thesis on abelian integrals (a field essential to modern geometry). Both Haret and Emmanuel returned immediately to Romania where they set up university-level courses in mechanics, algebra, geometry, calculus and analysis; they are now considered among the founders of the Romanian school of mathematics. In 1897 Haret went on to be Minister of Education and continued his advocacy for the development of mathematics in Romania.⁷⁸

In this environment mathematical societies began to take shape: an informal association, the Friends of Mathematical Sciences, was founded in 1894; and a magazine promoting mathematics, particularly among high-school students, *Gazeta matematică*, was first issued in 1895.⁷⁹ The Romanian Society of Sciences was established in 1897, under the presidency of the mathematician, Grigore Moisil⁸⁰, and the official Romanian Mathematical Society was formed in 1910.⁸¹ The *Gazeta matematică* went on to become the official journal of the Romanian Mathematical Society.⁸²

With respect to external influence and style, Romanian mathematicians continued to return to the Sorbonne in particular as guest lecturers, to receive colleagues from around Europe and to participate fully in regional mathematics conferences, and they published a mathematics journal from Cluj-Napoca, in which European mathematicians published including from France (and Poland).⁸³ Becheanu reflects that in Romania a formalist approach to mathematics teaching is still, in the twenty-first century, more common than a more ‘intuitive’ approach, and that this dates specifically to the French Bourbaki, who ‘made a lasting impression’ on both the research and teaching communities in Romania. Indeed, this formalist approach is evident in the work of Barbilian and of his major critic, Solomon Marcus, which I discuss in chapter 2 on mathematics and poetry. The work of Barbilian as a whole is the subject of chapter 5.

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⁷⁸ Iacob, “The Solid Foundations of Tradition.”

⁷⁹ Berinde and Berinde, “The Romanian Mathematical Society.” Its full title was *Gazeta Matematică, revistă de cultură matematică pentru tineret* (“The Mathematical Gazette: Journal of Mathematical Culture for Youth”).

⁸⁰ It was Moisil who assisted in Barbilian’s promotion to full professorship in 1942. See chapter 5.

⁸¹ Șt Andonie, *Istoria științelor în România*. The Romanian Mathematical Society is thus rather late in its foundation, compared with elsewhere in Europe. Berinde and Berinde, “The Romanian Mathematical Society.”

⁸² The *Gazeta Matematică* and the Romanian Mathematical Society continue to have a strong focus on education and encouraging mathematics education among youth. It was in Romania, for example, that the International Mathematical Olympiad - a mathematics competition for high-school students, initially in the Soviet Bloc and now world-wide, was initiated in 1959. Berinde and Păcurar, “The Measure of a Great Idea.”

⁸³ Iacob, “The Solid Foundations of Tradition.” Cluj was the hometown of non-Euclidean geometer, Bolyai.

Concluding remarks: the multiple nature of mathematics

Mathematics is and can suggest many things, particularly as it has evolved in the modern era. While it originated as a practical tool, from the time of Pythagoras it developed its deeply theoretical and intellectual nature, moving towards an ideal of a universal logical and rational, even spiritual language. By the beginning of the twentieth century mathematics had come to encompass abstraction, specialisation and unification, and had encountered undecidability, self-questioning, multiplicity and anxiety. With advances in non-Euclidean geometry and in mathematical formalism, mathematics was far from a readily comprehensible picture of the observable world, and had become ‘unmoored from its foundations in physical reality and cast adrift in conceptual space’.⁸⁴

At the same time, the questioning and alternately affirming of an eternal truth in mathematics has run up against demonstrations of its firm embeddedness within its immediate socio-cultural context. Mathematics is simultaneously invented and discovered, externally existent and created. These extraordinary possibilities are represented in deeply metaphorical language, with an allure that is on the one hand very precise, and on the other, ineffable.

These characteristics were all well understood by modern mathematics communities in Poland and Romania. Heavily influenced by the French and to some extent German traditions, Polish culture underwent a flowering between the two world wars, developing particular specialisations in logic, algebraic set theory and foundations of mathematics. In Romania that intellectual growth was most pronounced from the start of the twentieth century. In both societies, the promotion of and spread of mathematical learning across the curriculum, from primary schooling, was important and influential.

The next and subsequent chapters of this thesis will explore how much of this complex nature of mathematics has been understood and incorporated into poetics.

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⁸⁴ See note 26.

CHAPTER TWO

Mathematics and Poetry:

‘a delicate, beautiful explanation of the world’⁸⁵

Abstract

The previous chapter examined the complex and varied nature of mathematics, in the rich period of the late nineteenth and early twentieth centuries. This chapter draws on various strands of that richness, suggesting multiple connections with poetry through questions of meaning, truth, ambiguity, imagination, concision and language. Essential to the question of language, and the various aspects of a relationship between mathematics and poetry, is metaphor.

Building on the previous chapter, this one is also essentially a literature review, drawing attention to various specific issues that have emerged around mathematics and poetics. These will inform the later discussion around what might make up possible frameworks for the relations between mathematics and poetics.

Introduction: “Mathematics and poetry” as an academic discipline

Of any established academic sub-discipline, literature and science initially seems an appropriate frame of reference in which to set a discussion of the relationship between poetry and mathematics. And indeed there are a number of issues arising in this field that directly inform the present research topic. However, as the discussions around the nature of mathematics develop, particularly against a background of poetry, it becomes increasingly apparent that many of the aspects of mathematics that offer the most potential in such a comparison are those which are peculiar to mathematics’ own special characteristics that set it apart from the experimental sciences. That is, the fact that mathematics is both a science and humanities subject becomes particularly pertinent, and mathematics and poetry do not necessarily fit neatly into a literature and science framework.

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⁸⁵ Paul Valéry in 1891. See note 134.

There are also significant differences between national traditions in “literature and science”. Anglophone scholarship tends to take as its starting point an assumption that the two fields are starkly different from one another, and then challenge this assumption by identifying hitherto underexplored points of commonality. This approach stems in particular from the “Two Cultures” debate, resurrected in the 1950s by C.P. Snow and F.R. Leavis, and which for a long time formed a theoretical starting point for the emerging academic sub-discipline of “science and literature”. The debate essentially veers back and forth between the dialectic of two separate cultures of science and the humanities, the question of which should take greater precedence, efforts to unite these cultures, claims that they already are united, and denying that in fact no such separate cultures exist in the first place.⁸⁶ While interdisciplinary work between literature and science has largely moved on from this point, scholarship in the field can inform the less well-developed area of mathematics and poetry, and I draw on some specific notions in the current chapter.

In continental Europe, this distinction between literature and science, and between mathematics and poetry was less evident in the first place, hence the remark of the Czech immunologist and poet, Miroslav Holub, that the “two cultures” discussion is a non-debate.⁸⁷ This view is also reflected in comments on the Anglophone influence by Romanian mathematician, Solomon Marcus, at an inaugural interdisciplinary conference for mathematics and the arts, held in 1998. Marcus contends that in Eastern Europe (and similarly in countries such as Brazil) that due to ‘a great delay in their cultural development’ or absence of ‘long cultural tradition’, scholars and artists there have been more open to bridging art and science than in other parts of the world.⁸⁸ Marcus goes on to argue that mathematics has long been a

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⁸⁶ In 1880 Thomas H. Huxley publicly argued that literature should be barred, in favour of science, from what is now the University of Birmingham. This was challenged by Matthew Arnold in the 1882 Rede Lecture at Cambridge, “Literature and Science”, in which he raised concern over the emerging division between the two disciplines. In 1956 C.P. Snow gave that year’s Rede Lecture: Snow, *The Two Cultures*. His remarks were immediately challenged by various academics including F.R. Leavis, Jacob Bronowski and later Aldous (grandson of T.H.) Huxley. Snow’s initial stance derived from a concern that the views of scientists, particularly industrialists, were not being taken into sufficient account by the British (and US) public service that was dominated by arts graduates. Snow argued that science and literature had in fact been scarcely distinguishable from one another in the classical and mediaeval periods, and that the two fields had grown separately only in modern times. This had resulted in two distinct cultures: on the one hand (pure) scientists and on the other literary intellectuals. The two groups were not communicating, with literary intellectuals tending to hold more influence over public-policy makers. Snow argued that the problem could be addressed through education, and that scientific technology could and should be employed to eliminate poverty. Snow’s lecture is fairly rhetorical in style and does not point to any particular abstract theory that might bridge the two disciplines, but is frequently drawn on as a fundamental text in scholarship on science and literature, a standard instance being Gossin, *Encyclopedia of Literature and Science*.

⁸⁷ Holub, “Poetry and Science.” See also note 209.

⁸⁸ Marcus, “Reza Sarhangi Ed., Bridges,” 150. Solomon Marcus is a key figure in this thesis, see note 248, also chapters 1 and 5. Marcus’s views on ‘cultural tradition’ are, of course, debatable.

‘catalyst’ for the transfer of ideas from one field to another, giving the example of thermodynamic entropy entering information theory then linguistics and art.

In the United States, the philosopher and mathematician Scott Buchanan began a series of night classes during the 1920s, teaching mathematics to immigrant workers in New York. Buchanan tried to impart to his audience his sense of beauty in mathematics, explicitly comparing it with poetry.⁸⁹ Recent attempts to ‘bridge’ mathematics and poetry, and mathematics and literature, include the inaugural *Humanistic Mathematics Network Journal* launched in the United States in 1987; and the aforementioned annual conference “Bridges: Mathematical Connections in Art, Music and Science”, which was established in 1998 in the US by the Iranian mathematician Reza Sarhangi, and which now takes place across Europe and North America.⁹⁰ In 2006 the Mathematical Association of America formed an arts-related branch, SIGMAA-ARTS, and in 2007 the *Journal of Mathematics and the Arts* was established. The first special issue on Mathematics and Poetry was issued in 2014.⁹¹

In the UK, the British Society for Literature and Science was formally established in 2004. In 2013 the 24th International Congress of History of Science, Technology and Medicine, a four-yearly conference run by the International Union of History and Philosophy of Science and Technology, was held in Manchester and, for the first time, this conference included a session specifically devoted to literature and science.⁹² The first international specialist conference on science and literature, within the IUHPST, took place in 2014 in Greece. But none of these to date has a specific stream for mathematics, although informal mathematics clusters are slowly emerging.

In 2012, the mathematician Barry Mazur and novelist Apostolos Doxiadis published their collection *Circles Disturbed*, remarking that although relatively recent, attempts to examine connections between mathematics and narrative are now becoming more frequent.⁹³ In March 2014 the University of Leipzig hosted an inaugural conference on mathematics and literature,

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⁸⁹ In his published lecture notes, Buchanan muses that poetry and mathematics both are mystical and exotic, and that – like poetry – mathematics is beautiful, but he does not offer a theoretical approach. Buchanan, *Poetry and Mathematics*.

⁹⁰ After the first conference in 1998, Solomon Marcus noted his regret that the resulting conference proceedings omitted the ‘important interaction between mathematics and poetry’. Marcus, “Reza Sarhangi Ed., Bridges,” 153. Mathematician Sarah Glaz observes that at the 2010 conference in Hungary, only one poem was entered. Glaz, “The Mathematical Art Exhibit at Bridges Pécs.”

⁹¹ Glaz, *Journal of Mathematics and the Arts*. Contributions were required to demonstrate ‘a blend of both scholarship and art’.

⁹² University of Manchester, “24th International Congress of History of Science, Technology and Medicine.”

⁹³ Doxiadis and Mazur, *Circles Disturbed*. See further note 177. Barry Mazur is Professor of Mathematics at Harvard and Apostolos Doxiadis studied mathematics at Columbia and the École Pratique des Hautes Études in Paris.

“The Common Denominator”, within the ambit of British (English-language) cultural studies.⁹⁴

Aside from these formalised attempts to bring together mathematics and poetry, there are a number of scholars working in a more *ad hoc* manner in the field, and it is on these works that I draw in this chapter.

Mathematical poetry

Chapter 1 examined the nature of mathematics in some detail, emphasising particular modernist characteristics. The nature of poetry is an equally vast field, but such a discussion is beyond the scope of this thesis; I mention here a few essential points which are particularly relevant in terms of their relationship to mathematics.⁹⁵ In this context, a remark by the literary theorist I.A. Richards is noteworthy:

A good deal of poetry and even some great poetry exists in which the sense of the words can be almost entirely missed or neglected without loss... the form often seems as an inexplicable premonition of a meaning which we have not yet grasped.⁹⁶

Ivor Armstrong Richards (1893-1979) was central to the establishment in the 1920s of literary study as a modern academic discipline. His 1926 *Science and Poetry* – later retitled *Poetries and Sciences* – laid out what was at the time an innovative distinction between scientific and poetic language.⁹⁷ What is interesting about his remark here is that he emphasises the form of poetry over its content and frequent elusive meaning. These are important aspects of the relationship of poetry with mathematics.

The multiple nature of poetry is inherent in sense 2a of ‘poetry’ in the *Oxford English Dictionary*, which reads:

Composition in verse or some comparable patterned arrangement of language in which the expression of feelings and ideas is given intensity by the use of distinctive style and rhythm; the art of such a composition.⁹⁸

Sense 1b of ‘poetics’, reads:

(in modern usage) The creative principles informing any literary, social or cultural construction, or the theoretical study of these; a theory of form.⁹⁹

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⁹⁴ University of Leipzig, “The Common Denominator.”

⁹⁵ A very useful anthology of writing on modern poetry is Cook, *Poetry in Theory*. Cook has selected a number of twentieth-century poets and critics whose works are covered in this thesis.

⁹⁶ Cited in Walker and Walker, *The Twain Meet: The Physical Sciences and Poetry*. Walker and Walker analyse a large range of poems from 18th to 20th centuries for their exposition of contemporary scientific ideas.

⁹⁷ *Science and Poetry* argues, inter alia, that poetry differs from science in that poetry has a value independent of its truth or falsity. See also note 215.

⁹⁸ “Poetry, N.”

⁹⁹ “Poetics, N.”

Without any desire to exclude broader discussions, these are some definitions that I found particularly useful as a starting point, and will draw on closely in this thesis. The understanding of poetics as ‘creative principles’ informing a construction, or form, are what I particularly employ in the overall thesis title.

Poets attracted to the structure and aesthetics of mathematics

Chapter 1 also touched on an aesthetic aspect of mathematics, and its beauty as viewed by mathematicians themselves. I look now at how practising poets see mathematics and use mathematical imagery in their poems.¹⁰⁰ Two prominent figures in the US are mathematicians Sarah Glaz and JoAnne Growney.¹⁰¹ They have both done much to raise awareness of the possible connections between mathematics and poetry, and in 2008 co-edited *Strange Attractors*, a collection of poetry that specifically uses mathematical imagery. Observing that mathematical poems rarely appear in mainstream literary publications, Glaz and Growney’s selection dates from the biblical King Solomon and Catullus, through to the modern-day. The poems encompass various references to mathematics, in content, form and imagery, ranging from simple counting to glancing allusions to advanced algebra.¹⁰²

Glaz and Growney describe one of the earliest known poets, the Sumerian Mesopotamian Enheduanna, who was chief priestess to the moon god Nanna around 2300 BC. Associated also with the grain goddess Nisaba, Enheduanna was patron of the written arts and mathematical calculations. These included astronomical calendrical calculations and civic mathematics related to engineering and property boundary setting: as I discussed in the previous chapter, early mathematics did not involve the complex specialist work associated with modern mathematics today. With reference to the separation of mathematics and the arts, Glaz and Growney link this to the general increase of knowledge, specialisation and consequent division of disciplines that took place in the modern period, to the extent that the volume of available knowledge has exceeded the learning capacity of any one individual.

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¹⁰⁰ The history of scientific imagery in literature is outlined in Rousseau, “Literature and Science.” An early instance of its analysis is Nicolson, *Newton Demands the Muse: Newton’s Opticks and the Eighteenth Century Poets*.

¹⁰¹ Glaz is a Professor in algebra and mathematics education at the University of Connecticut. Growney is a former mathematics lecturer and now poet, who runs a blog dedicated to mathematical poetry. Both Growney and Glaz have an interest in Romania: Growney translates Romanian poetry, and Glaz was born in Bucharest.

¹⁰² Glaz and Growney, *Strange Attractors*. The majority of the poetry is from the Anglophone world, and as such falls outside the central scope of my thesis. One poem in the collection is by the New Zealander C.K. Stead, in which he enumerates and categorises different types of romantic relationship with reference, including a graphic representation, to a Venn diagram. Asked, Stead later remarked that he had not been following any particular concept in his choice of mathematical imagery: ‘Maths has only crossed paths with poetry for me rarely and by accident.’ Stead to Kempthorne, “Mathematics and Poetry.”

Glaz and Growney identify a small number of explicit attempts to address mathematics in poetry before their own anthology, such as Robert Moritz's 1914 *Memorabilia Mathematica*, a collection of anecdotes, verse and aphorisms relating to mathematics, which includes poetry by Dante, Goethe and Tennyson.¹⁰³ Glaz and Growney find that the earliest collection of specifically mathematical poetry dates from 1979, Ernest Robson and Jet Wimp's *Against Infinity: An Anthology of Contemporary Mathematical Poetry*.

In 2008 Growney outlined various areas of mathematical influence on poetry, in an article that begins by noting similarities between the two: that the language of both explicitly favours precision and concise clarity; that each word and symbol is chosen with particular care; and that meaning is apparently created out of something relatively small on the page. Acknowledging that it is difficult to define either field with precision, she contends that they both nonetheless involve 'language', 'imagination', 'elegance' and 'delight'.¹⁰⁴ She cites T. S. Eliot's claim that poetry 'can communicate before it is understood', and suggests that mathematics also shares this characteristic.¹⁰⁵ Growney goes on to discuss the importance of counting in poetry, syllables and lines, which, while this may appear mundane, is an essential feature.

Growney does not always attempt to advance any theory of how mathematics and poetry might be related, preferring to offer the poems as they are, remarking that the use of mathematical terminology and imagery creates a particular vividness. Indicating that such images might not otherwise be easily rendered in ordinary language, she concludes:

These poets use mathematical terms [...] to give us the picture that is *worth a thousand words* (emphasis in the original).¹⁰⁶

This remark encapsulates an important point of this thesis: that both mathematics and poetry share an affective quality, otherwise indescribable.

In a similar work from 2011, Glaz discusses various poems inspired by mathematics, ranging from counting in ancient Mesopotamia, to geometric angles in Coleridge's "A Mathematical Problem", and one by the French poet Guillevic on parallel lines.¹⁰⁷ Glaz briefly

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¹⁰³ Moritz, *Memorabilia Mathematica*.

¹⁰⁴ Growney, "Mathematics Influences Poetry," 1.

¹⁰⁵ Eliot's poetics had an influence on both Milosz and Barbilian; in the case of Milosz for Eliot's views on cultural influence in poetry, and for Barbilian, his more esoteric experiments with language. See chapters 3 and 5.

¹⁰⁶ Growney, "Mathematics Influences Poetry," 5.

¹⁰⁷ Eugène Guillevic (1907-1997) was a French poet, one of whose collections, *Euclidiennes*, is a series of one page poems, each prefaced by a simple mathematical diagram derived from Euclid's *Elements*, such as a parallel line, a point, or a triangle, and then a response in verse to that geometric image. See Guillevic, *Euclidiennes*.

summarises key concepts in mathematics such as algebra, calculus, series, the number e , Cantor's set theory, Hilbert's foundations of mathematics, Gödel's incompleteness theorem and Mandelbrot sets, all as they appear in one or other of the selected poems; for instance, Sandra M. Gilbert's poem, "He Explains the Book Proof" is a reference to the Hungarian mathematician Paul Erdős.¹⁰⁸ Glaz concludes that the 'power of poetry to engage attention and enhance memory' is an excellent tool for mathematics education, where ideas can be conveyed in that form.¹⁰⁹

Another recent anthology of mathematical poetry is the 2008 collection edited by mathematician Marcia Birken and literary theorist Anne Coon.¹¹⁰ Each chapter of their book takes a different mathematical concept and analyses in detail its representation in poetry, starting with some of the more elementary concepts such as counting and shapes, before moving on to symmetry, fractals and what they describe as mind patterns: proof, paradox and infinity. Their categorisation of various concepts in mathematics as they relate to poetry is interesting, and the ordering is one that I draw on in chapter 4 on Zbigniew Herbert.

In their section on counting, Birken and Coon open with a description of what the natural numbers, integers, real numbers and so on are, then they discuss counting in poetry – rhythm, number of lines, and counting in lists (notably Elizabeth Barrett Browning's "How do I love thee?"); then counting in form, such as in Pascal's triangle, the Fibonacci sequence and golden ratio, as compared with counted form and permutations in the sestina, sonnet and villanelle. They then look at shapes, starting with mathematical descriptions of planes, spirals, and symmetries, moving on to give examples of shaped poetry and symmetries in form, with a discussion of hyperbolic geometry, its relation to Escher, and symmetry as metaphor. Fractals are another area of mathematics that they discuss, particularly self-similarity, recursiveness, iteration and scale, and the transfer of these features in specific poems.¹¹¹ They identify these features in modern poetry consciously inspired by mathematics, as well as noting fractal-like features in a Shakespearean sonnet, and an 18th-century German 'shaped' poem that they remark physically resembles Hilbert and Peano's 'pathological' oddly dimensioned curves.

Birken and Coon's particular point is that while modern mathematics gave the formulae and computer-generated images of fractals (a post-Second World War discovery

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¹⁰⁸ Erdős is discussed in chapter 1.

¹⁰⁹ Glaz, "Poetry Inspired by Mathematics," 181.

¹¹⁰ Birken and Coon, *Discovering Patterns in Mathematics and Poetry*. Birken is a former mathematics Professor and Coon a Professor of English.

¹¹¹ Fractals were developed by the Polish-born Mandelbrot, see Chapter 1.

initiated by Mandelbrot), the concepts themselves exist in nature. In other words, fractals are a good example of a not obviously uni-directional influence from mathematics into poetry.¹¹² Furthermore, they contend that poetic interpretation of fractals adds to intellectual understanding of the concept, because it is a fundamentally ‘poetic’ concept. They cite Mandelbrot himself in *The Fractal Geometry of Nature*:

The nature of fractals is meant to be gradually discovered by the reader, not revealed in a flash by the author. And the art can be enjoyed for itself.¹¹³

Taken in this context, Mandelbrot’s comment about mathematics is of course immediately applicable to the practice of poetics. Indeed, Sarah Glaz reviewed Birken and Coon’s book in 2010, commenting:

There is a deep connection between mathematics and poetry that defies all attempts to give it full explanation.¹¹⁴

Glaz goes on to say that there have in recent years been increased attempts ‘to explain or highlight’ the connection, and that one of the strengths of Birken and Coon’s book is that it highlights connections ‘without minimising their differences.’¹¹⁵

So far, I have looked at poetry anthologies, and the views of their mathematically-trained editors. I turn now to a small selection of individual poets themselves, all of whom employed mathematical imagery, and whose influence has some bearing on the main case studies. These poets and their critics raise issues of a mathematical literary structure, an innate mathematical quality to language, linguistic formalism, mathematics as a deterministic and ordering principle for the universe, and the sense of an ‘aesthetic’ that is mathematical.

Poetic Symbolism: Novalis; Mallarmé; Valéry; Norwid; Belyj; Khlebnikov

This thesis concentrates on modern mathematics. Predating the modernist movement by almost a century, however, was the German poet and philosopher, Novalis (Friedrich von Hardenberg, 1772-1801), who after his death became an influential figure for developments in poetics, particularly French Symbolism of the nineteenth century, and the Russian Symbolism of the early twentieth century. Novalis was deeply interested in science, particularly the contemporaneous empirical science of the 18th-century encyclopedists under Denis Diderot.¹¹⁶

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¹¹² N. Katherine Hayles has also written on fractals in literature, see for example Hayles, *Chaos and Order: Complex Dynamics in Literature and Science*.

¹¹³ *The Fractal Geometry of Nature*, 5 cited in Birken and Coon, *Discovering Patterns in Mathematics and Poetry*.

¹¹⁴ Glaz, “Discovering Patterns in Mathematics and Poetry,” 227.

¹¹⁵ *Ibid.*, 227–228.

¹¹⁶ Gjesdal, “Georg Friedrich Philipp von Hardenberg [Novalis].” See also the Booker Prize shortlisted: Fitzgerald, *The Blue Flower*.

He has been described as a unique figure in his attempts to synthesise the two discourses of poet-philosopher and geologist, considering the role of imagination central to both literature and science.¹¹⁷

Novalis wrote a number of letters expounding his views on mathematics, focussing in particular not on mathematical content as such, but on its methodology. He remarks:

The mathematical method is the essence of mathematics. He (sic) who fully comprehends the method is a mathematician.¹¹⁸

And similarly:

Pure mathematics is not concerned with magnitude. It is merely the doctrine of notation of relatively ordered thought operations which have become mechanical.¹¹⁹

That is, mathematics is less about its mechanics such as measurement, and more about a system of thought processes. This understanding of mathematics is taken up in greater detail in the case studies, particularly the third (on Barbilian) and to some extent the second (on Herbert) and it describes an aspect of mathematics that lies behind the attraction of poets to the subject: its perceived clarity of method.

Martin Dyck is a Professor in German who studied mathematics in his undergraduate degree. In 1960 he wrote a study of the mathematical content in Novalis's writing, estimating it at around five per cent.¹²⁰ Remarking on the low levels of general mathematical education available to literary scholars at the time, Dyck assesses Novalis's own efforts to improve his mathematical knowledge, basing this assessment on handwritten annotations and references across various manuscripts used by Novalis, and the nature of the philosophical and mathematical texts in Novalis's personal library. Dyck succinctly outlines the situation in mathematics at the time of Novalis in the fields of geometry, arithmetic, algebra, number, basic operations, infinitesimal calculus, function, continuity, and infinity; he considers Novalis's own comments and offers an estimate of Novalis's mathematical knowledge, his reading of basic mathematical symbols and formulae, and his likely understanding of concepts such as 'definition', 'axiom', 'theorem' and 'proof'.

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¹¹⁷ Weininger, "Introduction: The Evolution of Literature and Science as a Discipline." In fact, as was discussed in note 86 in the context of "two cultures", various scholars argue that originally the two were one discourse, that evolved and separated, but that this separation was far from inevitable, being rather a cultural phenomenon in itself.

¹¹⁸ Moritz, *Memorabilia Mathematica*, 121. From Novalis's *Schriften* (1901), 190

¹¹⁹ Ibid., 4. From Novalis's *Schriften* (1901), 282

¹²⁰ Dyck, *Novalis and Mathematics*. Dyck does not specify, but his analysis implies that this figure of five per cent refers to explicit mathematical imagery or reference, and not a 'mathematical' tone, as my own thesis later discusses.

Dyck concludes that Novalis had a fair, if not specialist, knowledge, which allowed him to argue that mathematics demonstrates the primacy of the spiritual over the physical world, and claim that only mathematicians could demonstrate a true scientific spirit in keeping with encyclopaedic ordering principles. He saw in mathematics the chance of finding a guiding principle for the universe, and considered grammar, symbolism and logic to be the points of connection between mathematics and language.¹²¹

Mathematician Mihai Brescan briefly discusses Novalis in his 2009 article, “Mathematics and Art”. Brescan remarks on Novalis’s particular emphasis on ‘algebra’ and ‘structure’, quoting from his “Hymn to Mathematics”:

Mathematics is poetry [...] The mathematician is, therefore, a poetic philosopher contemplating the mind as a distinct universe [...] algebra and structure symbolize the intellectual features of poetry.¹²²

Again, Novalis is referring to the broad nature of mathematics, rather than specific content as such, and it is this abstract characteristic that he likens to poetry.

Brescan’s article also discusses various poets, particularly those in the French Symbolist tradition: Paul Valéry and Maurice Maeterlinck, he comments, both took a keen interest in mathematics; Valéry was particularly enthused with the ‘beauty’ of geometry, and described poetry as ‘true mathematics’. Baudelaire, too, once remarked that metaphor ‘equals mathematical precision’.¹²³

A central figure in poetic Symbolism and Modernism is Stéphane Mallarmé (1842-1898). Like Novalis, Mallarmé drew attention to the functioning of language, and saw the reading of a poem as an unending process. In particular, ambiguity and obscurity are not obstacles, but rather essential to the continuous experience of understanding.¹²⁴ In his poetry, Mallarmé repeatedly suggests an ever-failing search for an unreachable ideal, represented in many images that have become classics of Symbolist poetry: the *fleur absente* (absent flower) in a bouquet; and the white swan on frozen water. Like any poetry, its evocative appeal defies

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¹²¹ Philippe Séguin claims that not only did Novalis draw on mathematics, but that he in turn influenced mathematicians; in particular the analyst and number theorist, Carl Jacobi, in his search for a universal principle in mathematics and science. This is an interesting claim, but Séguin does not provide supporting textual evidence: Séguin, “Ars Combinatoria Universalis.”

¹²² From Novalis’s “Hymn to Mathematics” in Brescan, “Mathematics and Art,” 107. Brescan is Professor in the Mathematics Faculty at Ploiești University in Romania

¹²³ Ibid., 107–109. Brescan also examines the writings of others, including Lewis Carroll, and cites Edgar Allan Poe: ‘any poem is a theorem, and its verses are its demonstration’, and goes on to discuss Barbilian, who is the subject of chapter 5 in this thesis.

¹²⁴ Mallarméan scholarship is vast, but on this point a useful discussion can be found in Johnson, “The Liberation of Verse.”

summary, but these are characteristics to which I draw particular attention here, not least in view of the third case study on Dan Barbilian.

In 1897, he wrote his now often-studied *Un Coup de dés* (A Throw of the Dice) a work that manifestly experimented with form, and that made multiple reference to number, counting and chance.¹²⁵ In this chapter, I concentrate on Mallarmé's *Livre*, which is a scarcely realised work that Mallarmé planned as a grand theory of aesthetics, to be written in a 'language of mathematics'. It survives in the form of a set of sketchy notes, first reproduced and released in a critical edition by Jacques Scherer in 1957.¹²⁶ Mallarmé himself described his *Livre* as:

Un étrange petit livre, très mystérieux [...] très distillé et concis – ceci aux endroits qui pourraient prêter à l'enthousiasme (étudier Montesquieu). Aux autres, la grande et longue période de Descartes. Puis, en général : du La Bruyère et du Fénelon avec un parfum de Baudelaire. Enfin du moi – et du langage mathématique.¹²⁷

What Mallarmé meant by a mathematical language is, appropriately for him, not made explicit. He considered mathematical writing to be an ultimate form, encompassing both universality and certainty. The manuscript itself exhibits only very limited and elementary arithmetic calculations, along the lines of counting page numbers; yet his 'mathematical' approach has attracted considerable scholarly attention, albeit – as it turns out – with little concrete analysis of just how mathematical it really was.¹²⁸

Roger Pearson mentions the 'profond calcul' intended by Mallarmé, noting that it was never fully explained; ultimately the *Livre* was probably never intended to be finished, and was just an ideal. That said, Pearson instances the counting and some pseudo-scientific references in the *Livre* as mathematical.¹²⁹ Éric Benoit also devotes some attention to the 'mathematics' of Mallarmé's *Livre*, but concentrates on what are in fact elementary arithmetic calculations of

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¹²⁵ See the epigraph in the Introduction to this thesis.

¹²⁶ Mallarmé, "[Le Livre]." The original manuscript is held by Harvard's Houghton Library, and since 2013 a full-colour digital edition has been available online. Scherer's annotated edition is Scherer and Mallarmé, *Le "Livre" de Mallarmé*.

¹²⁷ Mallarmé, *Oeuvres complètes*, 851.

A strange little book, very mysterious [...] very distilled and concise—this in places that could give rise to enthusiasm (study Montesquieu). In others, the great and long period of Descartes. Then, in general, some La Bruyère and some Fénelon with a hint of Baudelaire. Finally, some me—and some mathematical language.

Translation from Cassedy, *Flight from Eden*, 150.

¹²⁸ Philippe Séguin argues that unlike Poe and Novalis, Mallarmé consciously disliked and avoided science and mathematics. He asserts that while the ultimate search for truth and an ideal is very mathematical, Mallarmé refused to acknowledge this. This is a surprising approach to Mallarmé, and not very well substantiated in Séguin's work: Séguin, "Novalis, Poe, Mallarmé." See also note 121.

¹²⁹ Pearson, *Unfolding Mallarmé: The Development of a Poetic Art*. Pearson rejects the postmodern interpretation of Mallarmé as discovering a profound absence at the centre of a logocentric world, and instead discusses issues around harmonies and relations, particularly with reference to music.

numbers of pages, and numbers of folds within a page spread, or numbers of places at a theatre session.¹³⁰

Barbara Johnson describes, accurately, the manuscript sheets as calculations of numbers of pages or seats in a theatre and comments that the few pages in this collection are possibly more lacking and indeterminate than even Mallarmé intended. She adds, however, that that is appropriate, and part of the Mallarméan fold. On the potential of pagination, she then cites Mallarmé on a book of Verlaine:

the very rhythm of the book, having become impersonal and alive all the way down to its pagination, is juxtaposed to the equations of this dream, or Ode.¹³¹

Is Mallarmé suggesting that the ‘mathematics’ (calculations of page numbers) are impersonal albeit with a life of their own? It is difficult to say. Mallarmé is clearly reaching towards something in mathematics, but I think gets bogged down in counting.

Umberto Eco also sees complex mathematical reference in the *Livre*, remarking that the late-nineteenth century Symbolist period was when ‘open’ work consciously appeared in poetics, the intention being to open the work to the response of the reader. Eco comments that Mallarmé’s *Livre* was intended to be the quintessence of poetic production in this sense, pluridimensional and deconstructed, and that this ‘obviously suggests’ the modern universe of non-Euclidean geometries.¹³² Eco concludes that Symbolist poetics has ‘specific overtones’ of contemporary scientific thought, and goes on to draw parallels between poetics and multi-value logics and indeterminacy, including the indeterminacy and discontinuities of quantum physics, multiple possibilities as a field of relations in an Einsteinian sense, and infinity of aspects.

More concretely, he cites Mallarmé directly:

nommer un objet c’est supprimer les trois quarts de la jouissance du poème, qui est faite du bonheur de deviner peu à peu: le *suggérer*... voilà le rêve...¹³³

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¹³⁰ Benoit, *Mallarmé et le mystère du “Livre,”* 366–375.

¹³¹ Johnson, “Discard or Masterpiece? Mallarmé’s *Le Livre*,” 149.

¹³² Eco, “The Poetics of the Open Work: From The Role of the Reader,” 789.

¹³³ *Ibid.*, 783.

To name an object is to suppress three quarters of the pleasure of the poem, which is made for guessing it, little by little, to suggest it: that is the dream.

In fact Mallarmé’s full passage is even more mathematical, reading:

Nommer un objet, c’est supprimer les trois quarts de la jouissance du poème qui est faite du bonheur de deviner peu à peu : le *suggérer*, voilà le rêve. C’est le parfait usage de ce mystère qui constitue le symbole : évoquer petit à petit un objet pour montrer un état d’âme, ou, inversement, choisir un objet, et en dégager un état d’âme, par une série de déchiffrements.

Mallarmé, *Oeuvres complètes*, 869. Interview in 1891 with Jules Huret, “L’Évolution littéraire”.

To name an object is to suppress three quarters of the pleasure of the poem, which comes from the enjoyment of guessing little by little: to suggest it: that is the dream. It is the perfect use of this

This matter of suggestion as opposed to explicit statement is central to Mallarmé. What all these assessments have not articulated, however, is the nature of mathematics already alluded to by Novalis – its structure, aesthetics and generalised method – and not just the adding up numbers of pages in a book. Mallarmé's poetry however is beautiful, the tenuous images it evokes are deeply haunting, and to reduce its relationship with mathematics to basic arithmetic does it a disservice.

One of Mallarmé's great admirers was the poet Paul Valéry (1871-1945), who in 1891 wrote to him:

[P]oetry seems to me like a delicate, beautiful explanation of the world. Whereas metaphysical art sees the universe as constructed of pure and absolute ideas, and painting sees it in terms of colo[u]rs, poetic art will consist in considering it clad in syllables, organised into sentences.¹³⁴

To which Mallarmé replied:

Yes, my dear poet, to comprehend literature and for it to have a reason, one must attain that 'high symphony' that, perhaps, no one will create; but it has haunted even the least conscious of us and its main features, vulgar or subtle, stamp every written work.¹³⁵

As I discuss in the study of Dan Barbilian in chapter 5, 'a beautiful explanation of the world', a construction of pure and absolute ideas, and a 'high symphony' are all characteristics of mathematics, particularly in its modern abstract form. In this correspondence with Valéry, Mallarmé refers to his *Livre*, describing it as:

architectural and premeditated, and not a gathering of chance inspirations, however wonderful [...] the literary game, *par excellence*...¹³⁶

That is, what appeals to Mallarmé, and are translatable to literature, are the planned and ordered structural qualities of mathematics.

Valéry himself was very attracted to mathematics.¹³⁷ Building on a Mallarmean poetics of suggestion, and the uniting of meaning and form, Valéry developed a deep interest in the

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mystery that is the symbol: to evoke little by little an object to show a state of mind, or, alternatively, to choose an object and take from it a state of mind, through a series of decodings.

Translation into English by Carol Cosman in Sartre, *The Family Idiot*, 175.

¹³⁴ Lloyd, *Mallarmé: The Poet and His Circle*, 199. The translation is Lloyd's, from the original French:

La poésie m'apparaît comme une explication du Monde délicate et belle, contenue dans une musique singulière et continuelle [...]

Valéry, *Lettres à quelques-uns*, 46.

¹³⁵ Lloyd, *Mallarmé: The Poet and His Circle*, 199.

¹³⁶ Ibid., 199–200.

¹³⁷ Valéry's copious prose works can be consulted in the two-volume Valéry, *Oeuvres*. Rosemary Lloyd goes so far as to index Valéry as a 'mathematician', in Mallarmé, *Selected Letters of Stéphane Mallarmé*, 238 (index).

human mind, and the role of science and mathematics alongside poetry and philosophy, and expressed great admiration for Poincaré, Lord Kelvin and Descartes.¹³⁸

His thinking in this respect is most evident in his thirty or so personal notebooks (covering the years 1894-1928) that were first published in the late 1950s. French philologist Judith Robinson published a detailed study of the mathematics and physics content of these notebooks in 1960.¹³⁹ Remarking that ‘the achievements and methods’ of mathematics were central to Valéry’s thought, she argues that he read advanced mathematics in great detail, including the works of Riemann and Gauss, group theory, set theory, topology and n-dimensional geometry. She furthermore notes that Valéry also met a number of modern mathematicians personally, and had a very good grasp of the fundamental meanings and broad significance of areas of their work. This assessment is confirmed by French mathematicians Paul Montel and Edmond Bauer.

Robinson notes that what Valéry admired in mathematics was the precision and rigour of its language, and felt that it provided a solution to the problems of ordinary language which was imbued with ‘too many’ vague and chance associations, and multiplicities of meaning. Valéry was particularly taken with symbols in mathematical language, with modern logic – particularly that of Russell and Whitehead – the requirement in mathematics for each symbol to be precisely defined, and the emphasis on the relation between objects, expressed in a ‘logical and coherent’ way. For Valéry, mathematics was ‘not a science of quantities but a science of abstract relationships’ and it was about concepts that are ‘*non numerables mais combinables*’¹⁴⁰.

In the *cahiers* Valéry also describes his admiration for the flexibility in perspective that he sees as particularly inherent in the shift from Euclidean to non-Euclidean geometries, and associated developments in relativity, particularly the work of Riemann and Minkowski. Valéry also took a considerable interest in group theory, and in particular the property of “invariance” in a group, which is where transformations do not change the overall nature or members of the given system. He contrasted this invariance with the relativistic work of Lorentz and Einstein, where many things are, on the contrary, relative.

Robinson concludes that while Valéry over-simplified mathematical and scientific concepts, and held an idealised view of them, he nonetheless had a very good grasp of some of their complexities, and in particular held that ‘unambiguous notation’ was central to the solving of intellectual problems.

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¹³⁸ Cook, *Poetry in Theory*, 237.

¹³⁹ Robinson was Professor of French at Cambridge and Melbourne.

¹⁴⁰ Robinson, “Language, Physics and Mathematics in Valéry’s *Cahiers*,” 528, citing cahier X, 353.

Mathematician Philip Davis agrees with Robinson's assessment of the complexity of Valéry's understanding of and exposure to mathematics, emphasising that Valéry was a formalist, attracted to mathematics for its 'logical and coherent' relation of terms to one another. Calling mathematics his "opium", Valéry dreamed of an *algebra de l'esprit* or *arithmetica universalis* and had a real passion for both poetry and mathematics.¹⁴¹ Davis concludes, however, that the 'bridge' that Valéry constructed between the two was very personal, and difficult to transmit to readers.

The Polish poet, Cyprian Norwid (1821-1883), took a great interest in the poetic theories of Valéry, and in particular his views on how an 'enigma' of nature is transformed into the symbols of a written word. As with other Symbolists, Norwid's style is described as 'hermetic', in that he used signs and symbols in his poetry to eliminate ambiguity.¹⁴² Norwid argued that words have a very physical existence, with the shape of letters being archetypes of primordial forms (*archetypes de formes premières, pierwoksztaltów*), such as the triangle in the letter A, the perpendicular cross-bar, and similarly ellipses and rectangles.¹⁴³ In other words, he sees mathematical forms as basic building blocks; interestingly this idea reappears in some of Herbert's poetry.¹⁴⁴

Returning briefly to Mallarmé, Professor of Slavic Literature, Steven Cassedy compares him with Russian Soviet literary theorist and mathematician Andrej Belyj (1880-1934), who was writing in the early twentieth century, during the height of Russian Symbolism. Cassedy writes that Mallarmé and Belyj separately conceived of a literary object being mathematically defined, in the sense that there is a literary 'structure' that should be describable with 'mathematical' language. Consequently, Cassedy argues, the literary object achieves phenomenality, namely an external material existence.

Cassedy contends that Mallarmé's mathematics pertains to algebra, and groups in particular, in the sense that he defines sets relating to one another with 'pure' relations. His *Un Coup de dés* (A Throw of the Dice) is a particular example of that, which he sees as a game of chance, and explicitly speaks about 'relations entre tout'.¹⁴⁵ The literary object 'as a system of

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¹⁴¹ Davis, Philip J., "Bridging the Two Cultures: Paul Valéry," 95–97. Davis is Professor Emeritus in mathematics at Brown University. (Barbilian also considered mathematics his "opium", see chapter 5.)

¹⁴² Domaradzki, "En marge de l'esthétique de C. Norwid," 4. See further chapter 5 on hermeticism.

¹⁴³ Ibid., 7.

¹⁴⁴ See chapter 4, notably Herbert's "Winter garden" and "Architecture".

¹⁴⁵ Cassedy, "Mallarmé and Andrej Belyj," 1067. As the later case study demonstrates, Dan Barbilian was also particularly interested in algebra. Echoing the game in dice, Barbu's principal poetry collection, in which algebra also plays a key role, is called *Joc secund* (Second Game). But Barbilian was in fact wary of phenomenology. See chapter 5.

pure relations', according to Mallarmé, implies that words do not matter in themselves, but rather the functions, operations or relations between the words.

Cassedy argues that Mallarmé moved from abstract algebra to representing his ideas spatially, i.e. geometrically, as evidenced in the diagrams in the manuscript of the *Livre*.¹⁴⁶ Cassedy asserts that Mallarmé's *Livre* existed on several levels, and that some of the manuscript diagrams represent these levels. He also asserts that mathematics was relevant to Mallarmé in that he believed all existence to have an underlying determinacy. As I remarked earlier, it is difficult to see this complexity of mathematics in Mallarmé's manuscripts but the intent was there, and that intent brought with it an assumption of mathematics as a pure language not present in ordinary language, and which represented an underlying deterministic principle for the universe.

The purpose of Cassedy's article is to compare Mallarmé's Symbolism with that of the Russian Belyj, writing some fifty years later. Cassedy draws attention to Belyj's mathematical work in non-Euclidean geometry, which he describes as the 'most insistently recurrent subject of mathematical discussion in the late nineteenth century'.¹⁴⁷ Belyj's major prose essay collection, *Symbolism*, discussed 'the mathematical aesthetic', and whether aesthetics can be conceived of as an exact science. According to Cassedy, Belyj felt that music had long been considered suitable for study in an exact, scientific, manner, and that literature, including lyric poetry in particular, should likewise be so. Belyj looked for patterns in rhythm and metre (the iambic tetrameter in his case), then graphed these results and represented them as geometrical forms. He went on to examine these geometric forms, attempting to draw conclusions on how they might act as symbols with an existence of their own. This conception of aesthetics as an exact science is one that underlies much of the thinking of Novalis, Mallarmé, Valéry, and other later writers, who are trying to describe a connection between mathematics and poetry.

Contemporaneous with Belyj was the Russian modernist and Futurist, Velimir Khlebnikov (1885-1922), who developed the principle of "beyondsense" in language, aiming to break down the root meaning of words beyond their sense, into their sound.¹⁴⁸ The use of exponentials in the title of his poem "Nocnoj Obysk, 3^6+3^6 " has prompted considerable

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¹⁴⁶ See, for example the diagram in Mallarmé, "[Le Livre]," 87. In fact, the diagrams are very rudimentary sketches, and not as complex as Cassedy implies.

¹⁴⁷ Cassedy, "Mallarmé and Andrej Belyj," 1075. Non-Euclidean geometry is discussed at various points in chapters 1, 3 and 4.

¹⁴⁸ Among other works, Khlebnikov published the essays "On poetry" and "On contemporary poetry". He was a friend and close associate of Roman Jakobson, who, using Khlebnikov as an object of study, went on to devise a 'scientific' approach to linguistics and language analysis. Cook, *Poetry in Theory*, 94-96. Jakobson is discussed in greater detail in the concluding chapter of this thesis.

critical comment: Francis Poulin concludes that Khlebnikov was referring to time spans between historical events and that the mathematical notation was used to denote ‘a rational, understandable framework’ to the laws of the universe.¹⁴⁹ That is, the use of the mathematical notation in this case denoted a higher ordering principle to the universe, i.e. determinism, as similarly suggested in the writings of Mallarmé and Belyj on mathematics.¹⁵⁰ Khlebnikov did not give much explanation for his title but he was, on the other hand, well aware of the poetic Symbolist traditions and writings on mathematics.

An American comparison: Dickinson and Stein

Writing around the same time as Mallarmé and the European Symbolists, but in a quite different cultural milieu, was the American writer Emily Dickinson (1830-1886), who employed some extensive mathematical imagery in her poems. In 2006 Seo-Young Jennie Chu argued that Dickinson had a fairly developed knowledge of mathematics (Chu herself studied it at undergraduate level), and found that some two hundred of Dickinson’s poems include specific mathematical ideas.

Analysing critical scholarship on Dickinson, Chu notes that while there is a general acceptance that mathematics is a feature of Dickinson’s poetry, its significance is not always so well examined. Some scholars contend that too much can be read into the mathematical references in her poetry and that they are ‘at best’ suggestive and impressionistic. Chu finds that the references are on the contrary very precise: she discusses Dickinson’s use of circumference imagery to represent both infinity and boundedness, its ratio with diameters (the irrational π), evocations of polar angles at a horizon, and asymptotes in several poems to indicate striving towards an unreachable ideal.¹⁵¹ For Chu these are indeed precise mathematical concepts that enrich poetic imagery.

A smaller number of critics touch on the capacity of poetic language as a means of expression or representation. This is particularly so in the image of an asymptote that suggests, but never reaches, a limit. Chu finds that as a whole, Dickinson’s poetry is ‘a reflection of the ineffable’ and mathematical language can help formalise and express some of these elusive

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¹⁴⁹ Poulin, “Velimir Khlebnikov’s Nočnoj Obysk, 3⁶+3⁶, and the Kronstadt Revolts.”

¹⁵⁰ In 2007 Jonathan Taylor published an analysis of scientific determinism in literature: *Taylor, Science and Omniscience in Nineteenth-Century Literature*. Taylor looks in particular at the determinism of Pierre-Simon Laplace (in the first instance, a mathematician, interested in astronomy as well as early statistics), and argues that the latter’s ideas were clearly reflected in literary writings of the 19th century, in particular through narratives that look for a ‘vast intelligence’ and ultimate knowability or predictability about our world.

¹⁵¹ Polar angles are a way of plotting points in a plane alternative to the Cartesian grid method. An asymptote is a line which a curve increasingly approaches, but never quite reaches.

concepts.¹⁵² Another Dickinson scholar, James Guthrie, disagrees, claiming that Dickinson found mathematics ‘hopelessly inadequate to the task of describing the symbolic function she imagined herself fulfilling as poet’, a viewpoint with which Chu takes issue.¹⁵³ Chu concludes:

Through the strangely abstracted language and disembodied imagery of mathematics, Dickinson’s poetry speaks to us from beyond the world of time.¹⁵⁴

Whether mathematics is in fact so disembodied and outside of time is a matter of some debate, but regardless, Chu’s work suggests that for many poets the mathematical offers a formalised language capable of representing abstract and universal ideas and principles, in a manner that ordinary language cannot, and her thesis is a fascinating exposition of the far-reaching scope for interpretation offered by mathematical imagery.

Moving into the twentieth century, the Paris-based US modernist novelist and poet Gertrude Stein (1874-1946) claimed that her poetry had a ‘mathematical aesthetic’, a pronouncement with which American literary studies academic Ann K. Hoff agrees. Aside from the direct mathematical references in her poetry, the characteristics of this aesthetic are, according to Hoff, Stein’s logical, precise style, which utilised repetition, sequence, a focus on type and pattern, abstraction over the particular, and a sense of time conjoining the past and present.¹⁵⁵ Hoff furthermore remarks on Stein’s admiration for Alfred North Whitehead, notably his collaboration with Bertrand Russell in the original 1910 edition of *Principia Mathematica*, with its purpose of employing a ‘symbolism other than that of words’, which would reach an abstraction beyond the capacity of current language.¹⁵⁶ Stein argued that poetry also achieved these ends, through abstraction and – in her case – exactitude.

In her 1935 lecture, “Poetry and Grammar”, Stein argued that poetry could be differentiated from prose, in that prose tends more towards verbs, and poetry towards nouns.¹⁵⁷ This is of interest in the context of this thesis, as nouns themselves are arguably most important in the mathematical poetry of Barbu, compared with say the more lyrical works of

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¹⁵² Chu, “Dickinson and Mathematics,” 53.

¹⁵³ Ibid., 36.

¹⁵⁴ Ibid., 53.

¹⁵⁵ This view of mathematics of course, can be contested. Also contested is whether or not Stein’s poetry really does bear these characteristics in any way more pronounced than most other poetry. Hoff acknowledges the latter contention, but herself appears more or less to agree with Stein’s own evaluation.

¹⁵⁶ Whitehead cited in Hoff, “The Stein Differential,” 10. Whitehead and Russell parted company after the first edition of *Principia Mathematica*, and Whitehead went on to formulate some fairly controversial alternative theories of mathematics and mathematical philosophy. He devised, for example, an alternative theory of relativity.

¹⁵⁷ Cook, *Poetry in Theory*, 208–214. The use of ‘differential’ in Hoff’s title is not explained, but it appears to refer to the sense of this distinction between prose and poetry, and not any particular mathematical usage, although Hoff may have also intended to raise the mathematical meaning in the reader’s mind.

Herbert and Milosz. But at the same time, Barbilian and the Symbolists have emphasised relations between objects, and ‘relations’ could suggest verbs in preference to subject and object nouns.

Oulipo: constructing mathematical literature

The last case of mathematical poetry that I wish to consider is a group of poets and mathematicians who took a conscious and dedicated interest in the role that mathematical structures could play in creating a new kind of literature. In 1961 a collection of French-speaking mathematicians and writers established the group Oulipo (*Ouvroir de littérature potentielle*), to explore different ways of writing, primarily through mathematically-derived constraints. They drew a particular comparison between mathematical operations and syntax, but endeavoured also to demonstrate further avenues of experiment.¹⁵⁸ One of the founding Oulipians, Raymond Queneau, set out to describe literature following the axiomatic method of the mathematician David Hilbert, by seeking to establish textual axioms from which literary fundamentals could be derived.¹⁵⁹ Their algorithmic methods, such as replacing nouns with other nouns that have been taken seven places further on in the dictionary, or omitting a certain letter, led to new forms of writing.

Oulipian Jacques Roubaud (1932 -) is both a mathematician and poet.¹⁶⁰ In 2007 he outlined Oulipo’s particular heritage from Bourbaki, the group of mathematicians discussed in chapter 1.¹⁶¹ Describing Oulipo as focussed on ‘the possibilities of incorporating mathematical structures within literary works’, Roubaud remarks on their ‘severely restrictive methods, i.e. constraints’ and the ‘minimal limits of literary form’.¹⁶² *Potentiality* is important, in that the group is interested in procedures that might produce something, rather than literary works per se. This notion of potentiality is something that arises also in Symbolist poetry with its striving

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¹⁵⁸ A key Oulipian text is Oulipo, *La littérature potentielle*. Mathematician Martin Gardner’s long-running “Mathematical Games” column in *Scientific American* often included verse, and led to a greater awareness of Oulipo in the English-speaking world.

¹⁵⁹ As chapter 5 notes, David Hilbert (1862-1943) is a major figure in modern mathematics, in part for his work in setting out fundamental axioms of geometry, and later of functional analysis. Hilbert is said to have rejoiced on hearing that a promising mathematics student had decided instead to study poetry, commenting that the student ‘did not have enough imagination to become a mathematician’. Hoffman, *The Man Who Loved Only Numbers*, 95.

¹⁶⁰ Roubaud was for most of his career Professor of Mathematics at the University of Paris X, then later appointed Professor of Poetry at the European Graduate School in Saas-Fee, Switzerland. In 1990 he was awarded the Grand Prix National de la Poésie. See European Graduate School, “Jacques Roubaud - Biography.”

¹⁶¹ Roubaud, “Bourbaki and the Oulipo.” In writing his PhD Roubaud studied under several members of Bourbaki: Montémont, “Roubaud’s Number on Numbers.” Somewhat unexpectedly, I met Roubaud in person in May 2014 in Auckland as I was writing up this thesis, and his remarks as they pertain to my own conclusions were particularly helpful.

¹⁶² Roubaud, “Bourbaki and the Oulipo,” 123.

towards an absolute and is, I believe, strongly present in the work of Ion Barbu, and to a lesser extent that of Zbigniew Herbert, as discussed in the case studies.

Bourbaki's plan had been 'to rewrite Mathematics in its entirety and provide it with solid foundations using a single source [...using] the axiomatic method, and this aim was explicitly taken up by Oulipo.¹⁶³ The 'axiomatic method' is credited to Hilbert, and in particular his 1903 *Grundlagen der Geometrie*; and hence the title of the work by Oulipo's founder, Raymond Queneau, *Les fondements de la littérature (après David Hilbert)* ("The foundations of literature (after David Hilbert)"). Noting in particular Hilbert's 'axiomatic system of Euclidean geometry (and of several others besides)', Queneau remarked:

M'inspirant de cet illustre exemple, je présente ici une axiomatique de la littérature en remplaçant dans les propositions d'Hilbert les mots 'points', 'droites', 'plans', respectivement par: 'mots', 'phrases', 'paragraphes'.¹⁶⁴

The influence of Hilbert on Dan Barbilian is discussed at length in chapter 5.

In 2007 Véronique Montémont examined the writing of Roubaud, arguing that his work is not just a mechanical use of constraints, but that it expresses emotions such as pain and sadness. Noting the influence on him of the Bourbaki project, she writes that Roubaud had memorised some of its structured mathematical writings as if they were a poem, finding the writing beautiful. Montémont notes that Roubaud takes a particular interest in poetical metrics, creating a theory of 'abstract mathematised rhythm' that relates in particular to the French alexandrine and mute e, and various syllabic and caesura groupings. In studying versification, Roubaud makes the comparison between mathematical operations and syntactic functions.

As for what mathematics offers the human psyche, Roubaud says that counting was a relief against '*angoisse*' (anxiety) and that symmetry shelters us from something possibly unbearable and ephemeral. One method he suggests for a comparison of mathematics and poetry is to look at a potential common (and not common) basis or source: he asks what part of our world is elucidated by mathematics, and then, what is poetry, both in and outside of that part of the world described by mathematics. This is an interesting approach to the relationship between mathematics and poetry, and is part of a wider discussion about influence and causation.¹⁶⁵ With respect to mathematics as a description of the universe (something that the mathematically-minded Symbolist poets were reaching towards), Montémont notes

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¹⁶³ Ibid., 127.

¹⁶⁴ Ibid., 131–132. From Queneau's *La Bibliothèque oulipienne I*, English translation by Harry Matthews in Roubaud: 'Taking this illustrious example as my model, I have here set out an axiomatic system for literature, respectively replacing the expressions 'points', 'straight lines' and 'planes' of Hilbert's propositions with 'words', 'sentences' and 'paragraphs'.

¹⁶⁵ See further note 216.

Roubaud's exploration of the Pythagorean argument that numbers are the key to deciphering the entire universe, a notion that can encompass such wide-ranging concepts as grammatical gender, geometry and music.

Not everyone is enamoured of Oulipo. Noting the classical link between mathematics and rhetoric dating back to the role of persuasion in Quintilian's (c. 100AD) *Institutes of Oratory*, Caroline Marie and Christelle Reggiani concede some significance in what Oulipo was attempting. They observe, for example, that a 'simple' way of integrating mathematics into literature is to write a poem about a mathematical theme, such as numbers. Oulipo, on the other hand, were trying to use constraints to give some kind of mathematical structure to literary form, with the aim of turning a piece of (Oulipian-constrained) literature into the equivalent of a formal mathematical text based on axioms.

But Marie and Reggiani question whether literature can ever be fully 'mathematised'; finding the suggestion fantastical and a 'pipe dream'.¹⁶⁶ They regard Queneau's attempts to construct an axiomatic model of literature based on Hilbert's *Foundations of Geometry* absurd, particularly when taken to the extreme of drawing conclusions from such a literary model. Marie and Reggiani conclude that Oulipo exhibited a post-war desire for a rational structure to make sense of our world, but that in fact:

natural language, that is, the stuff literature is made of, [is] fundamentally unreliable and unstable.¹⁶⁷

Whether or not Oulipo were successful in their attempts at an extreme mathematical literature, their motivations, theoretical aims, and connections with Hilbert and the later Bourbaki, are particularly interesting. The group provides an additional dimension to the ambitions of the Symbolists and mathematical poets already discussed, and also sheds light on later case studies.¹⁶⁸

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¹⁶⁶ Marie and Reggiani, "Portrait of the Artist as a Mathematician," 103.

¹⁶⁷ Ibid., 109. The authors do not appear to consider that modern mathematics, particularly since Gödel, and chaos theory, chance and probability theory, can in fact be compatible with such instability. Mathematics populariser David Bellos published an article in 2010 describing the origins and originators of Oulipo, commenting that the group had been formed in part in response to C.P. Snow's "The Two Cultures". Bellos remarks nonetheless that Oulipo generally dismissed this argument, being well aware of the long history of literature and mathematics combining, including for example the mediaeval troubadours who composed sestina, the poetic form that follows a spiral in its recursive cyclic patterning of repeated stanzas. Bellos identifies later Oulipian projects that do confront disruption, disjunction and random approximation in mathematics, such as Perec's *Life: A User's Manual* that uses various number games to describe aspects of living in Paris, including depictions of randomness. Bellos, "Mathematics, Poetry, Fiction: The Adventure of the Oulipo."

¹⁶⁸ Note Tadeusz's Różewicz's "Elegy", in the conclusion of this thesis, that is built around an Oulipian-like (should one choose to see it that way) breaking and disruption. Other examples include Danish poet Inger Christensen; consider also Borges, whose *The Library of Babel* is 'saturated with mathematical ideas', including references to spheres, hexagons, infinity, see Rotman, "Mathematics," 166. Douglas Hofstadter also writes poetry with constraint-based rules, see Hofstadter, *Gödel, Escher, Bach*.

The nature and representation of knowledge: towards a common aesthetic

I have discussed beauty in mathematics, as perceived by both mathematicians and poets. Often cited in Anglophone scholarship for making the link between the two is Bertrand Russell (1872-1970) in 1910:

Mathematics, rightly viewed, possesses not only truth, but supreme beauty – a beauty cold and austere [...] The true spirit of delight, the exaltation, the sense of being more than man (sic) which is the touchstone of the highest excellence, is to be found in mathematics as surely as poetry.¹⁶⁹

Earlier, Karl Weierstrass (1815-1897), one of the founders of modern analysis, was also attracted to the poetic aesthetic:

It is true that a mathematician, who is not somewhat of a poet, will never be a perfect mathematician.¹⁷⁰

Weierstrass felt that there was something in poetry that was necessary to perfect mathematics. According to Growney, what Weierstrass meant was that a good mathematician, like a poet, must take particular care with language, in that both require particular attention to saying the essential and not saying the unnecessary, in the best possible style.¹⁷¹ I would argue that in addition, Weierstrass is referring to an imaginative or creative side of mathematics that is essential to the field, but more often associated with poetry. Similarly, the algebraist Leopold Kronecker (1823-1891) once observed:

Are not mathematicians veritable and innate poets? Indeed they are, just that their representations ought to be demonstrated.¹⁷²

Kronecker is observing that mathematics is poetic, but adds that mathematics differs in that its methods need to be demonstrated – a reference to the mathematical step-by-step style of theoretical exposition, particularly in proof. Another mathematician who turned to poetry is Felix Hausdorff (1868-1942), a German Jew (born in Breslau, now Wrocław in Poland) who made considerable advances in topology and set theory. Under the pseudonym Paul Mongré he published fiction, philosophy, plays and poetry. His major poetry collection, *Ekstases*, was published in 1900, and deals with ‘nature, life, death and erotic passion’. He then

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¹⁶⁹ Moritz, *Memorabilia Mathematica*, 182. From Russell’s *The Study of Mathematics: Philosophical Essays*

¹⁷⁰ Ibid., 121. Reportedly in an 1883 letter to Sofia Kovalevskaya and later shared at the 1900 Congress of Mathematicians in Paris, but the context of the citation is under some dispute, see discussion at Cipra, “Re: [HM] Poetry and Mathematics.”

¹⁷¹ Growney, “Mathematics Influences Poetry,” 2.

¹⁷² Brescan, “Mathematics and Art,” 104–105.

turned to professional mathematics, at Leipzig and Bonn, but committed suicide during the Holocaust.¹⁷³

Ambiguity and truth: imagination as a highpoint between senses and intellect

From the 1960s, Oulipo explored the application of mathematical tools to fictional narrative. This can take quite a simple form, for example counting multiples of three sisters, objects or events in fairy-tales; or in structuring chapters in a so-called ‘logical’ manner. In 2002, Canadian mathematician Robert Thomas (and editor of the journal *Philosophia Mathematica*) argued that the ‘genre’ of mathematical theorem and proof is akin to the ‘genre’ of classical (pre-1800) fiction, in that the initial ‘postulating’ of the main characters and subsequent flow of the narrative plot are similar to the structure of a mathematical proof.¹⁷⁴ In contrast to Oulipo, Thomas applies his argument to pre-postmodern literature (and, although he is not explicit, the mathematics invoked is also of a traditional nature). Thomas does not, however, explore any broader theoretical implications.

On the other hand, in 2005 a conference, “Mathematics and Narrative”, was held in Greece, purportedly the first dedicated to ‘exploring the interrelationships between mathematics and narrative’. Participants were asked whether narrative could build ‘a two-way bridge between the two cultures’, with the aim of seeing how the supposedly more emotive and attractive features of narrative could be applied to the sharing of mathematical knowledge. A starting assumption was that there exists an ‘inescapable tension’ between the two fields insofar as mathematics is ‘quintessentially rational’ whereas narrative ‘appeals to the emotions’¹⁷⁵ These somewhat sweeping statements, central dispositions to the present thesis, were examined and challenged in the course of the conference. Reflecting on the desire to extend mathematics beyond its own circles, one participant noted that ancient Chinese mathematics conveyed generality through model examples rather than through abstraction, and that this ‘art’ may have been lost in modern mathematics. Another participant cautioned against the conflation in the history of mathematics, particularly in popular histories, between what developed at the time (the *fabula*) and its subsequent retelling (the *synzhet*). As in any discipline, there is a divergence of understanding in mathematics as stories are told and retold. This distinction is of particular interest between the three poets of my case studies.

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¹⁷³ O’Connor and Robertson, “Felix Hausdorff.”

¹⁷⁴ Thomas, “Mathematics and Narrative.”

¹⁷⁵ Senechal, “Mathematics and Narrative at Mykonos.” The conference was focussed around paramathematics, described as ‘the use of narrative to explore, convey and teach mathematical ideas’.

Several of the key participants at the conference have written widely on the subject, and I return to their works in the course of this chapter. Among these were conference organiser, Apostolos Doxiadis, and Barry Mazur whose 2012 collection of essays, *Circles Disturbed*, mentioned earlier, explores the interplay between mathematics and narrative. Mazur has remarked, ‘to explain almost anything (mathematical concepts not excluded) you must launch into a story’.¹⁷⁶ This idea is elaborated in *Circles Disturbed*, when Mazur and Doxiadis observe that the appropriate narrative can make otherwise incomprehensible mathematics ‘digestible’.¹⁷⁷

Uri Margolin, who taught comparative literature in Canada, sets out a number of overlapping categories of interaction between mathematics and narrative, commenting that a systematic study of relations between narrative and mathematics ‘is in its infancy’.¹⁷⁸ Six specific areas of contact or comparison are outlined; while interesting, not all of them are pursued in this thesis.¹⁷⁹ Margolin’s multi-faceted fifth category, however, is of particular significance. Here, he discusses fundamental concepts that are central to, and the same or analogous to, one another in both fields. This category is divided into six sub-categories. First is freedom of invention, by which he contends that it is not essential for there to be a direct correspondence with the actual world, and that different constraints can be explored in a self-critiquing manner. This is a central concept of the thesis, as it touches on the very nature of mathematics and poetry, and what both are saying about, or beyond, this world. Margolin’s second sub-category expands on the first, describing the range of ontologies abounding for both: (i) the characters (in narrative) may exist in an external world and the author ‘finds’ them in a manner similar to a Platonic mathematician identifying, say, the real numbers; (ii) the author or mathematician may generate objects in a constructivist manner; (iii) the creation may be a contingent, incompletely determined process based on shared human understanding that is neither wholly physical nor wholly psychological; (iv) in a reductionist or formalist sense, there are no abstract literary or mathematical entities, but just strings of words and symbols that acquire meaning once given an interpretation.

Margolin’s third sub-category concentrates on the issue of truth, and the role of undecidability, according to the extent the system’s conventions allow for contradiction. This

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¹⁷⁶ Mazur, “Mathematics and Story.”

¹⁷⁷ Doxiadis and Mazur, *Circles Disturbed*, vii.

¹⁷⁸ Margolin, “Mathematics and Narrative: A Narratological Perspective,” 481.

¹⁷⁹ Margolin’s first category is the portrayal in fiction of a mathematician; second is use of mathematical elements such as puzzles and codes; third is numerical or geometrical formulae to determine narrative structure, such as triples in fairytales, combinatorics and permutations of chapters, compass points or Oulipian constraints; fourth is using a mathematical notion (eg infinity, branching time) as a key thematic element in the narrative, eg the two-dimensional world in E.A. Abbott’s *Flatland* or in Robbe-Grillet’s *La jalousie*.

is a central feature of modern mathematics, particularly post Gödel, and is an issue raised, albeit tangentially, in some of Herbert's poetry. The fourth sub-category concerns the nature of hierarchies and meta-levels and the functioning of layers of meaning in metaphor, axioms and theorems across mathematical systems.¹⁸⁰ I explore further a number of these concepts, in particular the nature of knowledge in mathematics and poetry (whether Platonist, constructivist, intuitive or formalist), the nature of truth and meaning, and meta-levels in the context of metaphor.

Central to narrative and to poetry is the role of the imagination.¹⁸¹ Less immediately obvious is the centrality of the imagination to mathematics, which is in part due to an arguably misconceived understanding of what mathematics is. William Whewell in the 1820s divided science into two types: deductive and inductive. According to him, mathematics was deductive, beautiful and rational, but also mechanical; whereas Whewell was more interested in inductive discoveries, which he saw as mental leaps into the mind of God.¹⁸² The implication here is that 'mental leaps' are not mathematical, which is a limited view of mathematics. Oddly, this same distinction is hinted at by Glaz in her remarks on the differing definitions of terms in poetry and mathematics, including for example symbol and metaphor, where she argues that in poetry proof relies on figurative language whereas in mathematics it relies on deductive logic.¹⁸³ Again, I would dispute that mathematics is only deductive: it can also be very much inductive.

Expanding on the role of imagination, mathematician Timothy Gowers points out in *Circle Disturbed* that in mathematics imaginary numbers demonstrate the importance of 'belief',

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¹⁸⁰ Margolin's fifth and sixth sub-categories cover computer simulations and futures scenarios; and rationality in decision making and game theory. I do not intend to investigate game theory, but note earlier remarks on the 'game' in Symbolist poetry, see note 145. Margolin's sixth and final overall category moves to theories of narrative and mathematics, arguing that most theories in narrative, eg text-user interface, many worlds, or structuralism, use mathematical or logical concepts.

¹⁸¹ Since writing up this thesis I was made aware of the excellent article by Robert Root-Bernstein, in which he sets out a number of compelling arguments pointing to a 'mathematical aesthetic'. Root-Bernstein places particular emphasis on the role of the imagination in mathematics, citing a number of mathematicians including those mentioned in this and the previous section of this chapter. In doing so, he repeatedly addresses what he describes as 'common misconceptions' about mathematics and science, including that scientific observations leave no room for individual differences, and that only artistic creativity is individual. He describes the particular case of the Hungarian Georg von Békésy, who was a Nobel laureate in medicine (for his work on the functions of the ear) and was also a strong advocate of the importance of artistic creativity in scientific discovery. See Root-Bernstein, "The Sciences and Arts Share a Common Creative Aesthetic." A similar point about the importance of a personal, even artistic, approach to scientific work is made by the philosopher of science Gerald Holton: Holton, *Thematic Origins of Scientific Thought: Kepler to Einstein*.

¹⁸² Sleight, *Literature and Science*, 82–83.

¹⁸³ Glaz, "Discovering Patterns in Mathematics and Poetry." Barbilian, too, suggests that mathematics should not be 'inventive', see chapter 5.

since they go beyond a ‘rational’ idea of counting and geometry.¹⁸⁴ He remarks furthermore that “vividness” in mathematics is not dissimilar in literary fiction, where previous allusions and experience can be triggered by a particular expression. Literary theorist Arkady Plotnitsky remarks that as mathematics has advanced, it has been written and disseminated not only in traditional mathematical symbolic form, but increasingly in narrative texts. Non-Euclidean mathematics he considers to be a particular example of this, arguing that it is characterised by an abandonment of the search for or construction of some kind of central object.

Returning specifically to poetry, in 2006 the Italian philosopher Ermanno Bencivenga argued that modern mathematics – which he dates from Descartes’s analytic geometry – has lost its desirable ‘poetic’ aspect, in the sense that poetry extends the imagination and creates symbolic figures, whereas modern mathematics constructs its own scope in a reductionist fashion, striving for greater certainty through greater specification, so relinquishing its creative possibilities. Put differently, semantic meaning is not stretched, at least in Bencivenga’s understanding of modern mathematics. Echoing in a new way the “two cultures” debate, he laments the divide between mathematics and social sciences, and argues that while social sciences apply mathematical methods, mathematics itself is insufficiently imaginative, and should return to ‘deep, intricate modelling’, drawing on literary style as much as that of Euler.¹⁸⁵

Bencivenga is not a mathematician, and does not in practice substantiate some of his views on the nature of modern mathematics. He does, however, tie his discussions to the work of Giambattista Vico, who in 1709 wrote:

Poets keep their eyes focused on an ideal truth, which is a universal idea. Even the geometrical method is conducive to the contriving of poetical figments, if the writer makes an effort to preserve throughout the continuity of the plot.¹⁸⁶

Vico is expressing a critique of the ‘rationalist’ method, but at the same time he sees it as potentially compatible with poetry, and its representation of an ideal truth. He argues that ideal truth is captured in poetry, but not always successfully in the mathematics of his day. This is of interest to this thesis, because in direct contrast, the Symbolist poets suggest the

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¹⁸⁴ Imaginary numbers, first posited by the Italians Cardano and Bombelli in the sixteenth century, are a specific subset of numbers, deriving from the hitherto impossible solution to the square root of minus one, $\sqrt{-1}$. (Timothy Gowers was introduced in Chapter 1.)

¹⁸⁵ Bencivenga, “Mathematics and Poetry.”

¹⁸⁶ Giambattista Vico, *On the Study Methods of Our Time* cited in Ibid.: 164. By ‘geometrical method’ Vico is presumably referring to Descartes (1596-1650) and Spinoza (1632-1677), an approach that I expand upon in the concluding chapter of this thesis.

opposite – that mathematics is more capable of expressing universal truths than poetry – and they look to mathematics to rectify what they see as a deficit in poetry.

In 1985 the journal *Leonardo* published a special commemorative issue on Jacob Bronowski, remarking that he took a great interest in the ‘essential unity of man’s creative activity’ and looked for a ‘common thread running through literature and biology, mathematics and human evolution, physics and the nature of man.’¹⁸⁷

Bronowski always claimed that scientific knowledge was creative, and that neither humanities nor scientific knowledge was ‘certain’.¹⁸⁸ He remarked that art (in relation to scientific knowledge as expressed through language and symbolisms) is ‘a powerful mover of the mind, for it helps to project thoughts forward, to form plans and enlarge knowledge’.¹⁸⁹

In 2006 the Royal Institution of London voted Primo Levi’s 1975 memoir, *The Periodic Table*, the best science book ever written.¹⁹⁰ Describing life under Fascism through the metaphor of chemistry, in the chapter “Potassium” Levi (1919-1987) despairs of chemistry for being fascist and says he wishes to return ‘to the origins, to mathematics’.¹⁹¹ For Levi, mathematics represented politically uncorrupted knowledge and activity, while forming a basis on which all later knowledge and representation has been built. As I discuss, pure mathematical truth is not to be taken for granted.

A mathematician who has addressed the issue of truth and meaning in narrative is Bernard Teissier, Emeritus Director of Research at the *Institut Mathématique de Jussieu* in France. Teissier argues that narratives and mathematical proofs are both ‘paths in a graph of logical interactions between statements’.¹⁹² He considers that mathematics must be true in a strongly precise sense, whereas narrative truth is more flexible, and conveys meaning, which need not immediately be so in mathematics. That said, meaning and truth are necessarily in dialogue with one another. Teissier is discussing here the notion that mathematics need not have ‘meaning’ in relation to some external reality, but it must be true within its own rigorous system. Narrative, on the other hand, can be flexible with the truth, but needs to mean something to

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¹⁸⁷ Roll, “Jacob Bronowski,” 215.

¹⁸⁸ Mazlish, “The Three and a Half Cultures,” 234.

¹⁸⁹ Bronowski, “A Twentieth-Century Image of Man,” 117.

¹⁹⁰ Randerson, “Levi’s Memoir Beats Darwin to Win Science Book Title.”

¹⁹¹ Cited in Sleigh, *Literature and Science*, 48.

¹⁹² Teissier, “Mathematics and Narrative: Why Are Stories and Proofs Interesting?,” 233.

its characters or readers. This is a claim that of course can be disputed, as some do, and Teissier himself acknowledges that the distinction is in practice blurred and fluid.

Concepts of meaning, fiction and mathematics are also discussed by the Israeli mathematician Leo Corry, whose work has been referred to in chapter 1. Corry was one of the presenters at the 2005 conference on mathematics and narrative in Greece, where he postulated a three-way relationship between mathematics, history of mathematics, and mathematics in fiction. Seeing them as points on a triangle with the relationships operating as continua along the edges, Corry sets forth various possibilities for differentiating and relating these disciplines, noting the Aristotelian tradition that views poetry as expressing future possibility compared with history that relates facts in the past. Mathematics fits into either definition, but ‘poetic license’ in fiction can be taken only so far in describing mathematical phenomena.¹⁹³

One of the perspectives from which Corry examines this issue is that of language, arguing that mathematics uses formalist language alongside narrative commentary, compared with fiction and history (including mathematics), which primarily use narrative language. I return to the issue of language. The essential difference – which again operates on a continuum – that Corry posits in this case is that a reader of fiction suspends disbelief in order to enter into the narrative, whereas this requirement is not as possible in mathematics.

This ‘model of pure thought’, truth, meaning and the imagination are all issues that arise in Jacqueline Wernimont’s 2009 doctoral thesis, where she argues that mathematics and poetry are both creative forms of writing, concerned with abstract knowledge. Wernimont compares two Elizabethan poets with the slightly later writings of Descartes, arguing that what they had in common was the challenge of writing about something that was both ‘real’ and ‘non-existent’ in the sense of being able tangibly to experience it. Both modes of writing were creative and non-mimetic, and attempted to express or represent the non-actual but possible. She argues that such characteristics, particularly the imaginative, have a significant bearing on the literary development of the time.

In tracing earlier work bringing together mathematics and poetry, Wernimont comments that they are often seen as the early-modern genesis of two very disparate disciplines. She observes that very few studies link the two, and that only a few examine how one might influence the other. In her view, such studies have been largely confined to the history of

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¹⁹³ Corry, “Calculating the Limits of Poetic License.” In Senechal, “Mathematics and Narrative at Mykonos.”

science, for example the place of mathematical and narrative forms in various disciplines, or the extent to which mathematical methods have constructed or perpetuated cultural forms. A few others have looked at the mathematics behind cognition and reading practices, or the application of mathematical instruments and tools to daily life. In her thesis Wernimont consciously takes an approach that focuses on the non-practical, day-to-day applications of mathematics and poetry, noting that as semiotic systems they are ‘decidedly not material’ and the works, in both fields, deliberately sought to create knowledge that was useful, but not immediately so in a working-day sense.¹⁹⁴ Wernimont remarks: ‘[C]reative math [sic] and poetry were used to make ideas and worlds in order to shape the ethical intellectual’.¹⁹⁵ She touches on the issue of semiotics, noting that a semiotic mode would be intensional, in that it creates meaning with reference to possibility and ideas, rather than a particular materiality.¹⁹⁶

In other words, Wernimont is concentrating on the abstract nature of both mathematics and poetry, which is reflected in her citing of the poet Philip Sidney (1554-1586), who writes that mathematician and poet express the ‘highest points of knowledge’.¹⁹⁷ Wernimont touches on the Platonic view of writing as an account of the material, comparing this with the Aristotelian view of poetry as an investigation of the possible, and mathematics as an abstraction. She also notes the views of Descartes (1596-1630), and writers such as Umberto Eco, who argue that these chosen modes of writing were in fact more about the creation, rather than the representation, of knowledge. Their referents are indeterminate. Furthermore, establishing their veracity is largely dependent on their own internal systems, created by both the writer and reader. Wernimont also refers to recent scholars including J. L. Lemke, Florian Cajori and Nicholas Dew, all of whom point to an acceptance by the early modern period that mathematics was already about affect and creation – and not just measurement.¹⁹⁸

Taken in a broader context, however, these examples are still few and piecemeal. Wernimont notes that a major problem in modern scholarship is the difficulty of talking in detail about both mathematics and poetry ‘at the same time in terms familiar to one or the other of those fields’.¹⁹⁹ Her own studies on the poems of Sidney and John Dee, and the mathematics of Descartes, attempt to illuminate shared strategies in writing, particularly in

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¹⁹⁴ Wernimont, “Writing Possibility,” 10.

¹⁹⁵ Ibid., 12. A writer such as Miłosz would, however, dispute whether such abstraction retains an ethical element.

¹⁹⁶ This emphasis on possibility and ideas is clearly present in the poetics of Dan Barbilian, and it is something that Zbigniew Herbert approaches, as the case studies will demonstrate.

¹⁹⁷ Philip Sidney, cited in Wernimont, “Writing Possibility,” 16. (Which, as chapter 5 demonstrates, closely matches Barbilian.)

¹⁹⁸ Ibid., 23–30.

¹⁹⁹ Ibid., 31.

terms of intension and creativity as opposed to the prevailing climate of empiricism. The intent is to demonstrate shared strategies; they are not combined directly.

In her section on Descartes, Wernimont acknowledges that his systems favour logic and rigour. However, she contests the view that this implied communication without ambiguity, arguing that Descartes's symbolic analysis went beyond the ordering of proof and certainty, in a revolutionary bid to make the 'non-actual possible'.²⁰⁰ In support of this, she refers also to the present-day mathematicians Isaac Barrow and John Wallis, arguing that both have argued that geometry has moved beyond the physical, to create new abstractions and mental ideas.²⁰¹

These complex intertwined issues of truth, imagination and meaning were canvassed in the 2009 special edition of the US journal *Configurations*, "Mathematics and the Imagination".²⁰² Literature scholars Arielle Saiber and Henry S. Turner set out a number of questions arising from discussions on the role of the imagination in mathematics, and the nature of mathematics and its language. Touching directly on literature and poetry, they cite mathematician Keith Devlin who suggests that there are similarities in the mental creativity required to conceptualise an intricate poetic image, or calculate the square root of a negative number. Saiber and Turner observe that modern mathematics in particular requires conceptions of paradox, ambiguity, multiplicity and relative truths. They also note its specificity, commenting that mathematical philosophy developed considerably in the nineteenth and early twentieth centuries, addressing issues such as the existence of mathematical objects; how we know and verify mathematical truths and certainty; semiotics and language in mathematics; how the mind articulates and visualises mathematical concepts; how abstract thought can be understood and represented; how mathematics and logic relate; whether mathematics is transcendental and external or immanent and eternal. Thinking about these matters variously contributed to work in the foundations of mathematics and logic; around linguistics; formalism (axiomatisation); and intuitionism. Saiber and Turner note that more recent work in mathematics has encompassed questions of performance, and connections to social and cultural phenomena. These are all issues that were raised in chapter one, and they feed into a more holistic understanding of mathematics, and its similarities to poetry.

Regarding imagination in mathematics, Saiber and Turner comment on classical and mediaeval accounts that view the human imagination as an intermediary between the senses and intellect, a notion that continued into the abstractionism of Descartes. They then address

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²⁰⁰ Ibid., 143.

²⁰¹ Barrow is Lucasian Professor of Mathematics at Cambridge, and Wallis the Savilian Professor of Geometry at Oxford.

²⁰² Saiber and Turner, "Mathematics and the Imagination: A Brief Introduction."

more modern concepts that view imagination as ‘that faculty of thinking that facilitates movement across systems of explanation that seem irreconcilable’.²⁰³ In other words, the imagination is a bridge between ostensibly different fields; in the case of this thesis, between mathematics and poetry.

Differentiating between fictional and mathematical truth and meaning, Saiber and Turner observe that Bertrand Russell distinguished logical fictions (mathematics) from ‘unreal’ literary fictions and, contra Vico, he dismissed the latter as decidedly inferior to the former. They also comment on the work of classical mathematical historian Reviel Netz who observes that the Greeks understood mathematics to point to real and ideal forms, while never being able fully to represent them. (Interestingly, the Symbolist preoccupation with an unattainable ideal was something that had already fascinated the ancient Greeks.) Saiber and Turner identify areas in literary theory and poetics believed to have been directly influenced by modern mathematics; they observe in particular that Deleuze and Guattari drew on Riemannian geometry; and Ezra Pound’s experiments in poetic form were similarly influenced by non-Euclidean geometries.²⁰⁴

Returning explicitly to the imagination, they quote C.S. Peirce:

If mathematics is the study of purely imaginary states of things, poets must be great mathematicians.²⁰⁵

For Peirce, the imagination was manifestly central to both. Charles Sanders Peirce (1839-1914) was a mathematical logician and general mathematician, and one of the founders of semiotics.²⁰⁶ Semiotics and the study of signs is another large area of mathematics and mathematical philosophy with considerable potential application to a study of poetics.²⁰⁷ Saiber and Turner ask whether the semiotic differences between words, numbers and diagrams are as distinct as they conventionally seem; or, how does the nature of meaning alter when represented by words, as opposed to mathematical symbols.

Two types of language

In the sixteenth century Galileo argued that mathematical and poetic language were essentially different. Canadian science historian Stillman Drake argues that Galileo was one of

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²⁰³ Ibid., 12.

²⁰⁴ The impact of non-Euclidean geometries on wider literary thinking is also discussed in chapter 1.

²⁰⁵ C.S. Peirce from “The Essence of Mathematics”, cited in Saiber and Turner, 1. See also note 270.

²⁰⁶ See further Atkin, “Peirce’s Theory of Signs”; Burch, “Charles Sanders Peirce.”

²⁰⁷ Roman Jakobson first posited the concept of intersemiotic translation, as discussed in the concluding chapter of this thesis.

the first thinkers to raise concern about language in scientific writing, citing Galileo's view that ordinary, 'philosophical', language was limited in its capacity to describe the natural world. The implied solution to this deficiency was to draw on both mathematical and poetic language. Galileo scorned those who derived scientific opinions from poetic and philosophical writing, instead arguing that theories must be 'deduced' from the observable, 'sensible' world. Drake contends that Galileo viewed mathematics as an essential complement to ordinary language in this regard through its mediation between philosophy (about which Galileo is sceptical) and the sensible world, claiming that poets were notably adept in ensuring that ordinary language retained a capacity to focus the reader's mind on sensory experience. Mathematics is not, however, conceded an all-encompassing privilege: it forms a necessary contribution to the scientific description of the natural world, but is not sufficient and entire in itself. Drake notes that Galileo deliberately wrote in a modern vernacular (Italian) in order to make scientific issues intelligible to many. All types of language are necessary.

Drake cites Galileo:

Poetry is acquired by continual reading of the poets; painting is acquired by continual painting and drawing; the art of proof, by reading books filled with demonstrations – and these are exclusively mathematical books, not books on logic.²⁰⁸

Galileo is clear that mathematical language should be straightforward and self-evident, untainted by the personal reflections of the practitioner; and poetic language is cumulative, enriched by the works of other writers.

The Czech immunologist and poet Miroslav Holub (1923-1998), cited in the introductory section of this chapter, published seventeen widely-translated collections of poetry, over 130 papers on immunology, and edited both literary and scientific journals. His 1990 essay "Poetry and Science", while addressing science, is also relevant to mathematics, and indeed at the end Holub cites a mathematical example for his arguments. He considers that in modern science, interest has moved from observing and describing minutiae, to the study of general systems, and an acknowledgement of the role of the observer. With reference to Carl Sagan, he remarks that "the way of thinking" is what is important, rather than the body of knowledge itself.²⁰⁹

Holub goes on to argue that word meaning is 'polarised' between science and poetry, partly because the former aims for single unambiguous meaning, whereas in the latter more than one meaning is implicit in the text:

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²⁰⁸ Galileo's *Dialogue*, cited in Drake, "Galileo's Language: Mathematics and Poetry in a New Science," 19. 'Logic' here is the discursive philosophy that Galileo spurns.

²⁰⁹ Holub, "Poetry and Science," 53.

There is no common language and there is no common network of relations and references [...] Poetry is not the thing said, but a way of saying it (A.E. Housman). For the sciences, words are an auxiliary tool. In the development of modern poetry words themselves turn into objects [...] The basis of poetry is the unpronounceable [...] whereas science] has to say everything [...] The aim of a scientific communication is to convey unequivocal information about one facet of a particular aspect of reality [...] the aim of poetic communication is to introduce a related feeling or grasp of the one aspect of the human condition [...] I have been repeatedly intrigued by hearing from scientific colleagues that they do read poetry, because it is short, instantaneous, and rewarding on the spot, just as a good scientific paper should be.²¹⁰

Holub is claiming a very clear distinction between poetic and scientific language, which I return to later in this chapter, and while I do not agree with such a stark rejection of any commonality, the passage is interesting in that it picks up on certain characteristics in common, notably with poetry in the last sentence here.

In this same article Holub also discusses one of his own poems, “Zito the Magician”, where Zito is asked to think of things such as dry water or changing water into wine, which he is able to do. But then he is asked:

Think up sine alpha greater than one
to which Zito replies sadly:

Sine alpha is between plus one and minus one. Nothing you can do about that.²¹¹

In Holub’s view, there are concepts in mathematical language that do not allow for the level of equivocation or multivocalness present in poetry, a notion that is in fact contestable. (The sine function, for example, can in some systems – notably the hyperbolic – extend outside plus or minus one.)

I have cited Holub at some length because although he ostensibly claims to be talking about science, he in fact touches clearly on mathematics, using its language as a direct counterpoint to poetry, but acknowledging that poetry’s brevity and concision has much in common with scientific writing. The Romanian mathematician Solomon Marcus, who is discussed more fully later in this chapter, has also theorised about these “two poles of language”; again, in his case, closer examination suggests the distinction is not very great.

Literary critic Gillian Beer also examines the concept of two languages, rapidly coming to the conclusion that there is no one-to-one correspondence between language and its referent in science.²¹² In 1989 Beer delivered the inaugural lecture on literature and science at the Royal

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²¹⁰ Ibid., 55–58.

²¹¹ Ibid., 57.

²¹² Dame Gillian Beer is a Professor Emerita of English at Cambridge University, and very influential in the establishment of the British Society of Literature and Science.

Society in London, rejecting any assumption that the relationship between the two disciplines is only unidirectional: that literature might act as some kind of ‘mediator’ for scientific ideas that themselves ‘remain intact’. Instead, Beer emphasises ‘interchange rather than origins and transformation rather than translation’, suggesting that it may be unrealistic to expect stable translation between the two, and proposes rather that ideas are transformed and take on different meanings in differing contexts and with new readers.²¹³ Similarly her entry on literature in the *Routledge Companion to the History of Modern Science* argues against looking for any ‘tight equivalence’ but rather for ‘fugitive allusion, a changing of contractual terms of belief [...] in an incompletely argued form’.²¹⁴

With reference to I. A. Richards’s *Science and Poetry*²¹⁵, Beer comments that modern literary theory tends not to see literature as a unitary, autonomous writing system, and that the drawing of linguistic lines around ‘science’ and ‘literature’ is fairly recent. Until the early 19th century science meant empirical enquiry, then narrowed to refer to knowledge about the material world. Literature acquired connotations of aesthetic value only from around the 1860s. Beer notes the argument that scientific language is ‘univocal’, while making significant references to the physical world, compared with poetry’s multivocality and multiple referents. Richards had distinguished between the two by arguing that science demanded belief through a propositional style, whereas literature was not necessarily asking the reader to believe in the same manner. (Beer queries Richards’ distinction.) She comments that Derrida also tries to do away with traditional assumptions about certain types of writing, through his deconstructionism that attempts to deny an infallible ‘origin’ or ‘grounding’ for a text. Derrida’s work is part of an academic shift away from science being seen as ‘source’ and literature as ‘embellishment’.²¹⁶

Beer notes that Heisenberg in particular argued that the use of ‘vague’ natural (conversational) language as opposed to the technical discourse of modern physics had in fact served:

in the expansion of knowledge [rather] than the precise terms of scientific language, derived as an idealization from only limited groups of phenomena.²¹⁷

She explains that Heisenberg’s “vagueness” arises from multivocality, where certain meanings come to the fore at certain times, leaving others in shadow, but still there. On the

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²¹³ Beer, “Translation or Transformation - the Relations of Literature and Science,” 81–82.

²¹⁴ Beer, “Science and Literature,” 787.

²¹⁵ See note 97.

²¹⁶ Beer, “Science and Literature,” 789.

²¹⁷ Heisenberg’s *Physics and philosophy: the revolution in modern science*, 200, cited in Beer, “Translation or Transformation - the Relations of Literature and Science,” 87.

contrary, immunologist (and Nobel laureate) Peter Medawar in 1968 regretted that the advent of literature diminishes science. (In other words it introduces multiple meanings and allusions not intended in the scientific original.) Beer adds that Bertrand Russell said that ordinary language was insufficient to represent the abstraction of physics (and of mathematics).

These are very pertinent remarks, but interestingly, at one point in her 1989 lecture Beer makes what for me is a less insightful assumption about mathematics:

The movement towards mathematicization [of science] has enhanced hopes of a stable community of meaning for scientists at work; the spread of English makes for often delusive accords between different communities of meaning.²¹⁸

Beer is discussing the room for differing interpretations as English becomes used by diverse national groups, but her implication that mathematics is a ‘stable’ language is in fact very much contestable. Mathematics is in fact itself a changing subject, with additional discoveries or inventions about particular concepts often in a state of development, as discussed at length in Chapter One.²¹⁹

Joel Cohen is an American mathematical biologist. In 2011 he drew general parallels between applied mathematics and poetry, and their use of symbols. Referring to a shared aesthetic of beauty, Cohen comments:

Poetry and applied mathematics both mix apples and oranges by aspiring to combine multiple meanings and beauty using symbols. These symbols point to things outside themselves, and create internal structures that aim for beauty. In addition to meanings conveyed by patterned symbols, poetry and applied mathematics have in common both economy and mystery. A few symbols convey a great deal.²²⁰

The choice ‘economy and mystery’, encapsulates a central strand of the present thesis: that concision, suggestiveness and the requirement for the reader to create a personal interpretation is central to both mathematics and poetry.

As discussed already, an essential feature of algebra is relationships between objects, and Cohen selects various examples of chiasmus (the parallel switching of word order in poetry) to demonstrate how repetition in different order has its parallel in mathematics, in particular the work of algebraist Gheorghe Zbaganu of Bucharest University, in commutative products of matrices.

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²¹⁸ Ibid., 81.

²¹⁹ These concerns notwithstanding, mathematics is arguably more stable than many other disciplines, a feature assumed also by Lakoff and Johnson, see note 237.

²²⁰ Cohen, “Mixing Apples and Oranges,” 189. It is not clear why Cohen focuses on applied mathematics in particular, as his arguments in fact apply just as well to pure mathematics, in particular abstract algebra.

In this context Cohen also refers to the writings of William Empson, who commented that in mathematics the symbols themselves are not always of interest, but rather the relationships between them.²²¹ Cohen notes:

The differences between poetry and applied mathematics coexist with shared strategies for symbolising experiences. Understanding those commonalities makes poetry a point of entry into understanding the heart of applied mathematics, and makes applied mathematics a point of entry into understanding the heart of poetry. With this understanding, both poetry and applied mathematics become points of entry into understanding others and ourselves as animals who make and use symbols.²²²

For Cohen, the route into both mathematics and poetry is symbolism. This interest in symbols in mathematics is shared by Brian Rotman, who wrote the chapter on mathematics in the inaugural 2011 *Routledge Companion to Literature and Science*. (Rotman describes a nexus of literature and mathematics.) His introduction contrasts signs in literature with signs in mathematics, arguing that the former are limited to a traditional alphabet and punctuation, and – in his view – represent speech and emotion, whereas the number of mathematical signs is unlimited and they represent invented thought, ‘detached from the person thinking about them’.²²³ Echoing the earlier-discussed distinctions about truth and meaning and their relation to ‘reality’, Rotman considers mathematics to be ‘free from empirical reality’, which makes it an art as well as a science. It has a dual nature: as a science it describes the physical world, and is also a ‘model of pure thought’, Rotman making the point that this model of ‘pure thought’ derives from the structure of Euclid’s *Elements*.²²⁴

Rotman notes Hardy’s view that mathematics has beauty, and argues in addition that pure mathematics has affect. He examines several literary genres, looking for the influence of mathematical form; his examples include the repetition of three, trinity and triads in Dante’s *Divine Comedy* and the zero in Shakespeare’s *King Lear*. Regarding the latter, Rotman notes that mathematics was entering intellectual discourse in Europe, in ‘new, increasingly prominent’ ways, during the time of Shakespeare. He then gives examples of modern literature that explicitly depict mathematics, either as beautiful, or as cold and emotionless. He also points out that particular features of mathematics are its problem-solving aspect and playfulness, as evident in Lewis Carroll and the idiosyncratic novel of mathematical characters in Abbott’s 1884 *Flatland*. Rotman is thus underlining several recurring themes of this chapter.

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²²¹ William Empson (1906–1984) was a British literary theorist and poet who took two successive degrees, in Mathematics then English, at Cambridge. He is remembered in particular for his 1930 work, *Seven Types of Ambiguity*, which examines the workings of poetic language. He studied under I.A. Richards, see note 97.

²²² Cohen, “Mixing Apples and Oranges,” 201.

²²³ Rotman, “Mathematics,” 157.

²²⁴ Ibid., 157–158.

Common to these discussions are aspects of mathematics and poetry that go beyond the immediate written word. Citing Russell on beauty in mathematics, US mathematician W.M. Priestley argues that mathematics has a clear ‘humanist’ basis to it, and that to interpret it otherwise is mistakenly narrow and implies a limited focus on just the formalistic and logical aspects of mathematics. Comparing mathematics directly with poetry, Priestley argues that the medieval ‘bonding’ of the *trivium*, including rhetoric, with the *quadrivium*, including geometry, demonstrates that there was a ‘natural affinity’ between the two disciplines. He comments that logic and linguistics today are an obvious ‘low-level’ example of a bond. At a ‘higher level’ he argues that the early Greek understanding of the word ‘mathematics’ meant ‘something that has been learned or understood’, being in fact comparable to ‘poetics’, implying ‘done, manufactured or achieved.’ He then looks at how words in poetry operate on several levels, and argues that in mathematics also, a function that can be conceived graphically, geometrically, kinematically or statically. Both mathematics and poetry can model different situations or interpretations.²²⁵

Priestley’s article is very brief, but Sha Xin Wei extends the discussion of less-explored aspects and representations of mathematics. In his 2004 article on poesis in mathematics, Sha examines what mathematics is, arguing that mathematics has an overlooked performative aspect that goes beyond most mainstream views about its written signs.²²⁶ In particular, he argues that while speech may be absent from mathematics, its writing and sketching has a value that is not captured in the ordinary algebraic approach to semiotics and linguistics. He contends that the drawing and graphing of mathematical ideas can be an important step in arriving at new concepts, and while such concepts may eventually be represented through formulae and equations, the graphical representation has an imaginative value that may be deemed redundant but which should not in fact be totally discarded. Sha ties this argument in with some of the work on mathematics as metaphor by George Lakoff and Rafael Núñez, commenting on the mapping of inferences from one conceptual domain of knowledge to another. He concludes by noting the “paradox” of intersubjectivity in mathematics, asking how subjective experiences of mathematicians might contribute (or sum) to an objective whole.

In 2005 Sha examined the later writings of Alfred North Whitehead (who collaborated with Bertrand Russell on the *Principia*²²⁷), looking at how complex mathematics can be drawn

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²²⁵ Priestley, “Mathematics and Poetry: How Wide the Gap?,” 14–19.

²²⁶ Sha, “Differential Geometrical Performance and Poesis.” Poetry also has an underexplored performative aspect to it.

²²⁷ See note 156.

on to arrive at a ‘poetic’ ontological philosophy that links the sensory and factual worlds. Sha suggests how Whitehead might have constructed his theories arguing – inter alia – that all mathematics is part of a sensory world. He argues that although Whitehead’s theories have a rich basis in modern mathematics, his argumentation does not stand up to standard mathematical rigour of proof, containing, for example, a number of assumptions in excess of what might normally constitute reasonable starting definitions and axioms. Sha outlines Whitehead’s ontological principle: that the concrete cannot be derived from abstraction or the ideal; and that nature is ‘unbifurcated’ in the sense that it is a single complex entity of facts, feelings, matter and experience.²²⁸ A key point here is that there is no ultimate separation between feeling and an unfeeling world, and Whitehead models this notion, drawing on set and category theory.²²⁹

Of Whitehead’s work, Sha concludes that it demonstrates a rich, prolifically imaginative understanding of mathematics with deep potential. He nonetheless cautions that in reaching this point, mathematical processes have been blunted to serve a particular philosophical purpose.²³⁰ This concept of ‘blunting’ is of interest, because it graphically describes what occurs in the transference of mathematics into poetry, or translation losses in general; a fruitful aspect of the relation between mathematics and poetry, that I return to in the concluding discussion of this thesis.²³¹

Metaphor in mathematics and poetry

I come now to address what is arguably one of the most powerful figures in poetry, namely metaphor.²³² Metaphor underlies what has been implied in many of the previous discussions around imagination, truth, meaning, suggestion, and abstraction. Metaphor describes, represents or suggests one thing in terms of another; and Sha, Wernimont, Teissier, Rotman and others have all suggested that metaphor is also central to mathematics. In 1980

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²²⁸ Sha, “Whitehead’s Poetical Mathematics,” 79.

²²⁹ I discuss the twentieth-century development of category theory – a branch of mathematics closely related to abstract algebra and the foundations of mathematics – in the concluding chapter to this thesis.

²³⁰ Sha, “Whitehead’s Poetical Mathematics,” 91–94.

²³¹ As for where the ‘poetical’ comes into the title of the article, “Whitehead’s Poetical Mathematics”, Sha is not explicit, but one can infer that it is the rich, fertile and imaginative ‘region between the impossible and potential real’ in Whitehead’s mathematical ontology.

²³² On metaphor, see Cuddon, *A Dictionary of Literary Terms and Literary Theory*, 507. Roman Jakobson (whose work is discussed in more detail in the conclusion) distinguished between metaphor and metonymy in his 1956 *Two Aspects of Language and Two Types of Aphasic Disturbances*, plotting them on two perpendicular axes. Metaphor he associates with continuous substitution of one meaning for another; and metonymy with where words are contiguously associated with one another. He finds that metaphor is more prevalent in modern poetry, and metonymy in the realist novel. While in the case of my initial cases study – on Miłosz – metonymy is a more appropriate term for his use of mathematics, I generally use the term metaphor in this thesis.

US linguist George Lakoff and philosopher Mark Johnson published *Metaphors We Live By*, which they saw as filling a gap in contemporary scholarship on meaning, claiming that much of what is ‘meaningful’ in everyday life relates to metaphor. Specifically, they rejected the notion of an objective or absolute truth, stating:

The heart of metaphor is inference.²³³

For Lakoff and Johnson, a critical characteristic of metaphor is that it is *conceptual*, and thus more than words in a linguistic construct. This is all the more evident when considering metaphors across domains. They comment that their first ‘metaphor’ for describing their notion of conceptual metaphor came from mathematics:

We first saw conceptual metaphors as mappings in the mathematical sense, that is, as mapping across conceptual domains.²³⁴

But Lakoff and Johnson found that mathematical mapping proved inadequate in that it does not create target entities, in other words the mapping – in mathematics – does not add to the original meaning. This brings it somewhat closer to metonymy, where the target or referent can stand in for the original (a discussion that is also directly applicable to translation studies).

Lakoff went on to write various works in collaboration with other scholars. With cognitive linguist Mark Turner he argued that metaphors in poetry are ‘for the most part, extensions and special cases of stable, conventional metaphors used in everyday thought and language.’ By contrast, ‘If any area has been taken to be literal, disembodied, and objective, it is mathematics.’²³⁵ Yet in his 2000 collaboration with cognitive scientist Rafael Núñez, Lakoff determined that mathematics is very much metaphorical, arguing, for example, that numbers as points on a number line, or as sets, is a metaphor.²³⁶ In their 2003 edition, Lakoff and Johnson conclude:

Mathematics turns out not to be a disembodied, literal, objective feature of the universe but rather an embodied, largely metaphorical, stable intellectual edifice constructed by human beings with human brains living in our physical world.²³⁷

The role of a reader and creator thus becomes central to mathematics. In 1999 the logician James Gasser argued that metaphor and analogy are widespread in logic, and are essential to understanding. Gasser asserts that mathematical intuition is very similar to poetic inspiration, and draws parallels between the role of the reader in negotiating meaning from

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²³³ Lakoff and Johnson, *Metaphors We Live By*, 244.

²³⁴ Ibid., 252.

²³⁵ *More Than Cool Reason*, 1989, cited in Ibid., 267–270.

²³⁶ Lakoff and Núñez, *Where Mathematics Comes From*.

²³⁷ Lakoff and Johnson, *Metaphors We Live By*, 270. With reference to the ‘stable edifice’, see also note 219.

poetry and mathematics, given that both are dense and concise. Gasser comments that while logic becomes very abstract, its ordinary-language examples are frequently couched in everyday terms, metaphors being used to enhance elucidation. Mathematical logic in particular is predicated on axioms, which may be more or less obvious, and a mathematician's role is to expand upon them. Logic viewed as a deductive science implies that every proposition contains subsequent propositions. Gasser explores what could be seen as a logical paradox: that while mathematics is purely deductive, there is nonetheless a seemingly unending and rich 'series of surprising discoveries' in it, much as in the observational sciences. As Gasser notes, this was a 'puzzle' remarked upon explicitly by C.S. Peirce.²³⁸

Anne Brubaker, a literary theorist currently of Wellesley College in the US, wrote her doctoral dissertation investigating the role of mathematics in the development of modernist modes of writing. In her 2008 essay on literary theory and mathematics, Brubaker argued that literary theory and criticism should take more account of cultural science studies, particularly mathematics, in the development of (literary) representation theory, and concluded that an essential notion for consideration should be metaphor. Brubaker examines issues around language in particular, noting the work of a number of scholars that suggest alternative interpretations of how mathematical language should be viewed when directly compared with ordinary alphabetic language.

Brubaker notes that in discussions about the cultural embeddedness of language by postmodernists such as Jacques Lacan, Gilles Deleuze, Julia Kristeva and Jacques Derrida, mathematics is often treated as an exception to or exterior to language.²³⁹ Brubaker challenges this, making considerable reference to the work of Brian Rotman, whom she considers to be one of the few scholars to have examined 'the particular qualities that make the semiotics of mathematics both similar to and distinct from language'.²⁴⁰

Beginning with Derrida, Brubaker analyses his arguments about language to demonstrate that they are not always consistent in their treatment of mathematics. On the one hand, Derrida has argued that mathematics is not a closed system, citing Gödel's conclusions about incompleteness in support of his argument, and noting that geometry in particular is 'open to its own revolutions'. Furthermore, in addressing specific issues of language, Derrida

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²³⁸ Gasser, "Logic and Metaphor," 232. As Gasser discusses, it was also an issue considered by the linguistic philosophers Gottlob Frege, Ludwig Wittgenstein and Willard Quine. Quine in particular described the phenomenon as 'potential obviousness'.

²³⁹ This approach is also taken by Gillian Beer, see note 213, who at times demonstrates an implicit assumption that mathematical language is invariable, an assumption which in fact goes to the heart of this thesis.

²⁴⁰ Brubaker, "Between Metaphysics and Method: Mathematics and the Two Canons of Theory," 870.

adds that mathematical systems are dependent on writing for both their transmission and origin. Derrida also uses mathematics as an argument against logocentrism (that is, speech), because mathematics is non-phonetic:

The effective progress of mathematical notation thus goes along with the deconstruction of metaphysics, with the profound renewal of mathematics itself, and the concept of science for which mathematics has always been the model.²⁴¹

Brubaker points out various contradictions in Derrida: that he uses a concept of number to demonstrate inherent multiplicity in texts, and that his use of number actually implies a belief in an a priori existence of mathematics. In this regard, Brubaker observes a general tendency in literary studies to see mathematics as an abstract, ‘exemplary semiotics’. In contrast, she notes, science scholars such as Bruno Latour, Michel Serres, N. Katherine Hayles (and others) see mathematics as a ‘material semiotics’, but these ‘canons of theory’ rarely interact.²⁴²

Brubaker notes Brian Rotman’s observations that the nature of mathematical language, and in particular the question of whether its signs have referents, is a contested subject among mathematicians. Rotman describes three models of thinking in this regard: the Platonic that assumes an objective external reality to which mathematics is referring; formalism that sees mathematical signs as obeying only internal and formal rules; and intuitionism whereby mathematics constructs abstract signs that have referents, albeit immaterial. Rotman rejects all three models, arguing for some kind of codependency to allow for the creation of new mathematical knowledge:

In no sense can numbers be understood to precede the signifiers that bear them; nor can the signifiers occur in advance of the signs (the numbers) whose signifiers they are. Neither has meaning without the other: they are coterminous, cocreative, and cosignificant.²⁴³

Rotman endeavours to elucidate the constitutive nature of mathematics, and Brubaker argues that his work emphasises the connections between mathematics and language, in a way that has hitherto been largely ignored. Brubaker suggests that further work be done on the use of metaphor in mathematical reasoning and expression, and the ways in which metaphor, ambiguity, narrative and logical argument cut across disciplinary boundaries. Doing so would

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²⁴¹ Derrida cited in *Ibid.*, 872–873.

²⁴² Brubaker notes that other scholars, such as Vicki Kirby – see chapter 1 – have also performed useful work in analysing the unusual relationship that mathematics has with alphabetic writing. She also mentions the writing on relationships in mathematics by the US professor of feminist and cultural studies, Karen Barad, whose doctorate was in theoretical particle physics.

²⁴³ Rotman *Mathematics as Sign*, 39, cited in Brubaker, “Between Metaphysics and Method: Mathematics and the Two Canons of Theory,” 878.

give a deeper understanding of the centrality of mathematics in theories of representation, materiality and subjectivity, without which, as Brubaker remarks:

we risk stalling further explorations of the epistemological and conceptual overlaps of literary and mathematical study that could help to overturn the still prevalent perception that these two fields are fundamentally antagonistic or that they are disciplinary opposites.²⁴⁴

Drawing especially on postmodern literary criticism, Brubaker has given a detailed exposition of developments in literary theory that clearly point to a variable, and socially-embedded, nature of mathematics, contingent on personal interpretations and background. All of these issues are deeply inherent in metaphor, and indeed it is the study of metaphor that Brubaker sees as a fruitful way in which to examine issues of relations between mathematics and literature.

In 2005, literary critic Barbara Naumann discussed metaphor in the first issue of *Science in Context* devoted to the theme of science and literature. Naumann argues that:

literature contributes to the knowledge of science, particularly where the question of the essence of humanity is raised.²⁴⁵

In part this is because literature can make things ‘understandable’, since it adds a self-reflective element to the representation of scientific matters. She contends that recent historians of science have clearly demonstrated that science has an imaginative and creative side to it, but that the style of modern scientific writing does not make this evident.

Goethe attempted to address this in his writings on botany and colour theory; so too did Nietzsche. Referring to Nietzsche’s nineteenth-century writings on category and metaphor, Naumann remarks that he wanted to restore some of the Romantic impulsive and impressionistic attitude to rational thought. Metaphor, for Naumann, has an additive quality as it does not necessarily represent an independent entity in itself, but contributes directly to the development of knowledge. She argues that metaphor in science has taken over from rhetoric which used to represent ideas with clarity, but still as a ‘symbolised, circuitous form’ of knowledge:

A metaphor is not only a pictorial and direct expression of scientific facts that exist independently of their representation. The metaphor marks a process of translation that the movement of thought itself represents, and it thus affects the scientific orientation within which it appears.²⁴⁶

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²⁴⁴ Ibid., 886.

²⁴⁵ Naumann, “Introduction: Science and Literature,” 512. Barbara Naumann is a Professor of German Literature at the University of Zurich.

²⁴⁶ Ibid., 516–517.

Naumann goes on to assert that:

[T]he field where literature and science encounter each other is none other than that which was opened by the process of translation. It is the aesthetical and rhetorical field that finds a common terrain, a *logos* and a context, through reciprocal translation.²⁴⁷

In other words, Naumann contests the notion that scientific findings are necessarily independent of their language of representation. Naumann concludes that while science may give us models of human existence, it is through literature that we assess them.

Solomon Marcus: metaphor, inventiveness and language

Metaphor is also a central concept for Solomon Marcus. Marcus (1925-) is a Romanian mathematician and linguist, and a key figure in this thesis.²⁴⁸ Given his explicit attention to the relationship between poetry and mathematics, and his knowledge of Dan Barbilian, I have left his writings to the end of this chapter. Alongside his mainstream mathematics Marcus has taken a sustained interest in the relations between mathematics and poetry, often taking Dan Barbilian, whose work I discuss in greater detail in chapter 5, as an exemplar for his discussions. His evolving thoughts on the connections between mathematics and poetry focus on his interest in linguistics and language, and enrich the ideas already discussed in this chapter.²⁴⁹

In Marcus's 1967 piece, "Questions de poétique algébrique" (Issues of Algebraic Poetry), he outlines what he considers to be clear differences in language between the two fields, and argues that there is a dichotomy between poetic and scientific language. The issues that he raises in this context are multiple and important. He suggests that poetry is dominated by the 'ineffable' and science by the 'explicable'; poetic discourse signifying the specific, and characterised by infinite ambiguity, whereas the scientific, with its general significance carries no ambiguity. Signification in the former is 'lyric and continuous', whereas in the latter it is

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²⁴⁷ Ibid., 517.

²⁴⁸ Marcus was introduced in note 88. He is Emeritus Professor in Mathematics at the University of Bucharest, specialising in analysis, computer science, linguistics and semiotics. By 1995 he had published some 300 research papers, and is cited in another 5,000 by around 1,000 authors, and is a full member of the Romanian Academy. See Păun, *Mathematical Linguistics and Related Topics*, vii. Marcus, "Grigore C. Moisil: A Life Becoming a Myth."

²⁴⁹ The distinctions in what are perceived as two types of language are examined by a number of scholars working in or on the peripheries of science and literature. Stephen Weininger (see note 117) remarks that by the 1970s science and literature studies had developed to such a point that, along with much literary theory, the field was almost dominated by language and discourse studies: Weininger, "Introduction: The Evolution of Literature and Science as a Discipline." See also the remarks of Holub (note 209) and Beer (note 216). In the context of the "two cultures" debate (see note 86), Aldous Huxley in 1963 distinguishes literature as private, and science as public, discourse, and regrets that in his view writers and poets had not responded sufficiently to the pervasiveness of science in everyday life. Huxley assumes a marked difference or 'polarity' between scientific and literary language, whereby 'verbal caution' is paramount in science, with a 'one-to-one relationship' between words and ideas, compared with poets who are required to have multiple meanings. Huxley, *Literature and Science*, 36–37.

discrete.²⁵⁰ While Marcus's later work tones down the starkness of such a dichotomy between two types of language, the concepts that he raises here remain very relevant, and pervade this thesis.²⁵¹

In 1970 Marcus published a monograph, *Poetica matematică* (*Mathematical Poetics*), in which he develops his arguments regarding the two forms of language, again making an essential opposition between lyric (poetic) and scientific language. Marcus argues that whereas in scientific language no connotation is possible, poetic language is the opposite. For him, mathematical language is the 'supreme form' of scientific language.²⁵² Mathematical language is denotative, but also has a figurative character. He claims that mathematical language can always be precisely translated into natural language, but that this is not the case with poetry. In addition, mathematical metaphor is different from poetic metaphor, in that mathematical language is denotative; one knows exactly what a mathematical metaphor denotes, whereas in poetry metaphor is open to suggestion and connotation. Referring to Jakobson, Marcus avers that in its 'optimum' form scientific language represents ultimate rationalism and poetic language the ultimate state of emotion.

These views are on the face of it somewhat strict, but the question of mathematical versus poetic language is something over which Marcus demonstrates a nuanced view, developed over time. Towards the end of the book he remarks that while one might superficially associate certain characteristics more closely with one language over another: such as the general and singular, infinite and finite, types of infinity (cardinal numbers), logic and anti-logic, they are in fact present in both.

As Marcus acknowledges, what he says of mathematical language is often closer to a pure ideal, rather than everyday reality. In a review of Marcus's *Poetica matematică*, mathematician Barron Brainerd and French philologist Henry Schogt comment:

Marcus claims that only the mathematical language in its purest non-verbal version fulfils the requirements of pure denotation and absolute freedom from associations and connotations called forth by, among others, metaphor and metonym.²⁵³

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²⁵⁰ Marcus, "Questions de Poétique Algébrique," 75–76. As an example of his work in computer science, this same year, 1967, Marcus published a work that compares natural and computer-programming languages, where he defines various sets, permutations and relations in an attempt to map out the losses in meaning as words are translated into computer-language. His approach is very formalistic and does not touch on poetic meaning: Marcus, *Algebraic Linguistics; Analytical Models*.

²⁵¹ It should also be noted that this form of written exegesis as 'oppositions' was particularly common in socialist countries of the time, encouraged by the state publishers for reflecting the emphasis on dichotomies within Marxist doctrine.

²⁵² Marcus, *Poetica matematică*, 389–390.

²⁵³ Brainerd and Schogt, "Poetica Matematică," 163, referring to 109. Brainerd, a former Professor in mathematics at the University of British Columbia, researched algebra - ring theory - as well as taking an interest in statistical methods - algebraic probability - in linguistics. Henry Schogt is a former Professor in French at Toronto.

Because the vast majority of mathematical texts have recourse to natural language – that is they are not written in wholly symbolic form – any given (mathematical) text is never free of connotation and association. Marcus acknowledges this and suggests that possibly Russell and Whitehead in their *Principia Mathematica*, Bourbaki and Euclid are closest to reaching an ideal and ‘pure’ exposition of mathematics.²⁵⁴

Marcus not only discusses and compares mathematical language with poetic, he also posits a mathematical-like model for “meaning” in poetry and mathematics. Mathematics has ‘ultimate freedom from form’, and so the same content can be expressed in an infinite number of ways, but each expression is unambiguous – ‘infinite synonymy’ – whereas poetry is the opposite – ‘unlimited homonymy’. In a sense, ‘style belongs to mathematics’ because there are many ways of saying the same thing, whereas poetry has no style because its form is ‘the unique way of expressing the message’. This assessment assumes that style ‘implies formal choice without altering the message’, as recognised by the equation, or equals sign, in mathematics. So science is ‘transitive’, unique and unambiguous and poetry ‘reflexive’ and

conceived as well as perceived by the individual in such a way that it is impossible to communicate the message unaltered.²⁵⁵

Marcus does advance a so-called ‘mathematical model’ for his theories. He posits a “support biplan”, namely sets of objects relating vocabulary sets, and collections of these vocabulary strings and meanings.²⁵⁶ Within this, he sets up a cartesian product, and argues that scientific language is a function (with mathematical inverse) because it has unique meaning but infinite possibilities of expression, whereas lyric language has uncountable meanings and intersections of phrases are empty sets in that they are without an exact common meaning.

The concept of vocabulary sets is further developed to incorporate rhythmic structure in the case of translation. Taking a poem, Marcus compares it with its translation and identifies structures – topic order as well as prosodic, syntactic, lexical, content – thus identifying ‘distance’ between the translated and original poem. He then sets up some formal frameworks for describing recurring grammatical structures in poetry, using Baudelaire as an example.

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²⁵⁴ One might also note the suggestion here that ‘pure’ mathematics should be written, not spoken, something that Barbilian also considered self-evident. As Marcus remarks, sound does not play a role in mathematics but is very important in poetry. (By contrast, it is not clear what role sound had in poetry for Barbu; his poems certainly scan and rhyme.)

²⁵⁵ Brainerd and Schogt, “Poetica Matematică,” 166.

²⁵⁶ *Ibid.*, 164.

Marcus remarks that ‘algebraic structures of language preside over the whole book’.²⁵⁷ In mentioning ‘algebraic structures’, he is touching on an essential issue of the relations between objects, or in this case words. Algebra is a central aspect of the Romanian poet mathematician Dan Barbilian’s mathematical poetics, and is discussed at length in chapter 5.

Brainerd and Schogt are on the whole complimentary about the *Poetica matematică*. But as theoretical models, they observe that Marcus’s are ‘youthful’, in that they are highly speculative and general, and not yet very specific and compartmentalised. They add that while some of his theories are abstract and formalist in nature, others are little more than ‘a formalised descriptive device’. The mathematics used ‘is not highly technical, and depends on results easily derived from the definitions introduced by Marcus in the text.’²⁵⁸ In the appendix Marcus sets out some basic concepts in set theory, which, the editors consider probably allow a committed non-mathematical reader to understand the arguments within the work itself. Indeed as this thesis develops, I find on many occasion that the mathematics required is not in itself highly complex, notwithstanding the complexity of the underlying ideas and concepts.

In 1970 Marcus published a series of articles “Two Poles of the Human Language”, which was essentially a summary of the issues raised in his *Poetica matematică*. He contends that mathematical and poetic language lie at two extremes of the expressive capacity of human language: ‘The mathematical language is the apex of scientific expression and the poetic language is the vertex of fiction’. Marcus goes on to enumerate in a 20-odd point list what he calls a mathematical model of the dichotomies between the two, with the qualification, however, that both are ‘abstract expressions’ and ‘ideal forms’, and that natural language uses elements of both.²⁵⁹

Mathematics tends to eliminate homonymies, as style in scientific language aims towards a uniform, universal understanding and ultimately serves to transmit this understanding, whereas style in poetry presumes a subjective and individual interpretation. Alternatively, this can be viewed as a distinction between connotation and denotation; a scientific expression might be replaceable with an equivalent, whereas this should not be possible in poetry.²⁶⁰ Marcus claims that in science, implications should be a countable number whereas in poetry they are uncountable, and he notes that Jakobson’s work on equivalence is important in this context.²⁶¹ Another aspect of the duality is that scientific language aims to

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²⁵⁷ Marcus, *Poetica matematică*, 389.

²⁵⁸ Brainerd and Schogt, “Poetica Matematică,” 162.

²⁵⁹ Marcus, “Two Poles of the Human Language,” 187.

²⁶⁰ In fact, it is exactly what is going on in the translation of poetry from one natural language to another.

²⁶¹ Jakobson is discussed in the concluding chapter of this thesis.

explain and reduce, whereas poetic language aims to create new meaning. In the former, reality and truth are distinguishing features, whereas this is not an essential feature of poetry. Marcus does concede nonetheless that ‘today’s ineffable can be tomorrow’s explainable’.²⁶²

In 1974 Marcus edited a special edition of the Dutch journal *Poetics*, dedicated to ‘ways in which mathematical methods are used in the study of literature’, suggesting that metaphor and semantic deviance can be analysed from a mathematical point of view, as can ‘isomorphism’ in the translation from one language to another of poetry.²⁶³

Also in 1974 Marcus returned to his modelling of dichotomies, publishing a list of 52 differences between the two forms of language.²⁶⁴ This understanding of ‘mathematical poetics’, whereby poetic and mathematical language are at two extremes of linguistic expression is picked up by some linguistic scholars, especially in the field of Romanian semiotics.²⁶⁵ By now, however, Marcus notes that some differences are not quite as clear cut as they might first appear, and are in fact on a continuum.

Metaphor is also an area where one can see a development in Marcus’s thinking. In 1973 he published “The Mathematical Metaphor”, describing metaphor in mathematics largely in terms of multiple meanings in natural language when used mathematically. Marcus observes that mathematical language is a mix of natural and symbolic languages. He delineates three types of words in the natural component of mathematical language: those that have the same meaning in mathematics as in natural usage (eg they, with); words which do not exist in natural language (eg holomorphic); words which exist in both but have different meanings, ranging from very similar (eg union), less similar (eg connected), dissimilar (eg analytic). Marcus then asks what kind of metaphoric transfer has taken place in the less similar group, arguing that in some cases mathematical metaphor is akin to poetic metaphor in that it sets up an analogy between the denoted term and the connoted term, as in poetry and unlike ordinary linguistic metaphor. In most cases, mathematical metaphors are in fact more akin to linguistic metaphors in that their function is to communicate, and they are potentially replaceable, through ‘infinite mathematical synonymy’.²⁶⁶

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²⁶² Marcus, “Two Poles of the Human Language,” 312.

²⁶³ Marcus, “Editorial Note,” 5.

²⁶⁴ Marcus, “Fifty-Two Oppositions between Scientific and Poetic Communication.”

²⁶⁵ Golopentia-Eretescu, “Romania,” 406.

²⁶⁶ Marcus, “The Mathematical Metaphor,” 158. Marcus sustains an interest in contextual ambiguities across natural languages, comparing for example English, French and Romanian with major computer programming languages, of the time, in his 1981 piece, Marcus, *Contextual Ambiguities in Natural and Artificial Languages*.

Twenty years later, in 1993 Marcus has moved beyond the metaphorical use of language in mathematics, to look at metaphor as an underlying concept in the field. He posits a “dictatorship” of metaphor, referring to the notion that accepted metaphors dictate the directions of new knowledge (which is akin to Kuhn’s paradigms, for example). He argues that in certain areas of modern science, recent developments are determined to some extent by starting metaphors, in the sense that these determine the problems being investigated, and he discusses the shift away from the Newtonian model of physics that allowed for different starting approaches on how subject and object relate to one another. In mathematics specifically, he asks whether the ‘infinitely small’ as conceived by Newton and Leibniz carried with it a connotation of constant, rather than later mathematical conceptions of this as a function.²⁶⁷ (By which he presumably was referring to process and to limits.)

He argues that dominant metaphors in poetry have been well investigated, from Aristotle, Quintilian and Vico, to the more systematic approach of I.A. Richards in his 1936 *The Philosophy of Rhetoric*, but research into metaphor has been far less frequent in the case of science.²⁶⁸ Marcus takes from Richards a concept of metaphor with three aspects: expressive or ornamental; modifying or enriching; and creating. Aristotle considers metaphor to be largely about comparison, and Quintilian about substitution for literal expression. Traditional semantics looks upon it as a deviance from a literal meaning, or abbreviated analogy.

Marcus makes reference to a number of works already discussed in this chapter. He notes the work of George Lakoff in ensuring that discussion of metaphor entered cognitive science research in the 1980s and 1990s.²⁶⁹ Placing metaphor in the realm of pragmatics rather than semantics, he cites C.S. Peirce’s conception of metaphor as a ‘totality of interactions’ with people.²⁷⁰ He also discusses Derrida, and his interest in relativity and quantum physics, where the role of time and space and the observer are significant.²⁷¹

He also recognises that Leibniz’s notion of the infinitely small was a founding metaphor in analysis, which was defined by Cauchy as a function with limit zero, whereas for Leibniz it was not a function but a constant. Not until 20th-century ‘crazy mathematics’, particularly under Abraham Robinson, did another model take hold, known as non-standard analysis and in which infinitesimals and the infinite take on a (mathematically) objective reality as opposed to the potential or dynamic conception of the earlier view. Finally, Marcus

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²⁶⁷ Marcus, “Metaphor as Dictatorship,” 103.

²⁶⁸ I.A. Richards is discussed in note 215.

²⁶⁹ On Lakoff, see note 235.

²⁷⁰ On Peirce, see note 205.

²⁷¹ On Derrida, see note 241.

observes that a common metaphor in mathematics is using the three-dimensional Euclidean space model as the ‘term of reference’ for other spaces invented by later mathematicians.²⁷²

In the 1970s Marcus wrote about the differences between mathematical and poetic language, describing them as ‘poles apart’. Yet he was drawn to both fields and, furthermore, indicated that some differences may in practice be blurred. By 1998 he was explicitly drawing out similarities between mathematics and poetry. Pointing out that ‘differences and similarities alternate in an endless succession’, he comments that both fields are difficult to define, particularly as mathematics has moved beyond being a science of numbers and visible spatial forms.²⁷³ (In other words, it has acquired its modernist character.) Marcus notes that both have specific external aspects: mathematics in symbols, formulae and equations; and poetry in metre, rhythm and rhyme. On the other hand, once one moves beyond the external aspect, they both become more difficult to describe.

Much of what Marcus says is implicitly present in the discussions of this chapter. Both poetry and mathematics require ‘a balance between invention and discovery’, by which he means that definitions, axioms, postulates and the like are invented, but theorems more likely to be discovered.²⁷⁴ As for poetry, the form is constructed, but combinations of existing words are discovered. He also refers to the related role of fiction in mathematics: Euclid, for example, described fictional entities such as a point with no part or a line with no breadth. Both share a tendency towards higher abstraction, alongside an interest in the hidden and invisible aspects of reality, and they also tend to deal with infinity, within a finite context. Imprecision, too, is ‘genuine’ to both; with fuzziness, chaos, randomness and approximations common to mathematics, and vagueness, ‘the crepuscular’, obscurity and mystery common to poetry.²⁷⁵ Self-reference is ‘essential’ in both; Marcus compares this explicitly with Gödel’s incompleteness theorem.²⁷⁶

Both mathematics and poetry involve what Marcus terms ‘semiotic optimisation: maximal of meaning in minimum of expression’.²⁷⁷ Compression is not possible, and a précis, or writing of an abstract or summary that retains the original flavour, is difficult. Marcus also

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²⁷² Marcus, “Metaphor as Dictatorship,” 105.

²⁷³ Marcus, “Mathematics and Poetry,” 175.

²⁷⁴ Ibid.

²⁷⁵ Ibid., 179.

²⁷⁶ Gödel’s theorems relate to sets talking about themselves; that no set can ever be completely described using its own terms of reference. See chapter 5.

²⁷⁷ Marcus, “Mathematics and Poetry,” 176. Barbilian’s adoption of this maxim, attributed to Gauss, is discussed in chapter 5.

remarks on the ‘solidarity’ between the ‘local and global aspects’, by which he refers to the capacity in poetry for an isolated word or expression to both take from and give meaning to the whole.²⁷⁸ He likens this to analyticity in mathematics where the behaviour of an analytic function in a local neighbourhood determines its global behaviour. It is also true of mathematics as a unified whole.

As Marcus himself remarked in 1998, the field of semiotics, and in particular mathematics and metaphor, is a particularly rich one that deserves further investigation.²⁷⁹

Concluding remarks: imagination and method

According to Aristotle’s *Poetics*, a hypothesis in its early state is neither true nor false, belonging to the realm of the possible. In his 1990 monograph, *La structure poétique du monde*, Fernand Hallyn remarks that this is like a poem, whereas order and ‘what is’ come later.²⁸⁰ This searching for order as more scientific corresponds to *mimesis* (schema of representation), and the choice of a particular schema relates to *semiosis*, or schemas of meaning. Hallyn concludes that finding order and levels of explanation was what Copernicus and Kepler meant by their “poetics”. He furthermore quotes the Viennese philosopher Karl Popper, who invokes literary or artistic intuition; arguing that hypotheses are ‘free creations of our own minds, the result of an almost poetic intuition, of an attempt to understand intuitively the laws of nature’.²⁸¹

Much of the obvious difference between mathematics and poetry can be discussed in terms of language. At first glance, mathematical language is logical, unambiguous and pure, and mathematical knowledge is singular and universal. Poetry, on the other hand, is traditionally perceived as subjective, imaginative and determinedly ambiguous. However, as discussed in the previous chapter and in this, mathematics is not always clear, objective and universal, and the types of knowledge it represents are multiple. Mathematics is subject to cultural context, it can be sensitive and imaginative, and its scope extends well beyond the description of an immediately observable world. Similarly, poetry, while indeed highly imaginative and unpredictably creative, possesses many characteristics closely aligned with logic, rationalism and universality.

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²⁷⁸ Ibid., 178.

²⁷⁹ Marcus, “Reza Sarhangi Ed., Bridges,” 161.

²⁸⁰ Hallyn is drawing in part on Paul Ricoeur’s “The Meaning of a Poetics” in Hallyn, *The Poetic Structure of the World*, 17–23.

²⁸¹ Popper’s *Conjectures and Refutations*, 192, in Ibid., 8. Popper is also discussed in note 33.

Poetry, like mathematics, uses methodological systems. Both mathematics and poetry attempt to articulate a truth often beyond words, and they do so in a way that is paradoxical: suggestion, multiple and ambiguous meaning are necessary to allow for the possibility of unrestricted limit and maximum interpretation, but this is best conveyed through stipulating as little as possible. Concision, precision, exactness and brevity are essential.

These are all evident features of poetry, and they are also evident in the highly formalist and structural approach of the modern algebraists and groups such as Bourbaki, as well as in the questioning and open-mindedness of the non-Euclidean geometers and Gödel. Social context is important: questions of human ethics, individuality and narrative creativity are all set against abstraction and universalism. This paradox is encapsulated in metaphor. An ideal in mathematical language is that it is free of uncertain connotation, and represents a unique form of expression. Poetry, on the other hand, is open to individual interpretation. But in practice, both are true of the other. While the room for versions of the truth may be broader in poetry than in mathematics, it is precisely the interplay of creativity and imagination that can stretch the mind, and allow for a full examination of the possibilities and interpretations suggested by metaphor.

It is these understandings – the ‘poetics’ of mathematics and the ‘mathematical’ in poetry – that bring the two closely together.

PART II
CASE STUDIES

CHAPTER THREE

**‘I sigh and think of a starry sky, of non-Euclidean space,
of amoebas and their pseudopodia’²⁸²:
Science in the society of Czesław Miłosz**

PIEŚŃ OBYWATELA

Kamień z dna, który widział wysychanie mórz
I milion białych ryb skaczących w męczarni –
Ja, biedny człowiek, widzę mrowie białych obnażonych ludów
Bez wolności. Kraba widzę, który ich ciałem się karmi.
[...]
Ja, biedny człowiek, siedząc na zimnym krześle, z przyciśniętymi oczami,
Wzdycham i myślę o gwiaździstym niebie,
O nieeuklidesowej przestrzeni, o paczkującej amebie,
O wysokich kopach termitów.

Kiedy chodzę, jestem we śnie, gdy zasnę, przydarza się jawa,
[...]
Gdzie mały chrabąszcz i pajak są równe planecie,
Gdzie jak Saturn rozjarza się wędrowny atom,
[...]
Tego chciałem i więcej niczego. Więc któż
Winien? Kto sprawił, że mi odebrano
Młodość i wiek dojrzały, że mi zaprawiono
Moje najlepsze lata przerażeniem? Któż,
Ach któż jest winien, kto winien, o Boże?

I myśleć mogę tylko o gwiaździstym niebie,
O wysokich kopach termitów.

Warszawa 1943 ²⁸³

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²⁸² An early version of this chapter was published as Kempthorne, “Czesław Miłosz and Zbigniew Herbert: Literary Responses to Non-Euclidean Geometries.” Some of the material was also presented as a paper at the annual conference of the British Society for Literature and Science in Cardiff in April 2013. The title of this chapter is taken from Miłosz’s “Song of a Citizen”, see note 283.

²⁸³ Miłosz, *Wiersze wszystkie*, 207–208. First published in 1945 in *Ocalenie (Rescue)*. English translation by Czesław Miłosz, in Miłosz, *New and Collected Poems*, 57–58.

SONG OF A CITIZEN

A stone from the depths that has witnessed the seas drying up
and a million white fish leaping in agony,
I, poor man, see a multitude of white-bellied nations
without freedom.
[...]

Abstract

Nobel laureate Czesław Miłosz was a widely-respected poet of the twentieth century, and much can be said about him and about his poetic oeuvre. But the overall purpose of this thesis is to examine poetry's relationship with mathematics. The following discussion therefore focuses on one particular area of Miłosz's thought and writing: his views on science and the incorporation into poetic metaphor of mathematical imagery. "Song of a Citizen", like the entire cycle of which it is part, is memorable in its own right, but others of the selected poems that follow have been chosen for their place in this discussion of mathematics and science, and not necessarily for their intrinsic poetic quality. There are in fact relatively few poems by Miłosz that could be said to be of an overtly 'scientific' or 'mathematical' nature; it is his prose that gives far more insight into his views in this regard.

Introduction

Nobel laureate Czesław Miłosz (1911 – 2004) was a political poet, who witnessed and lived through some of the major historical events of the twentieth century in Eastern Europe.²⁸⁴ The Soviet and Nazi wartime occupations of Poland, the Holocaust, communist rule and eventual transition to western capitalism, all had a significant impact on him and how he viewed

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A poor man, sitting on a cold chair, pressing my eyelids,
I sigh and think of a starry sky,
of non-Euclidean space, of amoebas and their pseudopodia,
of tall mounds of termites.

When walking, I am asleep, when sleeping, I dream reality,
[...]
where a tiny beetle and a spider are equal to planets,
where a wandering atom flares up like Saturn
[...]
This I wanted and nothing more. So who
is guilty? Who deprived me
of my youth and my ripe years, who seasoned
my best years with horror? Who,
who ever is to blame, who, O God?

And I can think only about the starry sky,
about the tall mounds of termites.

Miłosz's own translation is not always literal: the 'pseudopodia' (second stanza), for example, do not appear in any overt form in the original Polish.

²⁸⁴ The select bibliography at the end of this chapter includes a wealth of biographical information on Czesław Miłosz; one official biography is in "Nobel Prize in Literature 1980 - Press Release."

the role of the poet in an ethically-aware political environment.²⁸⁵ The place of science in contemporary society concerned Miłosz, and he took a generally negative view of its influence on human morality.

Miłosz was by no means scientifically trained and, as I will explain, his mathematical education appears to have been relatively minimal. Yet the poem opening this chapter, “Song of a Citizen”, incorporates a reference to a quite specific and ground-breaking concept in modern mathematics; non-Euclidean geometry. The poem describes a Polish witness of the wartime destruction of the Jewish ghetto in Warsaw, and is part of a particularly haunting series of wartime poetry, *Głosy biednych ludzi* (Voices of Poor People), which reflects on human behaviour under occupation.²⁸⁶

What was Miłosz thinking of in his evocation of non-Euclidean geometry?

Miłosz was born in 1911 in Lithuania, a region that had for several centuries been part of the greater territories of Poland.²⁸⁷ During the Second World War the area was occupied first by the Soviets then the Nazis, until after the war – along with the other Baltic states – it was subsumed into the Soviet Union; it is now independent. Miłosz published his first collection of poetry in 1930, in a university periodical at the Stefan Batory University in Vilnius, where he was studying law.²⁸⁸ In 1934-35 he spent a year in Paris on a Polish cultural fund writing grant, a period that is particularly significant for his meeting with his older relative, Oscar Miłosz, a relationship that for the rest of his life Miłosz credited as having been a profoundly formative influence.²⁸⁹ Oscar Miłosz was already a published French-language poet, with a deep interest in French Symbolism, metaphysics and (as an amateur) modern scientific

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²⁸⁵ While it may seem self-evident that a poet living through this period would demonstrate such political awareness in his or her poetry, it is in fact far from evident in the case of the Romanian Dan Barbilian, whose work I examine at length in chapter 5.

²⁸⁶ Also in this cycle is “Biedny chrześcijanin patrzy na getto” (A Poor Christian Looks at the Ghetto), Miłosz, *New and Collected Poems*, 63–64; Miłosz, *Wiersze wszystkie*, 211–212. Miłosz describes ants, bees and a ‘guardian mole’ pushing into the broken and decaying mess of the abandoned ghetto. “Campo dei Fiori” is another well-known piece written at this time, with the unforgettable image of Warsaw residents at Easter riding on the carousel in the tree-lined Krasiński Square (where the old National Library, and still the archives, are housed) as the carousel repeatedly circles up and over the ghetto wall during the brutal liquidation of its inhabitants. Miłosz, *New and Collected Poems*, 33–35; Miłosz, *Wiersze wszystkie*, 192–194.

²⁸⁷ Lithuania has a complex history of various occupations and changing ethnic majority and minority populations. During Miłosz’s time the dominant culture in the educated and ‘noble’, or ‘gentry’, classes, and in the capital Vilnius, was Polish, and to a lesser extent Jewish, Russian and Lithuanian. See Davies, *God’s Playground*; Snyder, *The Reconstruction of Nations*.

²⁸⁸ Miłosz remarks that at that time the study of law in Poland included economics, anthropology and sociology, and was akin to a general arts degree for students who did not wish to specialise in one particular academic field. See Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 31.

²⁸⁹ Oscar Miłosz (1877-1939) was also born in Lithuania, but moved permanently to France in his youth, after which he did not use the Polish spelling of his name.

theories of relativity.²⁹⁰ In 1938 Oscar Milosz translated and published in a French journal a translation of one of Milosz's poems, his first to appear outside Poland.

In 1940 Milosz left Soviet-occupied Vilnius for Warsaw, which was under Nazi occupation. He continued to publish in the underground press, run by Polish resistance groups. It was at this time, in 1943, that he wrote "Song of a Citizen", published in the collection *Ocalenie* (Rescue) immediately after the war, in Kraków.

After the war, Milosz served as a diplomatic attaché for the new Communist Polish government first in New York then Washington. In 1950 he transferred to Paris and there in 1951 sought political asylum. For ten years he wrote and published with émigré presses in Paris (most notably the long-running *Kultura*) and in 1960 moved to the University of California at Berkeley, where he remained for twenty years as a professor in Slavic languages and literatures. Sensitive to the situation of an exile, he was instrumental in bringing Polish literature to the attention of English-speaking audiences, translating and ensuring the dissemination of the work of many of his Polish compatriots.²⁹¹

In 1978 he won the Neustadt International Literary Prize and in 1980 the Nobel Prize for Literature. Until 1980 his writings were officially banned in socialist Poland – the 1945 collection *Ocalenie* remaining the only officially sanctioned publication – although his work was widely available in underground circulation. This changed after the award of the Nobel Prize, following which he was able officially to visit Poland. He returned to live in Kraków in 2000 as an 'honorary citizen' of the city, was held in great public esteem, and died there in 2004.²⁹²

Ethics and religion

Milosz held that poetry should not be separated from life, history and politics, and what for him is their absolute and essential ethical and moral core.²⁹³ "Song of a Citizen", like his entire wartime collection, is a painful instance of this belief, in its expression of horrific

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²⁹⁰ The section on Milosz and Einsteinian relativity discusses in more detail the role of Oscar Milosz in Milosz's life.

²⁹¹ Milosz wrote the first English-language history of Polish literature, based initially on his lectures to Slavic-studies graduate students at Berkeley: Milosz, *The History of Polish Literature*.

²⁹² Widely honoured, Milosz often said he felt out of place and in many respects lonely away from Poland, and he describes his trauma of exile in various formats, see for example Milosz, *Emperor of the Earth*. In 2011 Cynthia Haven published a fascinating collection of quite candid recollections of Milosz by lesser known colleagues, academics and poets, many of whom comment on his loneliness, marriage difficulties with his first wife Janina, his happy second, late, marriage with Carol, his contentment on returning to Kraków and devastation at Carol's early death soon afterwards: Haven, *An Invisible Rope*. These recollections provide a very good complement to the more hagiographic biographies of Milosz the Nobel laureate.

²⁹³ This was a common reaction of Eastern European poets. As one critic remarks of that era, 'Why did intellectuals think they could change history through poetry?' Okey, "Marci Shore, Caviar and Ashes," 198.

recent events, and the confusion, helplessness and guilt felt by those who witnessed and survived them. This is recognised by fellow Nobel laureate Joseph Brodsky, who observes of the parent cycle *Voices of Poor People* that it ‘does not so much sing of outrage and grief as whisper of the grief of the survivor’.²⁹⁴

Moral self-questioning by the survivor is a critical aspect, but the poems are not only a witness to past events, but a consideration of why society failed and how this should be addressed by the poet. Miłosz, like other Holocaust-survivor poets, felt that writers had a responsibility to face the ethical dilemmas and profound pessimism brought on by what they had seen, and try to make some sense of it through language. Brodsky remarks of “Song of a Citizen” that it depicts the inability of human beings to grasp certain experiences, and that Miłosz saw language – hence poetry – as a tool not of ‘cognition’ but of ‘assimilation’ in an otherwise hostile world.

Miłosz’s wartime poetry was widely read throughout his career, and he usually included a selection from that period of his writing in his many anthologies. But it should be noted that he once remarked that they were early poems and he did not like to be ‘reduced’ to them. They had a certain authorial ‘immaturity’ in that they in some respects lacked universality: they were a response to very particular historical circumstances.²⁹⁵ Miłosz’s later poems are arguably less raw, and they examine more ‘universal’ issues of human ethics.

In later years Miłosz emphasised the role of poetry not only as witness to and examination of horror and amorality, but also as an expression of hope for the future. Rejecting what he viewed as undesirable trends towards negativity and catastrophism in modern literature, Miłosz declared that one of the ‘essential attributes of poetry is its ability to give affirmation to things of this world’.²⁹⁶

What Miłosz considered essential to achieving this affirmation, and lacking in contemporary society, is religion. Like the vast majority of post-war Poles, Miłosz was Roman Catholic, and although he was of a liberal and generally open-minded bent, his ethical stance derives largely from his typically intense Polish religious education. The poems in *Voices of Poor People* are all written from the perspective of a Christian examining his or her conscience, and the religiosity, and Catholic guilt, in the direct appeal to God of “Song of a Citizen” is palpable. For Miłosz the place of religion, with its associated code of ethics, has been drastically weakened in modern public life.

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²⁹⁴ Joseph Brodsky cited in Riggan, “Czesław Miłosz: Silence... Memory... Contemplation... Praise,” 617.

²⁹⁵ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 131–133.

²⁹⁶ Riggan, “Czesław Miłosz: Silence... Memory... Contemplation... Praise,” 618. (The ‘catastrophist’ vogue is one with which Miłosz himself was aligned in his youth, but as I discuss shortly, he later rejected it as being a precursor of the ‘avant-garde’ Marxist movement.)

Scientism in Nazism, Marxism, Western Capitalism

Alongside his poetry, Miłosz wrote and published many essays and other prose works, and among other preoccupations he consistently expresses concern at the impact of science on society.²⁹⁷ For Miłosz the reason for the decline of an ethical and religious society is clear: science has ‘undermined’ religion.²⁹⁸ Certainly many aspects of his own history mitigate against a positive view of science, from the alleged scientific bases of Nazi theory (notably racially-based eugenics), to the medical experiments and so-called rational and efficient extermination processes of the concentration camps, where a distorted and ‘mechanistic’ understanding of Darwin’s ‘survival of the fittest’ was applied.²⁹⁹ The atomic bomb was another reservation about scientific development.³⁰⁰

The impact on Poland of post-war Marxist-socialist materialism, with its emphasis on economic growth through the development of science and technology, was immense. While Miłosz acknowledges that Karl Marx himself was more sophisticated, he condemns the version of Marxist theory that was adopted in the twentieth-century Soviet bloc, with its slanted appropriation of science.³⁰¹ This includes the growth of Marxist ‘social sciences’, or society observed and analysed from a pseudo-scientific viewpoint. Miłosz explains that he believes a scientific mind-set was responsible for nihilism, indifference and a decline in religion in modern society, directly attributing this to advances in science and technology.³⁰² Hence his remark, ‘the erosion of religion has its cause in a breakthrough in science and technology [...] and a mechanistic image of the world [...] as created by materialism’.³⁰³ By contrast, in communist Poland adherence to Roman Catholicism, and the State’s tolerance of spirituality in the institutionalised Church, became an expression of resistance against the regime, lending another strand to Miłosz’s arguments against the decline of religion.

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²⁹⁷ This is in contrast to the work of compatriot Zbigniew Herbert, discussed in Chapter 4, who in prose said very little about science and mathematics, but in whose poetry can be traced a line rich with mathematical reference.

²⁹⁸ Faggen, “Czesław Miłosz: The Art of Poetry LXX,” 244. Miłosz discusses with Faggen the role of religion in modern society, agreeing that in his case his Catholic faith certainly ‘overrides the impact of science’.

²⁹⁹ Miłosz, *Native Realm*, 231.

³⁰⁰ The influence of the atomic bomb was one of the prompts in the 1950s revival of “two cultures” debate in Britain, as briefly discussed in chapter 2 of this thesis. It was also of great concern to Einstein, whose connection with Miłosz I discuss later in this chapter.

³⁰¹ Miłosz, *Native Realm*.

³⁰² “The Withering Away of Society”, interview with Nathan Gardels, 1985, in Haven, *Czesław Miłosz: Conversations*, 66–74.

³⁰³ Interview with Ayyappa K. Paniker, 1982 in *Ibid.*, 28.

Two poems depict these concerns of Miłosz. In “Three Talks on Civilization”, Miłosz depicts environmental degradation:

TRZY ROZMOWY O CYWILIZACJI

[...]

Gdzie były lasy, teraz gruszek fabryk i cysterny.
Zbliżając się do mostów przy ujściu rzeki, zatykamy nosy,
w jej nurcie ropa i chlor, i związki metylu,
nie mówiąc o wydzielinach z Ksiąg Abstrakcji:
ekskrementach, moczu i martwej spermie.

[...] ³⁰⁴

Alongside his revulsion at chemical pollution, this poem also touches on Miłosz’s dislike of ‘abstraction’, a matter to which I will return in the specific context of mathematics.

Environmental pollution was particularly marked in Soviet-controlled eastern Europe, but this poem was written in Berkeley in 1963, and Miłosz may equally have been talking about the United States. Certainly his concerns about the impact of science are relevant to western capitalist society: in one of the last poems written and published before his death, he returns to his theme of scientists remote from a world of ethics, and ultimately empty:

UCZENI

Piękno przyrody jest podejrzone

[...]

Nauka dba pozbawianie nas iluzji.
Jakim językiem, na Boga, przemawiają ci ludzie
W białych kitlach? Karol Darwin
Czuł przynajmniej wyrzuty sumienia,

[...]

A co nam zostawili? Tylko rachunkowość
Kapitalistycznego przedsiębiorstwa. ³⁰⁵

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³⁰⁴ Miłosz, *Wiersze wszystkie*, 533–534. Written in 1963, first published in *Gucio zaczarowany* (*Bobo’s Metamorphosis*), 1965. Translated by Czesław Miłosz and Jan Darowski in Miłosz, *New and Collected Poems*, 203.

THREE TALKS ON CIVILISATION

[...]

Where there were forests, now there are pears of factories, gas tanks.
Approaching the mouth of the river we hold our noses.
Its current carries oil and chlorine and methyl compounds,
Not to mention the by-products of the Books of Abstraction:
Excrement, urine, and dead sperm.

[...]

³⁰⁵ Miłosz, *Wiersze wszystkie*, 1240. Translated by Robert Hass and Czesław Miłosz in Miłosz, *Second Space: New Poems*, 25. The Polish title, *uczeni*, translates more literally into English as ‘scholars’.

SCIENTISTS

The beauty of nature is suspect.

[...]

Science is concerned to deprive us of illusions.

[...]

My God, what language these people speak
In their white coats. Charles Darwin

Running through this is a conception of science and technology as dispassionate and amoral.³⁰⁶

Rationalism, Newton and Darwin

Miłosz's objections to science centre on the European Enlightenment, or Age of Reason, and the dominant thinking of the time; that is, particular scientific discoveries, and the associated disposition within the wider society of the period. While science from the perspective of a practising scientist may concentrate on specific details of experiments and discoveries, for a scholar of humanities, scientific development is central to the Enlightenment. For many this period represents a challenge to tradition and faith, and the elevation of science-based knowledge gained through the scientific method.³⁰⁷ Key thinkers were René Descartes (1596-1650), Baruch Spinoza (1632-1677) and Isaac Newton (1643-1727), all of whom can be considered great Rationalists, and whom Miłosz discusses at one point or another in his writing, and usually not in a positive context, given his belief that their ideas had an undesirable hold over wider thinking, to the exclusion of alternatives.

In "Child of Europe", written in New York in 1946, Miłosz recalls the gas chambers of the concentration camps:

DZIECIĘ EUROPY

[...]

Uszczelnialiśmy drzwi gazowych komór, kradliśmy chleb,
Wiedząc, że dzień następny cięższy będzie od poprzedniego.

[...]

Szanuj nabyte umiejętności, o dziecię Europy.
Dziedzicu gotyckich katedr, barokowych kościołów
I synagog, w których rozbrzmiewał płacz krzywdzonego ludu,
Dziedzicu Kartezjusza i Spinozy, spadkobierco słowa „honor”,
Pogrobowcze Leonidasów,
Szanuj umiejętności nabyte w godzinie grozy.

Umysł masz wyćwiczony, umiejący rozpoznać natychmiast
Złe i dobre strony każdej rzeczy.
Umysł masz sceptyczny a wytworny, dający uciechy,
O jakich nic nie wiedzą prymitywne ludy.

At least had pangs of conscience

[...]

What have they left us?

Only the accountancy of a capitalist enterprise.

³⁰⁶ This view is also suggested in the wartime "A Book in the Ruins", set in an abandoned building in Lithuania, depicts a 'scientist' looking through the ruins, but does not elaborate in particular on the role of this scientist apart from as fleetingly appearing observer. (Written in 1941, shortly after Miłosz's flight from Lithuania to Warsaw. First published in *Ocalenie* in 1945. Miłosz, *New and Collected Poems*, 28–30.)

³⁰⁷ See Markie, "Rationalism." Also "Enlightenment, N."

[...]
Z małego nasienia prawdy wyprowadzaj roślinę kłamstwa,
Nie naśladowuj tych, co kłamią, lekceważąc rzeczywistość.

Niech kłamstwo logiczniejsze będzie od wydarzeń,
[...]
Ze słów dwuznacznych uczyni swoją broń,
[...]³⁰⁸

The rationalists are unambiguously associated with the camps, but while Miłosz is certainly wary of a rationalist approach, he does not denounce it entirely. In referring specifically to Descartes and Spinoza, to logic and a dialectic of truth and falsehood, Miłosz is clearly invoking the Enlightenment, and with a degree of European pride.³⁰⁹ But at the same time the poem is ridden with cynicism about where this has led, to a blurring of the distinction between right and wrong, and it is this condemnation that ultimately pervades the poem as a whole.

The poet and publisher Jarosław Anders writes, ‘Reason and rationalism are for Miłosz perhaps the most ambivalent concepts with which he struggled throughout his life.’³¹⁰ Anders explains that there is a tension between instinct and irrationalism which promises creativity but

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³⁰⁸ Miłosz, *Wiersze wszystkie*, 236–238. First published in 1953 in *Światło dzienne* (*Daylight*). Translated by Jan Darowski in Miłosz, *New and Collected Poems*, 83–87.

CHILD OF EUROPE

[...]
We sealed gas chamber doors, stole bread,
Knowing that the next day would be harder to bear than the day before.
[...]
Treasure your legacy of skills, child of Europe,
Inheritor of Gothic cathedrals, of baroque churches,
Of synagogues filled with the wailing of a wronged people,
Successor of Descartes, Spinoza, inheritor of the word “honor”,
Posthumous child of Leonidas,
Treasure the skills acquired in the hour of terror.

You have a clever mind which sees instantly
The good and bad of any situation.
You have an elegant, sceptical mind which enjoys pleasures
Quite unknown to primitive races
[...]
Grow your tree of falsehood from a small grain of truth.
Do not follow those who lie in contempt of reality.
Let your lie be even more logical than the truth itself
[...]
Fashion your weapon from ambiguous words
[...]

³⁰⁹ I would argue here that in invoking Descartes, Miłosz is thinking of the philosopher and less so the mathematician. Elsewhere he similarly mentions Leibniz (in the context of Balzac’s search for principles of existence), but in that case too it is Leibniz the philosopher, and specifically his (philosophical) ‘monads’, with no suggestion of Leibniz the mathematician and founder of modern calculus. Miłosz, *Legends of Modernity*, 18.

³¹⁰ *Ibid.*, xii.

often delivers destruction; and ‘scientific’ rationalism that diminishes humanity and fails to account for the mystery within human nature. This ambivalence can be seen across Miłosz’s writing.

In another of the *Voices of Poor People* cycle, “The Poor Poet” depicts a cynical and experienced writer plotting the ‘revenge’ of hope, in response to humanity’s sufferings:

BIEDNY POETA

[...]

I kiedy lata odmieniły krew,
A tysiąc systemów planetarnych urodziło się zgasło w ciele,
Siedzę, poeta podstępny i gniewny,
Z przymrużonymi złośliwie oczami,
I ważąc w dłoni pióro
Obmyślam zemstę.

[...]

Jedni chronią się rozpacz, która jest słodka
Jak mocny tytoń, jak szklanka wódki wypita w godzinie zatury.
Inni mają nadzieję głupich, różową jak erotyczny sen.

Jeszcze inni znajdują spokój w bałwochwalstwie ojczyzny,
Które może trwać długo,
Chociaż niewiele dłużej, niż trwa jeszcze dziewiętnasty wiek
[...]³¹¹

From 1795 to 1918 Poland was partitioned between the Russian, Prussian and Hapsburg Empires, and so did not exist as an independent state. The nineteenth century thus carries for Poles connotations of (temporarily) lost sovereignty. Miłosz also has concerns about what he understands to be nineteenth-century scientific advances, which he sees as a culmination of the Enlightenment. In particular he objected to the theories of Charles Darwin (1809-1882) and argues that nineteenth-century social doctrines used science, and biology in

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³¹¹ Miłosz, *Wiersze wszystkie*, 208–209. Written in 1944, first published in 1945 in *Ocalenie* (*Rescue*). Translated by Czesław Miłosz in Miłosz, *New and Collected Poems*, 59–60.

THE POOR POET

[...]

And now that the years have transformed my blood
And thousands of planetary systems have been born and died in my flesh,
I sit, a sly and angry poet
With malevolently squinted eyes,
And, weighing a pen in my hand,
I plot revenge.

[...]

Some take refuge in despair [...]
Others have the hope of fools, rosy as erotic dreams.
Still others find peace in the idolatry of country,
Which can last for a long time,
Although little longer than the nineteenth century lasts.
[...]

particular, to argue for moral relativism in the sense of hitherto immutable moral laws being subject to continual change.³¹² In a lecture he prepared for delivery at Harvard, “The Lesson of Biology”, he laments the exclusion of alternative images to those of Copernicus, Newton and Darwin. Copernicus, in fact a Pole, is held responsible for the removal of an earth-centred and moreover anthropocentric model of the world.³¹³ Newton’s equations of motion are later ‘put in the place’ by Einstein, of which more shortly.

As for Darwin, Miłosz was born in the Lithuanian countryside and had an early self-professed love of nature. He went on to depict apparently idyllic countryside scenes in his prose works *The Issa Valley* and *The Land of Ulro*. Miłosz explains that he was fascinated, apparently from a distance, by the natural-science department of his university, and that in some respects he wished he had devoted his life to studying nature: ‘If you study my work, you’ll find that the sense of guilt is central to me, and to all my poetry. I also feel guilty for not having become a naturalist.’³¹⁴ But elsewhere Miłosz remarks that his Roman Catholicism was first shaken at the age of fifteen by a ‘so-called scientific worldview in [his] biology classes’.³¹⁵ And as for his partially formulated wish to be a naturalist, Miłosz expands on his view of nature, conceding that it has its ‘cruel side’: ‘my entire life and all my creative work are against nature, against so-called Mother Nature – an attempt to liberate myself from its demonic embrace.’³¹⁶ In other words, Miłosz’s opinion of ‘nature’ and of biological science is somewhat ambivalent. It would seem that he appreciates the appearance and beauty of nature, but less so the implications of its scientific reality.

In 1974 Miłosz published a long, 50-page, multi-part poem *From the Rising of the Sun*.³¹⁷ Set largely in his native Lithuania, the poem yearningly explores many of Miłosz’s preoccupations: religion, reason and the natural world, and is a reflection on the meaning of existence. Joseph Brodsky considered *From the Rising of the Sun* to be Miłosz’s best work.³¹⁸ In Part 2 of that poem, “Diary of a Naturalist” Miłosz ‘pays homage’ to a school biology teacher who entranced him with microscope slides.³¹⁹ But, again displaying an ambivalence towards such a scientist, the poem goes on gently to mock the priorities of two naturalists in ruined

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³¹² “Speaking of a Mammal”, first published in 1956: Miłosz, *Proud to Be a Mammal*, 181. An excellent recent study of Darwin’s work and influence is Ruse, *The Cambridge Encyclopedia of Darwin and Evolutionary Thought*.

³¹³ Draft copy of undated typescript in Miłosz, “Czesław Miłosz Papers, 1880-2000,” Box 123, Folder 1907, “The Lesson of Biology”, 1. Nicholas Copernicus (Mikołaj Kopernik) was born in the Prussian town of Toruń.

³¹⁴ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 29. Miłosz recalls the allure of the dissection of frogs, taking place in the science faculty when he was a university student.

³¹⁵ “Against Incomprehensible Poetry” first delivered (as a lecture) in 1990: Miłosz, *To Begin Where I Am*, 373.

³¹⁶ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 29.

³¹⁷ *Gdzie wschodzi słońce i kędy zapada*. First published in 1974. Miłosz, *Wiersze wszystkie*, 631–684.

³¹⁸ “Obituary: Czesław Miłosz.”

³¹⁹ Seamus Heaney’s *Death of a Naturalist* was published in 1966.

Warsaw, who continue seeking insects and amoebas, their lives apparently unaffected by the city's destruction.³²⁰ In this light, the amoebas in "Song of a Citizen" also have mixed connotations.

Twentieth-century science: Albert Einstein 'via' Oscar Miłosz

While lamenting the dominant scientific viewpoint of the nineteenth century, Miłosz accepted that an alignment between science and poetry had been present in the past:

Goethe [1749 – 1832] has an intuition that something was going wrong, that science should not be separated from poetry and imagination. [...] Maybe we are going to return to a very rich era where poetry and imagination are once again alongside science.³²¹

For Miłosz this was indeed to be the case: rescue against despair, or rationalised (irrational) hope lay in modern, twentieth-century science. In "The Withering Away of Society" he explains both his particular concerns about misused old science, and the need for society to catch up with and adapt to new science, thereby restoring some sense of anthropocentrism and spirituality. It is useful to look at a substantial extract of this interview, as it touches on and elucidates many aspects of Miłosz's objections to science:

The transformation which is going on in religion reflects something extremely profound in the sense of nihilism. I am inclined to believe that only when profound shifts appear, for example a new science, will there be a basic change [...] At the present moment science is in the process of transition from the science of the nineteenth century to a new approach, in physics particularly. The whole society, as we observe in America, lives by the diluted "pure rationalism" of nineteenth-century science. [...] In this naive view, we live in a universe that is composed of eternal space and eternal time. Time extends without limits, moving in a linear way from the past to the future, infinitely. Functionally speaking, humankind is not that different from a virus or a bacteria. A speck in the vast universe. Such a view corresponds to the kind of mass killing we've seen in the past century. To kill a million or two million, or ten, what does it matter? Hitler, after all, was brought up on the vulgarised brochures of nineteenth-century science. This is something completely different from a vision of the world before Copernicus, where humankind was of central importance. Probably, the transformation I sense will restore in some way the anthropocentric vision of the universe. These are processes, of course, that will take a long time.³²²

Here Miłosz clearly articulates his concerns about physics (Newton and Copernicus), the nineteenth century's rationalism and adherence to an 'eternal' space and time, Nazism and what it means to be a bacterium, 'a speck', or – in the case of "Song of a Citizen" – an amoeba.

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³²⁰ "Diary of a Naturalist" in *From the Rising of the Sun/Gdzie wschodzi słońce i kędy zapada*, where Miłosz dreams of a unity with nature, but it is not in the end achieved. Miłosz, *New and Collected Poems*, 286. Translated by Czesław Miłosz and Lillian Vallee.

³²¹ "The Withering Away of Society", interview with Nathan Gardels in Haven, *Czesław Miłosz: Conversations*, 74. In fact Goethe is mentioned in a section (omitted by me) of "Song of a Citizen", where Goethe 'stands up' and faces the Earth.

³²² "The Withering Away of Society", interview with Nathan Gardels in *Ibid.*, 71–72.

The central figure of modern science for Czesław Miłosz was another European exile in the United States: Albert Einstein (1879-1955). Miłosz was more than just an admirer of Einstein: ‘In fact, I worshipped him’.³²³

Einstein’s 1905 special theory of relativity builds on the Galilean notion of uniform motion as relative, meaning that there is no one special stationary or privileged reference point – such as the Earth – from which all other motion is measured. Einstein then added into the model the recently observed phenomenon that light has a constant speed. The consequences of this include the results that time dilates and length shortens, as objects approach the speed of light. Within this model Newton’s equations of motion are still more or less accurate, but only at speeds that are low, relative to the speed of light.³²⁴

Einstein then turned to a more generalised theory that takes into account frames of reference that are accelerating relative to one another, and theories of gravity. From a mathematical point of view the special theory is not very complex, but the incorporation of the latest work in gravitation required Einstein to draw on a wealth of recent and complex work in modern mathematical geometry, particularly ‘non-Euclidean’ geometry. His theory of General Relativity was published in 1916.³²⁵

Euclidean geometry describes the standard two- or three-dimensional space to which we are accustomed. As a description of our world and universe it had reigned essentially undisputed since around 300BC, when Euclid wrote his *Elements*, recognised as a paradigm of mathematical written exposition. Non-Euclidean geometries, however, are contrasting versions of space that display intrinsic curvature and imply multiple dimensions. They were developed in the nineteenth and early twentieth centuries by many European mathematicians, primarily the Hungarian Transylvanian János Bolyai (1802-1860), the Russian Nikolai Lobachevskii (1792-1856), Carl Friedrich Gauss (1777-1855) and Bernhard Riemann (1826-1866) both German, and later the French mathematician Henri Poincaré (1854-1912), and

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³²³ Faggen, “Czesław Miłosz: The Art of Poetry LXX,” 245. Miłosz makes no reference to it (and in all likelihood he was unaware), but in fact Einstein once wrote, ‘Pure mathematics is, in its own way, the poetry of logical ideas.’ (See obituary of Emmy Noether in Chapter 5.)

³²⁴ A plethora of sources outline Einstein’s theory of special relativity, including many university texts for later-stage undergraduate students of Mathematics and Physics. For a good and accessible summary by mathematicians, see Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*. For a discussion of the development of his theory in its historical mathematical context see DiSalle, “Space and Time.”

³²⁵ For an account of Einstein’s development of the general theory of relativity and the mathematics around that, see Gray, *Plato’s Ghost*, particularly 324–328. Note also the Riemannian metric, essential in theories of relativity, in the epigraph to this thesis.

another German, Felix Klein (1845-1925).³²⁶ Non-Euclidean geometries revolutionised mathematics and are a major part of its transformation into a modern discipline.³²⁷

The reference to non-Euclidean geometry in “Song of a Citizen” undoubtedly relates to these modern, sometimes counter-intuitive, models of space, but how well and how much of the detail Miłosz understood is debatable. I will turn later to the particular issue of Miłosz’s knowledge of mathematics. As for Einsteinian relativity, Miłosz’s various statements make it clear that his understanding stems from the views espoused by his distant cousin, Oscar Miłosz.³²⁸

In his 1980 Nobel lecture Miłosz describes the poet’s need for an essential quality in the self-imposed duty to ‘see and describe’ reality. He laments the events of the twentieth century, in particular the Holocaust and Soviet rule in Eastern Europe, as a failure to achieve this ‘double vision’ and the ensuing loss of clear distinction between truth, or ‘reality’, and falseness and illusion. He condemns the ‘uniform worship of science and technology’, holding it responsible for much that has gone wrong in society. The lecture finishes with a long acknowledgement of the influence on Miłosz of his cousin Oscar, with Miłosz stating that Oscar, ‘the visionary’, warned about the ‘erroneous direction taken by science in the Eighteenth Century’, that the Newtonian model of the universe was ‘polluting’, but that some hope lay in the ‘science of the future’:

For how to be *above* [emphasis in original] and simultaneously to see the Earth in every detail?

And yet, in a precarious balance of opposites, a certain equilibrium can be achieved thanks to a distance introduced by the flow of time [...] Thus both – the Earth seen from above and in an eternal now and the Earth that endures in a recovered time – may serve as material for poetry.³²⁹

This concept of the microcosm and macrocosm appears directly in “Song of a citizen”, with the equating of a beetle or spider with a planet, and the light of an atom with that of Saturn.³³⁰

That the notion of a ‘double vision’ derives from an Oscar Miłosz picture of relativity is elaborated upon in later interviews. In a 1989 discussion with Brodsky, Miłosz remarks:

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³²⁶ As discussed at greater length in Chapter 5, the German mathematicians were all at Göttingen.

³²⁷ For a discussion of these mathematicians’ relative roles in the development of non-Euclidean geometry see Gray, *Plato’s Ghost*, passim, particularly 44–55. Given his reluctance to publish, Gauss’s exact place in that history is disputed. See also chapters 1 and 5.

³²⁸ See note 289.

³²⁹ Miłosz, “Czesław Miłosz - Nobel Lecture.”

³³⁰ Similarly to the beetle and spider here, ants and bees reappear in Miłosz’s “A Poor Christian Looks at the Ghetto”, also of the same cycle, and that has been reproduced in a number of descriptions evoking life in Warsaw for gentiles living in full view of the Jewish Ghetto.

Oscar Milosz believed that the theory of relativity opens the gate to a new era, a new era of harmony between science, religion, and art [...] in a kind of instinctive rebellion against the road taken by nineteenth-century science – by the rationalists [...] space for Newton was a firm, objective space, while in modern physics, and for Oscar Milosz also, there was no such thing, because everything was a unity of movement, matter, time, and space.³³¹

And very similarly in 1994:

My cousin Oscar Milosz believed that his theory of relativity has opened a new era of mankind – an era of harmony, reconciliation between science, religion and art. The positive consequence of Einstein’s discoveries was the elimination of Newtonian time and space as infinite and the introduction of the relativity of time and space that underlies our cosmology and its concept of the big bang.³³²

I have quoted these very similar pieces here because they demonstrate the clear and enduring link in Milosz’s mind between Einstein, relativity and his cousin Oscar’s mystical understanding of it. In fact Milosz left behind little else to suggest that he had any other understanding of Einsteinian relativity. For him it represented a break with Newtonian physics, that for him assumes an infinite and ‘timeless’ existence of the universe; one not created at some point by God.

It is true that a big bang theory of the universe can be compatible with a more liberal creationist viewpoint, but Milosz’s approach is interesting, since the perceived attack on an omniscient, omnipotent God was often supposed to be the reason for the initial reluctance on the part of some mathematicians to propagate non-Euclidean forms of geometry – from which stems relativity. In fact Einstein’s general model of the universe allowed for an infinitely expanding one – he introduced a cosmological constant term to fit his assumption of it being closed, but by the early 1930s he removed that term as he considered his assumption erroneous. Recent models of the cosmos suggest again that the universe is open and expanding.³³³ Czesław Milosz was apparently unaware of this ongoing question around the nature of the universe, and neither does he acknowledge the legacy of Galileo (as much a ‘heretic’ as Copernicus) in Einstein’s theories.

In the notes to his collection, *Second Space*, published in English just before he died in 2004, Milosz continued to profess his reverence towards Oscar Milosz, contending that when the latter wrote his “The Letter to Storge”, in 1916, he was ‘unaware of Einstein’s discovery’, but nonetheless his poems ‘present a cosmological exposition that corresponds precisely to Einstein’s theory of relativity’. Furthermore, adds Milosz, the same “Letter to Storge” puts

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³³¹ Interview with Joseph Brodsky, 1989, in Haven, *Czesław Miłosz: Conversations*, 108.

³³² Faggen, “Czesław Miłosz: The Art of Poetry LXX,” 245.

³³³ Rosen, “Einstein Likely Never Said One of His Most Oft-Quoted Phrases.”

forth a hypothesis exactly akin to the Big Bang theory, decades before it was advanced in the scientific world.³³⁴

All this strongly suggests that Miłosz's understanding of Einstein's work was strictly limited to the individual impressionistic view held by his poet-philosopher cousin Oscar Miłosz.

Miłosz met Einstein once, in 1948, at Princeton. At that time Miłosz was posted as a cultural attaché at the (Socialist) Polish Embassy in Washington and the Soviet Union was organising a 'World Congress of Intellectuals for Peace' in Wrocław, western Poland.³³⁵ Einstein, as did many intellectuals, took the conference at face value and submitted a statement arguing for disarmament. Miłosz was the Polish Embassy official whose job it was to liaise with Einstein on that statement, but in the event, the conference turned out to be far more political than many of its international attendees had understood, and Einstein's statement was not read out in full, and was instead replaced in the official record by a far more anodyne letter of support. Einstein objected to the duplicity, and published his original statement in the *New York Times* the following month.³³⁶ Miłosz has described his own distress at these events, of which he apparently had no prior knowledge, claiming he was in fact the first to alert Einstein to what had happened, in a telephone call.³³⁷

Miłosz explains that he then spontaneously called on Einstein at Princeton, and sought his advice on whether he should defect from Poland, as he was increasingly concerned at censorship in the socialist regime.³³⁸ Miłosz reports that Einstein's 'warmhearted' advice was not to, as 'a poet should stick to his native country'.³³⁹

Around this time, 1948-1949, Miłosz wrote the draft of a poem in the form of a letter to Einstein, "Do Alberta Einsteina", where he laments Darwinism and the 'coldness' of those working with microscopes, adding that Einstein should be memorialised alongside Newton and Copernicus:

DO ALBERTA EINSTEINA
[...]

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³³⁴ Notes to the poem "Apprentice", Miłosz, *Second Space: New Poems*, 73, 83–84, Notes.

³³⁵ Attendees included Pablo Neruda, Pablo Picasso, Bertolt Brecht, Paul Éluard, Aldous and Julian Huxley and the Curie-Joliot children (Nobel laureate in both Physics and Chemistry, Marie Curie (1867-1934), was born Maria Skłodowska in Warsaw). For a discussion of 'peace' propaganda in post-war Soviet era Eastern Europe, and this 1948 World Congress, see chapter "Homo Sovieticus" in Applebaum, *Iron Curtain*. Also Wittner, *The Struggle Against the Bomb*, 174–178.

³³⁶ "Poles Issue Message by Einstein; He Reveals Quite Different Text", *The New York Times*, 29/08/1948 in Miłosz, "Czesław Miłosz Papers, 1880-2000," Box 177, Folder 2766.

³³⁷ See Miłosz's version of events in "Le message rentré d'Einstein" in *France Catholique-Eclésiastique*, 11/11/1983, 15, and also correspondence between Einstein and the Polish Embassy in Washington reproduced in *Krytyka*, August 1981, 196-199, held in *Ibid.*, Box 157, Folder 2511.

³³⁸ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 96–97.

³³⁹ Faggen, "Czesław Miłosz: The Art of Poetry LXX," 4.

Żal mi, że tak mało
 Pomogłem ludziom cenić wielkie piękno świata.
 Ciekawiło mnie wszystko. Nazwy drzew i roślin,
 Powstawanie gatunków, podróże Darwina,
 Polinezyjskie mity, godowy strój ptaków,
 Na wpół zatarte rzeźby zapomnianych krajów.
 W zimnych pracowniach nęcił mnie mikroskop,
 [...]

Jeżeli dzisiaj lubię zwracać się do Ciebie,
 To nie tylko dlatego, że kute w marmurze
 Stoi popiersie Twoje, tam gdzie naszą pamięć
 Ma Newton i Kopernik. Nie żeś wreszcie zdołał
 Pomieścić grawitacją i elektrycznością
 Postawić znak równania. Jest w Tobie coś więcej:
 Wiara w światło rozumu, nieprzekupna troska
 O nasz gatunek ludzki, o to, czym być może,
 I o to, co potrafi nikczemnie roztrwonić.
 Nie chłód obojętnego badacza Natury,
 Ale ciepło, niepokój prawdziwej dobroci.
 [...]

Ja jednak nauczyłem się odrzucać. Ten jest
 Przywilej nam poetom z dawna zapewniony,
 Że zarobki, wesela, chrzciny i pogrzeby
 Nie są nam treścią. Blaskiem chyba, lotem światła
 Na wielkich czarnych wodach. Jak przez ogród szklany
 Idziemy, widząc z żalem więcej, niż jest wolno.
 Czy jesteśmy naprawdę wrogowie gatunku,
 Którzy przemocą zmienić chcą wszystkich w aniołów
 Czystego intelektu? Wydrzeć z głębi iskrę,
 Znienawidzoną iskrę prometejskiej męki? ³⁴⁰

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³⁴⁰ Miłosz, *Wiersze wszystkie*, 360–361. See also additional handwritten fragments in Miłosz, “Czesław Miłosz Papers, 1880-2000,” Box 89, Folder 1190. Reproduced for the most part in Miłosz, “Do Alberta Einsteina.” My own translation into English, with the assistance of Polish native speaker Joanna Darmos.

TO ALBERT EINSTEIN

[...]

I'm sorry that I have done so little to help people
 Appreciate the great beauty of the world.
 I was interested in everything. The names of trees and plants,
 The origin of species, Darwin's travels,
 Polynesian myths, the mating attire of birds,
 The half-obliterated sculpture of forgotten countries.
 The microscope enticed me into cold laboratories
 [...]

If today I turn to you,
 It's not just that wrought in marble
 Stands your bust, where we pay tribute
 to Newton and Copernicus. Not that finally you managed
 To put an equals sign in the equation
 Between gravitation and electricity. There is something more in you:
 Faith in the light of reason, incorruptible care
 For our human species, and what it may become,
 And for that which can be abjectly squandered.
 You have not the coldness of an unemotional researcher of Nature
 But a warmth and concern, of true goodness
 [...]

The poem was only ever an unfinished draft.³⁴¹ It serves to underline, however, both his personal regard for Einstein, and at the same time his somewhat dismissive attitude to Einstein's actual scientific achievements, represented here in terms of mathematical equations. They take second place to Miłosz's own priority: an involvement in wider human society. The poem also reinforces Miłosz's view of scientific researchers as generally cold and unemotional.

It is possible that Miłosz may have been further drawn to Einstein because of his political dissidence. Einstein, a Jew, was obviously anti-fascist. He escaped the Nazi regime while visiting the United States when Hitler came to power in 1933, and remained there. Einstein also was not wholeheartedly embraced by the postwar regimes in the Soviet bloc: Miłosz argues that while in 1960s Warsaw large posters of Einstein and Newton were hung near the Copernicus statue (on the central Royal Route), Einstein was not always respected, on account of his stand against the atomic bomb, and his 'humanitarianism' which was rejected by Marxists. Miłosz claims that the theory of relativity, while discussed in specialist circles, was otherwise considered bourgeois.³⁴²

In 1951, after he had defected from Poland in Paris, Miłosz sought Einstein's support for obtaining a return visa to the United States. Einstein replied suggesting that he seek support from someone with more 'connections', adding that Miłosz would otherwise need to sign a declaration condemning the state of Poland.³⁴³ In 1953 Miłosz again wrote to Einstein, sending a copy of his (soon well-regarded) political monograph *The Captive Mind*.³⁴⁴ Miłosz does not appear to have met Einstein, who died in 1955, again.³⁴⁵

In 1954 Miłosz wrote another poem that praises Einstein, and likewise disparages Newton:

WEZWANIE
[...]
A przestrzeń, jaka jest? Czy mechaniczna,
Ta newtonowska, jak zamrzła turma,
Czy lotna przestrzeń Einsteina, *relatio*
Ruchu i ruchu? Nie mam co udawać
Że wiem, jeżeli nie wiem, albo wiem,

---

³⁴¹ When former American poet laureate Robert Hass and Czesław Miłosz were preparing the 2001 collected edition in English (Miłosz, *New and Collected Poems*), Hass asked Miłosz about translating the "To Albert Einstein" poem. Miłosz was not interested, shrugging off the suggestion. It has still not formally been translated into English. Personal email, Hass to Kempthorne, "The Miłosz Poem."

³⁴² "Speaking of a Mammal" in Miłosz, *Proud to Be a Mammal*, 184–185. Miłosz is concerned to reassert the particularities of human nature, as distinct to what he considers a more amoral mammalian nature in other living species.

³⁴³ Letter from Einstein to Miłosz, 6/2/1951 in Miłosz, "Czesław Miłosz Papers, 1880-2000," digital images.

³⁴⁴ See letter Einstein to Miłosz, 12/07/1953 in *Ibid*.

³⁴⁵ That they did not meet further is implied in Faggen, "Czesław Miłosz: The Art of Poetry LXX," 4. See also short set of correspondence Einstein-Miłosz in Einstein, "Albert Einstein Archives," online search.

A wyobraźnię mam tysiącoletnią
[...]³⁴⁶

Returning to “Song of a Citizen” and its reference to non-Euclidean geometry, Miłosz apparently had only a superficial knowledge of the mathematics; for him it was a concept that he was aware had a connection with the work of Einstein. And for Einstein himself, Miłosz appeared to see him primarily as a revered dissident, and viewed his science largely from the perspective of a non-scientist and ‘mystic’.

This is reinforced in remarks by Miłosz written in his later life: for him poets lacked adequate language to articulate all thoughts, while the new sciences ‘favour a specific realm of the imagination [already] cultivated by mystics’. The discoveries of Einstein ‘only seem to confirm their intuitions’.³⁴⁷ The insights of the poets came before those of the scientists and mathematicians.

Mathematics and modernist poetry: symbolism, formalism and order

In his discussions around science, Miłosz focuses on selected scientists: the physical sciences as represented by Newton and Copernicus, and the biological by Darwin. When it comes to Einstein, although relativity crosses clearly from physics into the mathematical sciences (and the theories are entirely dependent on advanced mathematics, as evidenced in Miłosz’s own reference to non-Euclidean geometry), it would appear that Miłosz views relativity largely from the perspective of an abstract theory, and in fact, almost as a metaphysical phenomenon.

Emily Grosholz, poet and professor in philosophy at Pennsylvania State University, is one of the few scholars who attempts to examine more deeply Miłosz’s understandings of science. She cautions that Miłosz’s perception of science and its hegemony, to the detriment

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³⁴⁶ Miłosz, *Wiersze wszystkie*, 621. Written in 1954 at Brie-Comte-Robert (Miłosz’s home near Paris), first published in *Gdzie wschodzi słońce i kędy zapada* (*From the Rising of the Sun*) in 1974. Translated by Czesław Miłosz and Robert Hass in Miłosz, *New and Collected Poems*, 268–270.

AN APPEAL
[...]
And space, what is it like? Is it mechanical,
Newtonian? A frozen prison?
Or the lofty space of Einstein, the relation
Between movement and movement? No reason to pretend
I know. I don’t know, and if I did,
Still my imagination is a thousand years old.
[...]

³⁴⁷ “During my life my main occupation...” undated typescript by Miłosz held in Miłosz, “Czesław Miłosz Papers, 1880-2000,” Box 126, Folder 1994, 13.

of a moral purpose, may have been too dichotomous.³⁴⁸ She contends that Miłosz had a Marxist understanding of science, which misapplies it in order to construct artificial and predictive theories of human nature. Grosholz remarks:

Reductionist theories of human nature pretend that people are like blocks and pulleys, that their actions are subject to physical laws and thus determined, inevitable, amoral. Moral responsibility as a category drops out of the description of human affairs. Thus, moral disputation (and poetry) are simply by-products of our confusion about ourselves, which we can ultimately do without.³⁴⁹

I find this an excellent description of what concerns Miłosz when he questions science, particularly in the context of Marxist theories of science and technology. However, Grosholz's objection to this view I think overlooks Miłosz's own more nuanced discussions about modern science. Grosholz goes on to argue that science can in fact be divided between mathematics and physics, which 'indeed behave predictably, as if they could not be otherwise', and the biological sciences which are made up of a heterogeneous 'patchwork' of sub-fields and moreover have a cognitive dimension.³⁵⁰ Grosholz contends that Miłosz has missed this distinction. That may be so, but I would question Grosholz's characterisation of the physical and mathematical sciences. In his understanding of modern, relativistic theoretical physics, Miłosz is in fact well aware that that field is not as 'predictable' as once believed by his archetypal dogmatic nineteenth-century rationalist.

That said, what did Miłosz understand of the nature of mathematics itself?

Miłosz does explicitly mention mathematics on occasion, including in its formalist application to poetry, but despite that occasional reference there is little to suggest that he had any deep familiarity with the subject. Recalling his high-school matriculation exam, Miłosz relates that he found humanities subjects easy, but mathematics and physics 'frightening'. He explains that he did not even attempt the mathematics section of the exam, and instead copied from a willing friend: 'I knew absolutely no math [...]'³⁵¹

So much for his youthful opinion of mathematics. One of his last poems is more ambiguous, opening with a 'stench' which immediately strikes an unpleasant note:

PAN OD MATEMATYKI

za tą linią zaczyna się smród przyrodzony
a linia żeby istnieć nie potrzebuje ciał

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³⁴⁸ Grosholz, "Miłosz and the Moral Authority of Poetry."

³⁴⁹ Ibid., 260.

³⁵⁰ Ibid., 261.

³⁵¹ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 26.

a jest odwiecznie czysta i niezmienna

mój dom z ogrodem niedaleko lasu
[...]
nie rywalizuję z panem od biologii
który tłumaczy dzieciom czego dowiodły
prawa nauki

podglądam rodzinę
[...]
i wszystko ogarnął sen ³⁵²

The middle section of the poem depicts a group of dishevelled foxes who are boiling up a stew of meat, cabbage and onions. The ‘stench’ does not in fact refer to mathematics at all; rather mathematics lies outside that ‘reality’ of everyday life. Miłosz must have absorbed at least some of his school mathematics lessons – Euclid’s *Elements* as taught to school pupils of Miłosz’s generation will have included the definitions including that of a point being ‘that which has no part’, and ‘a line is a breadthless length’.³⁵³ In other words, mathematics in this case exists in some kind of vacuum, detached from the life that Miłosz and his family live. It is not an entirely positive view, particularly bearing in mind what one knows of the priority that Miłosz places on living well within an ethical society. In other words, the poem depicts mathematics as a disconnected abstraction; something that he has already condemned in ‘Three Talks on Civilisation’, discussed earlier, for its role in the polluting factories and environmental degradation of socialist Eastern Europe. ³⁵⁴

As discussed in Chapter 2, certain schools of poetry can be particularly associated with abstraction, and within that, with mathematics, most notably some of the French Symbolists

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³⁵² Miłosz, *Wiersze wszystkie*, 1320. Written in 2002. Translated by Anthony Miłosz. Miłosz, *Selected and Last Poems*, 279.

THE MATH TEACHER

beyond this line begins intrinsic stench
yet to exist a line doesn’t need a body
it is forever clean and unchanging
my house with a garden is not far from the woods
[...]
I don’t compete with the biology teacher
who explains to the children what has been proved
by the laws of science
I spy on my family
[...]
And the dreaming swallowed it all.

³⁵³ O’Connor and Robertson, “Euclid’s Definitions.”

³⁵⁴ “*Veni Creator*” (1961), also depicts an ‘anti-human’ understanding of abstraction: “Come, Holy Spirit,[...]/I am only a man: I need visible signs./I tire easily, building the stairway of abstraction [...].” Translated by Czesław Miłosz and Robert Pinsky in Miłosz, *New and Collected Poems*, 223.

and later forms of ‘avant-garde’ poetics, particularly those that incorporate an element of language play ‘for its own sake’.³⁵⁵ It was not a form of poetry that appealed to Miłosz, and although he was associated with some groups of this nature in his youth, he later fell out with them in a quite public manner, objecting to their Marxist leanings as well as their writing style.³⁵⁶ In a 1958 publication he condemned the ‘avant-gardists’, and their ‘puzzles’ of language, in colourful terms:

[They] made of the poet a creature with a head covered by mathematical knobs and excessively large eye lenses, with a simultaneous atrophy of heart and liver.³⁵⁷

Miłosz disliked the avant-gardists as much for their play with language and metaphor as for what he saw as an abdication of moral norms, which for him gave art meaning and value.³⁵⁸

Paris as the birthplace of this poetic style has mixed associations for Miłosz. He considered Paris as a cultural centre for central and Eastern Europeans, recalling that during his time at the Embassy there he met Éluard and Neruda.³⁵⁹ After his defection, Miłosz himself published the vast majority of his Polish works in *Kultura*, the émigré journal based there.³⁶⁰ But the decade of the 1950s, which Miłosz spent in exile in Paris, was not a happy one for him. He felt shunned by the Polish regime for his defection, and also by other dissidents who were suspicious of his earlier associations, not least his official diplomatic posts.³⁶¹ He was also critical of French intellectuals of the era, objecting to their continued ideological support of communism in the east.³⁶²

As for poetry, Miłosz describes an ‘explosion of energy’ in France following the Symbolists, but with a ‘twilight’ that lasted from the time of World War I until the present

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³⁵⁵ The Romanian poet, Ion Barbu, studied in chapter 5, is a clear example of this type.

³⁵⁶ Poland’s ‘avant-garde’ poets are strongly associated with pre-war (1920s) Marxist groups, and many of them initially, if not long-term, supported the post-war Soviet communist regime. Their early poetic style included a focus on syntax, almost for its own sake, within poetry. Prominent members and associates include Antoni Ślōnimoski, Julian Tuwim and Aleksander Wat. Miłosz was associated with a precursor group in his own youth, and had a quite public falling out with them later – particularly Ślōnimoski – objecting to what he saw as their collusion with an abhorrent political system. Ślōnimoski in turn accused Miłosz of having been a traitor to the social and poetic cause, as well as to Poland. For a full discussion of Poland’s ‘avant-garde’ poets see Shore, *Caviar and Ashes*.

³⁵⁷ From *Kontynenty* (1958), 68, cited in Carpenter, “The Gift Returned,” 632.

³⁵⁸ Maciuszko, “The Moral Aspect of Czesław Miłosz’s Creativity.”

³⁵⁹ Miłosz, *Legends of Modernity*, 91, 96–97.

³⁶⁰ *Kultura* was the journal of the *Instytut Literacki* at Maisons-Lafitte near Paris, which was established after the war, in 1946, and ran until the death of its founder, Jerzy Giedroyc, in 2000. It was a refuge for exiled writers from Poland, including Miłosz in the 1950s, and responsible for publishing many great Polish writers during the period of socialist censorship in Poland, as well as being a centre of resistance to the socialist regime. See Modrzejewski, “Instytut Literacki w Paryżu 1946-2000.”

³⁶¹ See Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*.

³⁶² Faggen, “Czesław Miłosz: The Art of Poetry LXX,” 249–250.

day.³⁶³ He comments on developments in theories of poetry during the nineteenth century (again, as with science, the century attracting his opprobrium), arguing that, like art, poetry began to abandon the centrality of the subject in favour of the work itself. Miłosz is aware of the association with mathematics: in the case of art, he objects to cubist portraiture where the ‘cylinders and cones’, and not the human sitter, are a main, albeit oblique, subject. In the case of poetry this meant an increased attention to the form of poetry, with words themselves chosen to evoke a mood whose interpretation and associations depended on each reader. Miłosz sees Mallarmé and Valéry as symptomatic of this movement, and he held strong reservations regarding Mallarmé’s abstraction:³⁶⁴

It would certainly be nice to view a poem apart from its date and circumstances, but that can't be done. Besides, what do we want – marble, unshakable canons, beauty? I'm no Mallarmé. Dates are important. ³⁶⁵

Miłosz’s objections to Mallarmé are firmly grounded in his ethical and religious stance. He remarks:

thanks to my catholic upbringing I have exemplified the line of resistance against the poetries from under the patronage of Mallarmé i.e. against self-adoring art called an “act of mind”. Let us notice that the cult of the work of human hands as the highest and only value is possible only where the world is deprived of any principle and of any value...³⁶⁶

Miłosz contends that a concern with ‘purity of style’ was an unwelcome preoccupation of the French symbolists, Mallarmé in particular, and that in eliminating all that does not serve an aesthetic purpose, Mallarmé broke the traditional link with reality and rendered descriptive poetry impossible. ³⁶⁷

Miłosz met Paul Valéry in Paris and wrote a poem about him, describing himself (a ‘certain student’) in Paris attending a lecture by Valéry, but unable to concentrate, hearing instead the screams of humanity:

ODCZYT
[...]
Wyglądał Paul Valéry
Tak jak na swoich portretach:
Wąs krótko podstrzyżony, J
Jasnooki, uważny
Chłopiec, który posiwał,
Choć jest jak dawniej prędkie.

³⁶³ “Against Incomprehensible Poetry” in Miłosz, *To Begin Where I Am*, 376–377.

³⁶⁴ Miłosz, *Legends of Modernity*, 127–128. I examine in some detail Miłosz’s views on Mallarmé and Valéry, as both have a consistent underlying presence across my thesis.

³⁶⁵ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 133.

³⁶⁶ “During my life my main occupation...” undated typescript by Miłosz held in Miłosz, “Czesław Miłosz Papers, 1880-2000,” Box 126, Folder 1994, 14.

³⁶⁷ Miłosz and Hass, “‘Natura’: Section IV from ‘Treatise on Poetry,’” 629.

Układał na stole kartki,
Miał precyzyjne ręce,
Czytał logiczne ciągi
Zdań głównych i pobocznych

[...]

Siedział i liczył sylaby.

[...]

Hodowca odmian kryształu,
Stronił od nierozumnej
Sprawy śmiertelnych.

I niestety, niestety minęło

[...]

Upodlenie i groza.

[...]

Ziemia krzyki zabrała,
Nikt już dziś nie pamięta,

[...] ³⁶⁸

The poem is rich in allusions to Valéry's interest in the connection of mathematics with poetry, but, again, the suggestion is that these mathematical 'games' with language leave out what is most important, the human ethical dimension. Miłosz remarks:

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³⁶⁸ Miłosz, *Wiersze wszystkie*, 1051–1053. First published in 1994 in *Na brzegu rzeki* (*Facing the River*) 1994. Translated by Czesław Miłosz and Robert Hass in Miłosz, *New and Collected Poems*, 580–582.

A LECTURE

[...]

Paul Valéry looked exactly

Like his photographs:

A close-trimmed mustache,

A clear-eyed attentive

Boy who had gone gray

And was, as always, quick.

He arranged pages on the table.

His hands were precise.

He read logical sequences

Of main and subordinate clauses,

[...]

He was counting verse syllables.

[...]

A grower of crystals,

He shunned the unreasonable

Affairs of mortals.

And alas, alas it passed –

[...]

Debasement and terror.

[...]

The earth took in the screams,

No one anymore remembers

[...]

Some people go so far as to say that Valéry perfected a rhetoric in which the phrases seem to have some meaning but are in reality no more than extremely beautiful combinations of words. Though those phrases may have a great emotional meaning, they cannot be translated into the language of discourse.³⁶⁹

This link between mathematics and grammar in poetry is similarly evoked in one of Miłosz's later pieces, the two-line "Death of a poet", that suggests his lack of concern for this aspect of writing, compared with the richness of semantics:

NA ŚMIERĆ POETY
Zatrzasnęły się nim wrota gramatyki.
Teraz szukajcie go w gajach i puszczach słownika.³⁷⁰

This short couplet encapsulates Miłosz's objections to the Symbolist and 'avant-gardist' favouring of form over content. In this case the form, or grammar, is ultimately ephemeral, leaving the reader free to interpret individual meaning.

Yet Miłosz did not wholly reject poetic formalism. He was particularly interested in T. S. Eliot and ascribes to him a particular influence on *Voices of the Poor People*, for its linking of the historical and personal.³⁷¹ During the wartime occupation of Warsaw Miłosz translated contemporary poetry (both from and into Polish), including Eliot's *The Waste Land*, for the underground resistance. Miłosz explains that learning English and writing translations made sense of chaos and was a 'form of therapy', and explicitly describes the process of translation as 'mathematical'.³⁷²

Miłosz admired Eliot's modernist approach to poetry, describing his rhythm and metre as 'quasi-mathematical' with an 'efficiency' of the symbol, and he argued that Eliot had restored to poetry a simplicity that had been abused by the poetic symbolists. For himself, he claimed that the war taught him to strive towards 'simple speech'; he liked poetry that expressed a 'sharp, dry world', with 'purely logical reasoning'.³⁷³ These qualities extended beyond the war: Miłosz's preface to the "Treatise on Poetry" notes his favoured concepts in poetry: 'plain speech, dryness of form, rigor, intellectual content'; and expression of 'objective reality'.³⁷⁴

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³⁶⁹ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 105–106.

³⁷⁰ Miłosz, *Wiersze wszystkie*, 1188. First published in *To (This)*, 2000. Translated by Czesław Miłosz and Robert Hass in Miłosz, *New and Collected Poems*, 719.

ON THE DEATH OF A POET
The gates of grammar closed behind him.
Search for him now in the groves and wild forests of the dictionary.

³⁷¹ Czarnecka, Fiut, and Miłosz, *Conversations with Czesław Miłosz*, 133.

³⁷² Carpenter, "The Gift Returned," 632.

³⁷³ Ibid., 633–636.

³⁷⁴ Cited by Bogdana Carpenter in Ibid., 636.

A soothing mathematical-like process of ordering and equating imbues the process of translation. In a 1984 interview, despite his reservations about biology, Miłosz reflected on his childhood enthusiasm for Linnaeus’s orderly and Latinate system of biological nomenclature and taxonomy:

My [childhood] hero was Linnaeus [1707 – 1778]; I loved the idea that he had invented a system for naming creatures, that he had captured nature that way.³⁷⁵

In 1991 Miłosz published the poem “Linnaeus” describing a happy childhood with botanic boxes, dreaming up his naming system. Entirely optimistic, evoking a classical pastoral ode, Miłosz’s depiction features a Linnaeus who likes mathematical order:

LINNAEUS

[...]
Śpiewał z psalmistą. Ład, liczba, symetria
Są wszędzie, ich pochwałę wygrywa klawesyn
I skrzypce, i skanduje łaciński heksametr.
[...]³⁷⁶

Again the process of ordering is seen as mathematical, and the associations with biology and nature are positive. But in the end, this optimism is outweighed by the more prevalent view that mathematics is an inadequate mode of thinking that is deficient.

This is the case in Miłosz’s 1974 epic *From the Rising of the Sun*, where Part six of the poem, “The Accuser” questions the nature and extent of eternal life:

OSCARŻYCIEL

[...]
Duch czysty i wzdorliwie obojętny
Chciałeś widzieć, smakować, doznać i nic więcej.
Dla żadnych ludzkich celów. Ty byłeś przechodzień,
Który używa rąk i nóg, i oczu
Jak astrofizyk świetlistych ekranów,
Świadomy; że co pozna, już dawno minęło
[...]
Ten grzech i wino. A skarżyć się komu?

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³⁷⁵ Interview with Robert Faggen, 1984, in Haven, *Czesław Miłosz: Conversations*, 152.

³⁷⁶ Miłosz, *Wiersze wszystkie*, 982–983. First published in *Dalsze okolice (Provinces)*, 1991. Translated by Czesław Miłosz and Robert Hass in Miłosz, *New and Collected Poems*, 508–509.

LINNAEUS

[...]
would sing with the psalmist. Rank, number, symmetry
Are everywhere, praised with a clavecin
And violin, scanned in Latin hexameter.
[...]

Znam twoje mikroskopy, twoje dzieła,
 [...]
 Nie było żadnego zamku. Po prostu słuchałeś płyty.
 Igła, kołysząc się lekko na czarnym zamarzłym stawie,
 Głosy umarłych poetów pod słońce wyprowadzała.
 Ty wtedy krzywiłeś usta:
 - Bestiality
 - Bestialité
 - Bestialità

Któż z nich mnie oswobodzi
 Od wiedzy, którą mnie zostawił mój wiek?
 Od nieskończoności plus. Od nieskończoności minus.
 Od pustki, która siebie do gwiazd podnosiła?
 [...] ³⁷⁷

Here, Mathematics is ultimately stifling.

In 1991 Miłosz published “Meaning”. At first, the impression given is that mathematics can provide a means of making sense of existence, but immediately the second stanza challenges this as mistaken and illusory:

SENS

Kiedy umrę, zobaczę podszewkę świata.

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³⁷⁷ Miłosz, *Wiersze wszystkie*, 671–675. From *The Rising of the Sun*. Translated by Czesław Miłosz and Lillian Vallee in Miłosz, *New and Collected Poems*, 320–325.

THE ACCUSER
 [...]
 A spirit pure and scornfully indifferent,
 You wanted to see, to taste, to feel, and nothing more.
 For no human purpose. You were a passerby
 Who makes use of hands and legs and eyes
 As an astrophysicist uses shiny screens,
 Aware that what he perceives has long since perished.
 [...]
 This sin and guilt. And to whom should you complain?
 I know your microscopes, your many labours,
 [...]
 There was no castle. You were simply listening to a record.
 A needle, swaying lightly on a black frozen pond,
 Led the voices of dead poets out into the sun.
 Then you thought in disgust:
 - Bestiality
 - Bestialité
 - Bestialità

Who will free me
 From everything that my age will bequeath?
 From infinity plus. From infinity minus.
 From a void lifting itself up to the stars?
 [...]

Drugą stronę, za ptakiem, górą zachodem słońca.
Wzywające odczytania prawdziwe znaczenie.
Co nie zgadzało się, będzie się zgadzało.
Co było niepojęte, będzie pojęte.

A jeżeli nie ma podszewki świata?
Jeżeli drozd na gałęzi nie jest wcale znakiem,
Tylko drozdem na gałęzi, jeżeli dzień i noc
Następują sobie, nie dbając o sens,
I nie ma nic na ziemi, prócz tej ziemi?

Gdyby tak było, to jednak zostanie
Słowo raz obudzone przez nietrwale usta,
Które biegnie i biegnie, posel niestrudzony,
Na międzygwiazdne pola, w kołowrót galaktyk
I protestuje, wola, krzyczy.³⁷⁸

In both these final two pieces Miłosz has been clear that while mathematics and science can make some sense of the world, and provide some order, ultimately they fail to capture what for him is far more essential, namely issues of ambivalence and a necessary human response.³⁷⁹

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³⁷⁸ Miłosz, *Wiersze wszystkie*, 1036. First published in *Dalsze okolice (Provinces)* in 1991. Translated by Czesław Miłosz and Robert Hass in Miłosz, *New and Collected Poems*, 569.

MEANING

When I die, I will see the lining of the world.
The other side, beyond bird, mountain, sunset.
The true meaning, ready to be decoded.
What never added up will add up,
What was incomprehensible will be comprehended.

And if there is no lining to the world?
If a thrush on a branch is not a sign,
But just a thrush on the branch? If night and day
Make no sense following each other?
And on this earth there is nothing except this earth?

Even if that is so, there will remain
A word wakened by lips that perish,
A tireless messenger who runs and runs
Through interstellar fields, through the revolving galaxies,
And calls out, protests, screams.

³⁷⁹ The notion of cosmic bodies representing a greater order, but one which ultimately is not a meaningful endpoint, is suggested also in “What Does it Mean”: “[...] If only the stars contained me./If only everything kept happening in such a way [...] Were I at least not contradictory. Alas.” Miłosz, *New and Collected Poems*, 164. Translated by Czesław Miłosz, first published in 1962 in *Król Popiel i inne wiersze* (King Popiel and Other Poems). Also in the same collection is “Heraclitus”, which depicts multiplicity in meaning.

Concluding remarks: Marxist science and twentieth-century morality

Czesław Miłosz lived and wrote in times of immense and dramatic historical significance for his country, Poland, as it suffered foreign occupation and control by two totalitarian regimes. His writing, both poetry and prose, dwells intensely on the ethical disasters brought about by the horrors of the Second World War; the limits on human nature and guilt and the consequent moral responsibility of the survivor. Living in exile in the West, Miłosz experienced both the loss of his country, and the loss of the Catholic society of his youth. He associated atheism, both western and Marxist, with a loss of moral responsibility and integrity, and held a particular version of science largely accountable for this. For him Rationalism lacks what he held most important to poetry: anthropocentrism and richness and variety of imagination. His characterisation of mathematics as an orderly and pure language of abstraction emanates largely from his views on science, but while Miłosz could to a limited extent appreciate these qualities, ultimately he associated them with amorality and dogmatism.

Many aspects of communist materialist theory militated against Miłosz holding a positive view of science, and in fact militated against any non-specialist (who might understand the true intricacies of science) being positively disposed. Marxist theory places a heavy emphasis on science and technology: ‘phony truths’ resulted in intellectuals and academics forced to adopt a homogenous politically acceptable style of writing. Centralised socialist-realist dogma, or so-called Marxist ‘theology’, with its emphasis on ‘logical thinking and dialectical method’, demanded conformity, artistic dishonesty and repression of spontaneity.

³⁸⁰ Many of these are features that Miłosz saw embodied in mathematics, and the mathematisation of economic theory itself was also central to socialist theory.³⁸¹

However, there is little to suggest that Miłosz’s understanding of either science or mathematics came from anything but a lay perspective. He was not naturally inclined to these subjects – particularly not mathematics – at school, and he does not appear to have spent much professional time with practising scientists or mathematicians. His knowledge of Einsteinian relativity derives seemingly entirely from that of his cousin Oscar, whose humanist approach to relativity was not necessarily accurate from a scientific point of view. As for Marxist science, despite his awareness of the ideology expounded by the regime, there is no evidence that

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³⁸⁰ Miłosz first became known in literary circles for his 1953 publication of *Zniewolony umysł* (The Captive Mind), a critique of Marxist ideology and those who succumb. Its main characters are called Alpha, Beta, Gamma and Delta, a choice in itself a comment on the ‘mathematical’ method, where the Greek alphabet is widely used to denote various concepts.

³⁸¹ See Young, “The Politics, Mathematics and Morality of Economics: A Review Essay on Robert Nelson’s *Economics as Religion*.”

Milosz discussed these views with working dissident scientists and mathematicians within Poland at the time.³⁸²

It is in this light that the mathematical and scientific metaphors in Milosz's "Song of a Citizen" might best be interpreted: as a very specific reference to modernist and post-modernist implications of non-Euclidean space, against a backdrop of his admiration for the metaphysics of his influential mentor Oscar Milosz; and his nostalgic Romanticism in the immediate context of the horrors of rationalist Nazism and Marxist socialism. However, Milosz did hold some hopes for science, but understood in a particularly personal manner.

With respect to pure science and mathematics, while Milosz makes the occasional effort in his poetry to depict them more positively, this optimism rarely lasts. To some extent this is the case also with his compatriot Zbigniew Herbert, who shared many of the same concerns about society and the role of the poet. Yet Herbert, who pronounced little on science or mathematics, wrote poems that on close examination reveal a far deeper understanding of the intricacies and nuances of modern mathematics. This is the subject of the next chapter.

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³⁸² I asked chief archivist Andrzej Bernhardt of the *Instytut Literacki* (see note 360) whether the Institute's many salons and meetings had included scientists and mathematicians and the answer was no; the group was exclusively 'humanist'. Bernhardt, Interview at Instytut Literacki in Paris. (This conversation was not recorded.)

Czesław Miłosz, Zbigniew Herbert and one other (Antoni Miłom?) revisiting Miłosz's 1950s home in exile at Brie-Comte-Robert near Paris, 1965. Beinecke Rare Book and Manuscript Library.³⁸³

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³⁸³ Miłosz, "Czesław Miłosz Papers, 1880-2000," Box 182, Folder 2841.

CHAPTER FOUR

‘I felt my backbone fill with quiet certitude’: Zbigniew Herbert and a Poetic Interaction with Mathematics³⁸⁵

Abstract

Zbigniew Herbert (1924 - 1998) was a major twentieth-century Polish poet who was particularly preoccupied with the history of his time, and the role of literary writing within that. His writings often evoke a classical past, while at the same time dealing with modern issues of abstraction, human ethics and a truthful representation of the human condition. Mathematics is far from the mainstream focus of Herbert literary criticism, yet this chapter argues that the poet in fact reflects, in a surprising number of instances over the course of his oeuvre, many facets of the modern nature of mathematics.

Herbert’s poems touch on a number of issues related to modern mathematics, from his first collection in 1956 until his death in 1998. Furthermore, not only does he employ mathematical imagery, but his work indicates a comprehensive grasp of the variety and richness present in modern mathematical thinking. Some poems incorporate notions of mathematics as counting and measurement, abstraction and infinity, which he appears on one level to associate with an amoral approach to society and a lack of connection with significant human concerns. Other poems convey a yearning for the clarity and precision of mathematics, and an appreciation of abstract and rational forms as potentially perfect and the underlying fundamentals of physical existence. At the same time, Herbert suggests that knowledge that unquestioningly accepts such understandings is naïve, and criticises a classical rationalist approach for its shortcomings. Herbert also engages with modern theories of mathematical

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³⁸⁵ A version very similar to this chapter has been published as Kempthorne, “I Felt My Backbone Fill with Quiet Certitude.” The quotation in the title is a line from Herbert’s 1961 poem, “Revelation”, see note 461.

uncertainty and multiplicity; and in the final example presented in this chapter, explicitly links such concepts with theories of poetry.

Introduction

Biographical background

Zbigniew Herbert (1924 - 1998) was born in Polish Lwów (now L'viv), which during his lifetime was de-Polonised, Sovietised and subsequently returned to independent Ukraine.³⁸⁶ During the Second World War Herbert studied in the clandestine underground education system and joined the Polish resistance. He moved to Warsaw and began publishing in the 1950s. He did not actively cooperate with the communist regime, but due in part to his status as a writer managed to achieve a *modus vivendi* within Poland and to travel abroad as a recognised poet. During the 1970s and 1980s he was involved with the establishment of Solidarity-era underground literary journals and spent some time in Paris, where many of the Polish émigré journals were based. He returned again to Warsaw in 1992 after the fall of the communist government, and died in 1998. He has received approbation for remaining within Poland for much of the socialist era, while maintaining a stand against the regime.³⁸⁷ Through most of his career Herbert was feted, with many arguing that he was as great a poet as Miłosz, and equally deserving of a Nobel Prize.³⁸⁸ He was awarded the Nikolai Lenau Prize in 1965, the Herder Prize in 1973, the Bruno Schulz Prize in 1988, the Jerusalem Prize in 1991, the T. S. Eliot Prize in 1995, and was nominated for the Neustadt Prize five times between 1970 and 1994.

Herbert's exposure to mathematics

Between the wars, Lwów was a European centre of mathematics, with its mathematicians recognised for their work in modern logic, set theory and functional analysis. The Lwów School was decimated during the Second World War; some of its surviving members moved abroad, and the remainder – along with many Polish Lwówians – migrated

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³⁸⁶ There are many short biographies of Herbert, including within the introductions to most of his published collections. See for example Ministry of Foreign Affairs of the Republic of Poland - Department of Promotion, "Zbigniew Herbert: 1924 - 1998"; Herbert, *The Collected Poems*, chronology. See also a biography that Herbert himself wrote, or at least edited, for the *Times Literary Supplement* in 1968, in Herbert, "Utwory Zbigniewa Herberta," Box 18022. Other more critical and detailed works of scholarship are discussed throughout this article.

³⁸⁷ This is unlike his compatriot more widely-known outside Poland, Czesław Miłosz, who established his career largely in exile (see Chapter 3).

³⁸⁸ In 1995, for example, Ted Hughes invited Herbert to read his poems alongside readings of works by other major European poets Paul Célan and Eugenio Montale: Herbert, "Utwory Zbigniewa Herberta," Box 17977.

to Wrocław (formerly German Breslau, in the west) or to Warsaw.³⁸⁹ Post-war Poland underwent massive internal migration, and Herbert followed a common path for the time, in that he also ended up in Warsaw, in his case via Kraków (in the south), Gdańsk (in the north) and Toruń (in the west). At the Jagiellonian University in Kraków Herbert studied economics, alongside drawing classes, then law at Toruń's Nicholas Copernicus University, and finally philosophy at the University of Warsaw.

Unlike Miłosz, in his prose writing Herbert only rarely explicitly addressed the issue of science and mathematics, and the role of the latter either in poetry, or more broadly in society. However, his range of academic studies might suggest that he was more scientifically-minded than other literary contemporaries. Indeed, at least one modern critic asserts that his early training in philosophy and law made him more of a logician than most poets.³⁹⁰ The coincidence of the Lwów school of mathematics is also an interesting one: Herbert and his family were part of the intelligentsia of Polish-speaking Lwów, and might well have had contact with the mathematicians there.³⁹¹

In fact, Herbert's personal papers, now housed at the National Library in Warsaw, provide scant evidence of a particular familiarity with or love of mathematics.³⁹² His school reports no longer survive, so it is not clear how much and how well he learned mathematics at school, but it can be assumed that as an educated central European in a large city in the 1930s he would have been taught mathematics to a relatively advanced level.³⁹³ As for his university studies, slightly fragmented given the times, his economics and finance courses on inspection appear to include only a few hours of 'statistical methods', with the focus being on so-called 'scientific' research in application to trade and international relations.³⁹⁴ That said, he briefly worked as an economist for a socialist industry enterprise.³⁹⁵

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³⁸⁹ See further the section on mathematics in Poland in Chapter 1.

³⁹⁰ Hofmann, "A Dead Necktie." Note, however, that Hofmann is not a Herbert expert, see note 421. Unusually, and unfortunately with no further discussion, Herbert is listed, in passing and alongside Miroslav Holub (see Chapter 2), in a 1978 bibliography by the Australian, John Fuerst, of poets writing about science. Fuerst, "A Selected Bibliography of Twentieth-Century Poems Relevant to Science and Social Aspects of Science," 26.

³⁹¹ In the 1930s the population of Lwów was around 300,000, at least one quarter Jewish and some sixty to eighty percent Polish-speaking. Manekin, "L'viv."

³⁹² Herbert, "Utwory Zbigniewa Herberta."

³⁹³ In the late eighteenth century Poland became one of the first countries in Europe to introduce a national school curriculum, through the National Education Committee (*Komisja Edukacji Narodowej*). Davies, *God's Playground*. See also Chapter 1.

³⁹⁴ Record-book from the Akademia Handlowych at the Jagiellonian University, 1945/46 and 1946/47: Herbert, "Utwory Zbigniewa Herberta," Box 18024.

³⁹⁵ In 1954 Herbert worked in the accounts department at the Central Office of Research and Projects in the Peat Industry in Warsaw, see Herbert, *The Collected Poems*, "chronology", 586.

As part of his law studies at Toruń, Herbert was examined in the philosophy of Pascal and Descartes, and that of Spinoza, Aristotle and Plato.³⁹⁶ Again, there is a hint of mathematics, but the philosophical emphasis is clearly at the humanities end of the spectrum.³⁹⁷ There are certainly no mathematical diagrams or doodlings in Herbert's papers; the most mathematical, in the sense of symbolic notation, can be found in one of his many notebooks, where he writes a list of some dozen major geological events in the history of the earth, written by Herbert as: its temperature at the centre (50.10^6 °C); its age (2.10^4 years); the age of the sun ($5\div 8.10^{12}$ years).³⁹⁸ Herbert was familiar with – or had copied? – scientific notation for numbers; but the use of $\div$ rather than $/$ is idiosyncratic; the 50.10^6 suggests engineering, rather than standard, mathematical notation; and the values themselves are in fact glaringly incorrect.

It is worth remarking that Herbert's papers demonstrate considerable eclecticism. His notebooks are filled with short quotations or paragraphs copied out from books and articles, on a wide range of subject matter. While writing almost entirely in Polish, he quotes verbatim in French, German, Italian and English: according to his Jagiellonian records his French was 'very good' and English 'satisfactory', and at one point he attempts to teach himself some Hebrew.³⁹⁹ However, there is in fact little that specifically addresses the scientific or mathematical. Herbert's wide-ranging interests and formal study included not just philosophical logic, but finance and economics; it seems reasonable to conclude, however, that his mathematics came to him in a non-technical form, second-hand and largely through the work of philosophers.

Human Ethics and the Political

Polish history and its historiography imbue Polish identity, and the twentieth century was particularly traumatic. Poland was in succession partitioned and subsumed into three larger empires, it was for a short time an independent state ruling its own minority borderlands (including Herbert's modern-day western Ukraine and Miłosz's Lithuania), it then fell under Nazi-German occupation entailing the genocidal loss of its Jewish population, and finally acquired new territories under Soviet rule. These are important elements in considering Herbert's writing.

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³⁹⁶ Record-book from the Uniwersytet Mikołaja Kopernika: Herbert, "Utwory Zbigniewa Herberta," Box 18024.

³⁹⁷ It is interesting to recall Jeremy Gray's remarks in Chapter 2 that mathematical philosophy rarely appeals to practising mathematicians.

³⁹⁸ Herbert, "Utwory Zbigniewa Herberta," Box 17955, folder 52. (Original in Polish.)

³⁹⁹ Ibid., Box 17955, folder 10. (In Polish.)

Herbert's response was a deep awareness of the historical and political currents underlying everyday existence, particularly for him as a Pole, and, arising from this, the response of the writer when confronted with questions of human ethics.⁴⁰⁰ That is – in contrast to another twentieth-century poet, the Romanian Ion Barbu whom I discuss in the next chapter – he held that a moral perspective was both central and essential to poetics. This underlying conviction manifests itself in several respects.

On one level, Herbert aimed to keep his poetry well-grounded, in the sense that his poems – more or less obliquely – address the nature of human ethicality and the often disappointing responses of individuals faced with totalitarian political regimes. He considered it important to 'confront reality', and was as a consequence wary of abstraction. Citing a Polish proverb, *nadzieja jest matką głupich* ("Hope is the mother of the stupid"), Herbert remarked that the role of writing was to teach people to be 'sober' and 'awake', even if that meant rejecting optimism and hope.⁴⁰¹

In cautioning against the impersonal, he was critical of the socialist regime, which he considered to be laden with hypocritical, relativist and intellectually-impoverished theories of society. In particular, he questioned the role of scientific reason in Marxist-derived thought, seeing it as a de-personalising means of avoiding moral issues. His experience as a working economist in an early communist-era enterprise may well have contributed to his negative perception of the 'scientific', manipulated, method; as did the use of pseudo-science in Nazi theories of race and physiological perfection.

An important element in scientific argument is rationality. In a clear reference to Descartes' *cogito ergo sum*, in 1974 Herbert began a series of poems about a 'Mr Cogito', which examine rationality within a human individual. Mr Cogito is a rationalist, who nonetheless comes up against many less 'rational' considerations. The Mr Cogito poems demonstrate ambivalence towards reason: rationality as depicted by Herbert has merits in its capacity to witness and describe the world, yet in many cases it falls short of what he ultimately considers more important human qualities, which are linked to emotion and empathy. The Mr Cogito series is often held to mark a significant new period in Herbert's writing.⁴⁰²

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⁴⁰⁰ That Herbert held such a position is consistently asserted throughout the literary criticism, illustrated in the select bibliography here. See also Herbert's handwritten notes from 1971 on the social responsibility of a poet in *Ibid.*, Box 17845, folder 2, item 2, 37. Oxford-based critic and scholar Al Alvarez, who was instrumental in bringing Herbert to British audiences, argues in his introduction to the first UK edition that unlike in the West, it was impossible to separate the political from poetry, and history inevitably impinges on poetic writing; Herbert, *Selected Poems*, 1985, introduction, vi–xii.

⁴⁰¹ Carpenter and Carpenter, "An Interview with Zbigniew Herbert," 5.

⁴⁰² See for example Marcus, "Inside the Echo Chamber." Herbert wrote his first Mr Cogito poem during his residency in California at the time of the anti-Vietnam movement. For Herbert (and similarly for Milosz and

The Cogito series also sheds light on a remark Herbert made at an anti-regime rally in 1970, that our world was regrettably ‘defined in categories of politics and science’, as opposed to art.⁴⁰³ The conflation of science and politics is not explored further, but was symptomatic of Marxist-socialist regimes. Herbert was speaking out, acknowledging the inevitability of poets being caught up in political action, but noting that in doing so they needed to exercise caution.

Herbert’s mistrust of the use (and abuse) of a Marxist-influenced scientism continued after the socialist regimes fell in eastern Europe. After 1989, Polish politics and public intellectual life was, naturally, dominated by former heroes of the *Solidarity* era. Of them, Herbert caustically remarked:

The post-communist intellectuals are extremely subtle, they understand the concept of relativity, they analyze the flow of history and changing conditions, while maintaining that only simpletons simplify.⁴⁰⁴

This remark, as do others, demonstrates a conflicting attitude within Herbert towards abstract concepts, such as (philosophical) relativity in this case: he is clearly wary of the dangers of applying abstract concepts to real-life situations. But as poet and Slavic studies academic Stanisław Barańczak points out, Herbert’s anti-Marxist stand and abhorrence of moral relativism paradoxically inclined him towards the absolute, an abstraction in itself.⁴⁰⁵ His short poem, “The Pebble”, which very simply describes a pebble as perfect, suggests that true meaning can be encapsulated only in the inanimate.⁴⁰⁶

Opposites and Duality

Such a tension, or duality, is a recurring feature of Herbert’s writing, and stark opposition is a feature of several fields of mathematics, including in the formalist schools and modern mathematical logic. Barańczak devoted considerable effort to the analysis of various ‘antinomies’ or intellectual paradoxes in Herbert’s poetry, finding that while such pairs and contrasts certainly are prevalent, Herbert examined not only the confrontations, but also

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many other eastern European émigrés), the anti-Vietnam movement in the US represented reprehensible naivety and idealism towards socialism. Valles, “The Testament of Mr Cogito.”

⁴⁰³ “The Poet Facing the Contemporary World”, a 1970 speech given in Silesia (a heavy mining area and centre of anti-socialist opposition), cited in Valles, “The Testament of Mr Cogito.”

⁴⁰⁴ Poppek, Gelberg, and Herbert, “Mr Cogito’s Duels. Zbigniew Herbert: A Conversation with Anna Poppek and Andrzej Gelberg.” (This is an English translation of an original Polish article in *Tygodnik Solidarność*, 46(321), 11 November 1994.)

⁴⁰⁵ Barańczak, *A Fugitive from Utopia*. Stanisław Barańczak is a poet, literary editor and former lecturer in Slavic Studies at Harvard University. Herbert’s mistrust of abstraction is widely accepted, see for example Marcus, “Zbigniew Herbert: An Introduction”. See further note 436.

⁴⁰⁶ “Pebble”, translated by Czesław Miłosz was one of the latter’s favourites: Miłosz, *The History of Polish Literature*, 471–473. Polish original, “Kamyk” in Herbert, *Wiersze zebrane*, 286.

suggested a frequent coalescing and real co-existence of such distinctions, resulting in a ‘mutual unmasking’ of otherwise oppositional values.⁴⁰⁷

Barańczak’s influential book was originally published in Poland in 1984. Twenty years later, in 2007, Adam Zagajewski, himself one of the major Polish poets of the twentieth century and currently at the University of Chicago, returned to the widely acknowledged motif of duality in Herbert’s poetry, noting that it is a phenomenon in all ‘great’ poets; that they inhabit two worlds – the real one of history, be it private or public, and another of dreams and the imagination.⁴⁰⁸ Zagajewski observes that for Herbert this duality also resulted from and found expression in his personal experience of involvement in society while simultaneously maintaining a necessary distance; a stance clearly attributable to his witnessing, involvement in and reflecting on the horrors of the Second World War.

Language and Metaphor

As remarked in Chapter 2, the scope of this thesis does not allow for a detailed examination of the nature of poetry, but there are a number of essential figures of Herbert’s work that provide a useful paradigm for the consideration of its relation to mathematics. Herbert’s translators, John and Bogdana Carpenter, aver that the need to ‘forge a link’ between lived experience and concrete truths manifests itself in Herbert’s attention to precision in language.⁴⁰⁹ Herbert’s poetry is described variously as being characterised by its sparse use of punctuation, relying on ‘certain, unambiguous vestigial syntax’ to position the reader;⁴¹⁰ continual striving for a perfect expression, which often is represented by silence;⁴¹¹ or the presence of ‘suggestive expanses of the unspoken’.⁴¹² Metaphor is another characteristic of

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⁴⁰⁷ Barańczak, *A Fugitive from Utopia*. The reference to ‘mutual unmasking’ is at p. 64. Barańczak looks at opposites like darkness and light, abstraction and the tangibly concrete, and perfection and imperfection, concluding that this play of opposites and eventual state of both somehow co-existing, takes place within a single poem as well as across Herbert’s work as a whole. In a review of Barańczak’s original publication of *Fugitive from Utopia* in Polish, Czesław Prokopczyk, now emeritus Professor of the State University of New York at Buffalo, comments that Barańczak’s work far surpasses hitherto existing scholarship on Herbert, noting in particular the limitations in quality of literary criticism within Poland under the socialist regime censorship. He adds that Barańczak’s method of setting up oppositions dates from a particular fashion in 1950s to 1960s Poland, in keeping partly with later structuralist and formalist movements in France (see Chapter 1). While odd to the modern reader, and Prokopczyk himself has clear reservations as to this method, he notes that Barańczak is in part responding to current literary criticism in Poland, hence the somewhat laboured and artificial approach. Prokopczyk, “Zbigniew Herbert’s Poetry.”

⁴⁰⁸ Herbert, *The Collected Poems*, introduction.

⁴⁰⁹ Herbert, Carpenter, and Carpenter, *Report from the besieged city & other poems.*, introduction, p. xi. On precision see further note 431.

⁴¹⁰ Hofmann, “A Dead Necktie,” 121.

⁴¹¹ Al Alvarez in Herbert, *Selected Poems*, 1985, introduction.

⁴¹² Scott and Haven, “Expanses of the Unspoken.” Scott remarked that the ‘unspoken’ in Herbert transcends language differences, rendering him more of a universal, and relatively easily translatable, poet than some. These characteristics are, in fact, what many perceive to be typified in mathematics, as discussed in Chapter 2.

Herbert's poetry frequently remarked upon.⁴¹³ The Carpenters argue that metaphor was often Herbert's best vehicle for achieving linguistic precision.⁴¹⁴ Barańczak notes that Herbert himself considered metaphor on the one hand an inadequate form of expression (see further below), but at the same time a useful tool for linking myth and experience. I examine these features in several of Herbert's poems.

One of Herbert's early, not overtly mathematical, poems is "I would like to describe" (1957), articulating a tension between exactness and similitude. Describing his frustration with metaphor as an imperfect description, he searches in vain for an exact word, albeit 'not pure' and 'uncertain', that would do away with the need for metaphor, since the latter is an imperfect compromise of language that never reaches an ideal precise expression:

CHCIAŁABYM OPISAĆ
 [...]
 chciałabym opisać światło
 które we mnie się rodzi
 ale wiem że nie jest ono podobne
 do żadnej gwiazdy
 bo jest nie tak jasne
 nie tak czyste
 i niepewne

chciałabym opisać męstwo
 nie ciągnąc za sobą zakurzonego lwa
 [...]
 inaczej mówiąc
 oddam wszystkie przerośnię
 za jeden wyraz
 wyluskany z piersi jak żebro
 za jedno słowo
 które mieści się
 w granicach mojej skóry
 [...] ⁴¹⁵

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⁴¹³ See for example the 1972 Neustadt (then called the Prix International de Books Abroad) citation by François Bondy: *'il utilise parcimonieusement mais subtilement les métaphores'* (he uses metaphor sparingly and yet subtly) in Herbert, "Utwory Zbigniewa Herberta," Box 17938. The importance of mathematical metaphor, debunking the assumption of mathematics as always literal and anti-metaphorical, is discussed at length in Chapter 2.

⁴¹⁴ Herbert, *Report from the Besieged City*, introduction. Herbert's copy of these remarks is in: Herbert, "Utwory Zbigniewa Herberta," Box 17936, folder 3.

⁴¹⁵ First published in 1957 in the journal *Twórczość* and then in *Hermes, pies i gwiazda*. Herbert, *Wiersze zebrane*, 86–88. Translated by Czesław Miłosz in Herbert, *The Collected Poems*, 65–66.

I WOULD LIKE TO DESCRIBE THE SIMPLEST EMOTION
 [...]
 I would like to describe a light
 which is being born in me
 but I know it does not resemble
 any star
 for it is not so bright
 not so pure
 and is uncertain

Herbert clings, nonetheless, to an expression that comes from within himself, that in itself possesses ultimate clarity but not an abstract and impersonal ideal.⁴¹⁶

Translations into English

There have been several major translators of Herbert's work into English, beginning with the collection by Czesław Miłosz and Peter Dale Scott published in 1968.⁴¹⁷ Indeed Miłosz was largely responsible for introducing Herbert to the English-speaking world, arranging his academic residency in California in the 1970s, and the publication of his works outside Poland in the early 1960s.⁴¹⁸ In 1977 John and Bogdana Carpenter produced a further selection of largely different poems translated into English, followed by many volumes of both poems and prose in translation.⁴¹⁹ In 2007 Alissa Valles was the translator of Herbert's first full collected poems in English, authorised by Herbert's estate, run by his widow, Katarzyna Herbert. This collection reproduces the Miłosz-Scott translations and all other translations are new ones by Valles herself.⁴²⁰ Her translations caused some controversy, with a number of

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I would like to describe courage
without dragging behind me a dusty lion
[...]
to put it another way
I would give all metaphors
in return for one word
drawn out of my breast like a rib
for one word
contained within the boundaries
of my skin
[...]

Sharon Wood also remarks on precision in "I would like to describe" (and in "Mr Cogito and the Imagination"): Wood, "The Reflections of Mr Palomar and Mr Cogito." See note 457.

⁴¹⁶ This avoidance of the abstract also comes through in his very physical, tangible choice of body metaphors – the bones and skin. Herbert also describes the difficulty of writing in for example, "Never of You" (Herbert, *The Collected Poems*, 82.) and "Attempt at a Description" (Ibid., 192.)

⁴¹⁷ Herbert, *Selected Poems*, 1985.

⁴¹⁸ See for example a 1962 letter to Miłosz, from a US diplomatic spouse based in Warsaw, under which she transmits an update from Herbert on his latest anthology for publication in the US. Miłosz, "Czesław Miłosz Papers, 1880-2000," Box 25, Folder 400, letter dated 6 Sept 1962.

⁴¹⁹ Herbert, *Selected Poems*, 1977.

⁴²⁰ Herbert, *The Collected Poems*.

questions raised as to her experience and suitability as a translator of Herbert, given his great stature in Poland.⁴²¹ She was, however, the choice of the Herbert estate.⁴²²

A particular issue was the decision not to include any translation by John and Bogdana Carpenter.⁴²³ Unacknowledged by some of Valles's critics, Herbert had fallen out with the Carpenters in the early 1990s, expressing concern that their translations had for some time not sufficiently rendered the complexity of the original Polish. He eventually withdrew translation rights from them, but acknowledging that they retained rights to poems already published or prepared for publication.⁴²⁴ Indeed Herbert's papers demonstrate that from early on he took an interest in the English-language versions, himself proposing alternative translations of words and, given his relatively low-level of English proficiency – as compared with say French – taking the trouble to write out phonetic versions of some lines on the drafts.⁴²⁵

Valles, and others, note that Herbert suffered from a psychiatric illness (reportedly bipolar disorder) from at least the 1960s, which explains to an extent his outbursts against former colleagues and friends (including Milosz), and his resentment of Polish émigrés publishing abroad.⁴²⁶ Before his death Herbert had moved towards some kind of reconciliation with the Carpenters, but Valles nonetheless maintains that the Carpenter translations do not sufficiently capture the 'ontological uncertainty' within Herbert, particularly during his later years.⁴²⁷

The translations below are taken from a range of published versions, indicated in each case. Occasionally I have provided additional translations of individual Polish words where this adds another dimension to a mathematical interpretation. As I will show, once one looks at a poem through a particular lens, in this case mathematics, the most obvious alternatives in

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⁴²¹ See in particular Michael Hofmann's excoriating review: Hofmann, "A Dead Necktie." Hofmann is not, however, a Herbert expert; neither is he speaker of Polish. In response to the criticism of Valles, Polish scholar Anna Frajlich is more conciliatory, agreeing that a person with more literary stature in Poland and Polish circles may have been better, but adding that any translation will inevitably result in a loss of meaning and reference from the original: Frajlich and Haven, "Emigration, Displacement and Loss in Polish Poetry."

⁴²² According to papers in the Czesław Miłosz archive, Susan Sontag also was a translator of Herbert's poetry: Miłosz left behind a draft table of contents for a collection of translations split between himself and Sontag, with Miłosz, interestingly, assigning most of the selected *Mr Cogito* poems to Sontag. Miłosz, "Czesław Miłosz Papers, 1880-2000," Box 151, Folder 2379. If Sontag's translations survive, or indeed were even completed, they are not included in any major anthologies.

⁴²³ See note 419. At the time, the Carpenter translations were well-received: see for example Prokopczyk, "Zbigniew Herbert's Poetry."

⁴²⁴ A series of exchanges with John and Bogdana Carpenter, including from Herbert's lawyer, is in Herbert, "Utwory Zbigniewa Herberta," Box 17962.

⁴²⁵ See for example Herbert's annotated versions of draft translations in *Ibid.*, Box 17936, folder 1.

⁴²⁶ Frajlich and Haven, "Emigration, Displacement and Loss in Polish Poetry."

⁴²⁷ While Valles commends the Carpenter translations, she comments that they tend to concentrate on Herbert as a 'poet of conscience', to the detriment of also conveying his portrayals of uncertainty. Valles, "The Testament of *Mr Cogito*," 45. Correspondence indicating a rapprochement between Herbert and the Carpenters can be found in Herbert, "Utwory Zbigniewa Herberta," Box 17962, correspondence 18/7/1994–7/8/1994.

translation also change: what is an appropriate choice in an overall loss-gain situation of style and meaning in one context does not necessarily hold when one wants to grasp a specific metaphor. This underlies my choices of translator, and where appropriate I have provided commentary on alternative translations of my own, for words that have a potential further mathematical interpretation.⁴²⁸

I end this introductory section with a poem about translation, “On Translating Poetry”. Herbert describes the process of translating a poem as a bee, which in investigating a flower leaves only with traces of pollen on its nose.

O TŁUMACZENIU WIERSZY

Jak trzmiel niezgrabny
siadł na kwiecie
aż zgięła się łodyga wiotka
przeciska się przez rzędy płatków
podobnych słownikowym kartkom
do środka dąży
[...]
trudno wnikać
[...]
więc trzmiel wychodzi
bardzo dumny
[...]
nos pokazuje
z żółtym pyłem ⁴²⁹

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⁴²⁸ To this end, I have consulted a range of parallel technical mathematical texts in Polish and English, while the primary general dictionary consulted is Linde-Usiekniewicz, *Wielki słownik angielsko-polski*. It was interesting to discover that Valles herself has a poem “Mathematician” (2002), anthologised in Glaz and Growney, *Strange Attractors*, 194–195. This describes a mathematician trying to elucidate classical music through mathematics, and eventually he devises a ‘symbolic language’ that will make sense of his own life. While not consistent, and never avowedly deliberate, I identify several instances where Valles provides what I find to be a more mathematically evocative alternative translation.

⁴²⁹ First published in 1957 in the journal *Twórczość* and then in 1957 in *Hermes, pies i gwiazda*. Herbert, *Wiersze zebrane*, 129 and 729, notes. Translated by John and Bogdana Carpenter in Herbert, *Selected Poems*, 1977, 7.

ON TRANSLATING POETRY

Like an awkward bumble-bee
he sits on the flower
until the delicate stalk bends
he squeezes through rows of petals
like the pages of a dictionary
he tries to reach the centre
[...]
it is difficult to penetrate
[...]
so the bumble-bee goes out
very proud
[...]
he shows his nose
yellow with pollen

Whether illuminating the human condition through poetry, or striving for the ideal perfection, or correlating the mathematical and poetic figures, translation from one language to another is inevitably only an approximation, albeit like that of an asymptote, but richly suggestive.

Mathematical Poetry

In this section I follow some essential concepts in mainstream mathematics, as they find their way into the poetry of Zbigniew Herbert. The selected poems are arranged under a sequence of themes relating directly to mathematical ideas, and within each section presented chronologically. The poems that I have chosen for this study are not necessarily and comprehensively representative of Herbert's overall oeuvre: they are a subset of excerpts selected specifically for their engagement with mathematics, and I am far from suggesting that there should be a univocal reading of the poetic representations involved. However, it is clear from the selection presented that mathematics is indeed significant in Herbert's work, the poems entirely fit within the major bounds of his poetics, and together and individually they present an endlessly rich source of imaginative inspiration, giving authority to the form and adding to the poetic effect.

Herbert on occasion expresses doubts about rationalism, abstraction and mathematical concepts such as zero and infinity, and about basic features like counting and measurement. Yet he also at times embraces these very qualities, and furthermore demonstrates an understanding of and attraction to some of the more complex and philosophical questions raised by modern mathematics around both uncertainty and incompleteness. In doing so he confronts and explores the possible connections between the many facets of mathematics and poetic writing.

In 2013, the New Zealand Centre for Literary Translation at Victoria University of Wellington commissioned the following translation by New Zealand poet Murray Edmond, in cooperation with Joanna Forsberg: "About the translation of poetry/like a clumsy bumblebee/that sat on a flower/till the willowy stalk bent/pushing/through rows of petals/like dictionary pages/to the centre he aims for/where aroma and sweetness are/and though he has catarrh/and so lacks taste/nonetheless his aim is/such that he butts his head/into the yellow pistil/and here is the end of it/it's difficult to penetrate/through the chalice of the calyx/to the roots/then bumblebee emerges/very proud/and buzzing loud:/“I was inside!”/while to those /who don't entirely believe him/he shows his nose/yellow with pollen.”

Counting

Arithmetic is one of the more immediately accessible features of mathematics. Herbert introduces the act of counting into several of his poems, seeing it as a not altogether undesirable tool for factual record-keeping. Yet at the same time, he expresses a deep unease with what he takes to be an impersonal coldness also associated with numbers and counting.

Herbert's "Sequoia" (1969) depicts a classical geometer who apparently lacks emotion and is unable to use language for any purpose beyond counting. The piece opens with a fool counting out and marking off major historical dates – particularly of battles – on the rings of the cross-section of a giant tree (the sequoia). It continues:

SEKWOJA

[...]

Tacyt tego drzewa był geometrą nie znał przymiotników
nie znał składni wyrażającej przerażenie nie znał żadnych słów
więc liczył dodawał lata i wieki jakby chciał powiedzieć że nie ma
nic poza narodzinami i śmiercią nic tylko narodziny i śmierć
[...]

⁴³⁰

Here Herbert is suggesting that his geometer is emotionally impoverished, able only to record the passing years as a series of battles, fought by hollow individuals recalled primarily by their dates of birth and death. For Herbert, the mathematician is found severely lacking in the qualities relevant to a poem's essential concern – the precise and complex use of words to render human feeling. Such stark criticism of a mathematician does, however, soften in later poems.

Mr Cogito is the re-occurring rationalist character first introduced by Herbert in the 1970s. In "Mr Cogito Reads the Newspaper" (1974), an article reports the death of 120 soldiers during a war. Mr Cogito struggles to empathise with these dead, recorded only as statistics, and instead he focuses on the more personal tragedy of one particular farmer who has murdered his family. The poem concludes:

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⁴³⁰ Herbert, *Wiersze zebrane*, 399. First published in 1969 in *Twórczość*, then in 1974 in *Pan Cogito*. The sequoia are trees from the cypress family found on the hills around San Francisco, where Herbert was in residence at the time. (Refer *Ibid.*, 739, notes.) Translated by John and Bogdana Carpenter in Herbert, *Selected Poems*, 1977, 45.

SEQUOIA

[...]

the Tacitus of this tree was a geometrician and he did not know adjectives
he did not know syntax expressing terror he did not know any words
therefore he counted added years and centuries as if to say there is nothing
beyond birth and death nothing only birth and death

[...]

Alissa Valles's translation renders 'geometrą' as 'surveyor', which is a valid translation of the Polish, but loses sight of the more mathematical connotation in English. (See also note 438.)

PAN COGITO CZYTA GAZETĘ

[...]

nie przemawiają do wyobraźni
jest ich za dużo
cyfra zero na końcu
przemienia ich w abstrakcję

temat do rozmyślenia:
arytmetyka współczucia ⁴³¹

For Herbert, the statistical reporting of a round figure (the zero on the end) has turned the dead into an unwelcome abstraction, placing them beyond personal compassion. Such compassion is easier in the case of the farmer's family, because rather than a number they are described as individuals. They 'speak to the imagination', something that poetry undoubtedly does, but arithmetic – for Herbert – does not.

In a later poem, however, mathematical counting is praised for its capacity to return an ethical consideration to mass death, precisely by virtue of its capacity for accurate record-keeping. In "Mr Cogito on the Need for Precision" (1983), Herbert laments that the exact number of dead at Troy has been forgotten, suggesting that precision and exactitude in language, including numerical, are necessary to combat carelessness and forgetting:

PAN COGITO O POTRZEBIE ŚCISŁOŚCI

Pana Cogito
niepokoi problem
z dziedziny matematyki stosowanej

trudności na jakie napotykamy
przy prostych operacjach arytmetycznych
[...]

zmierzono cząstki materii
zważono ciała niebieskie
i tylko w sprawach ludzkich
panoszy się karygodne niedbalstwo
brak ścisłych danych

po bezkresach historii

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⁴³¹ Herbert, *Wiersze zebrane*, 382–83. First published in 1974 in *Pan Cogito*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 285–86.

MR COGITO READS THE NEWSPAPER

[...]

they don't speak to the imagination
there are too many of them
the numeral zero on the end
turns them into an abstraction

a theme for further reflection:
the arithmetic of compassion

krąży widmo
 widmo nieokreśloności
 [...]

liczymy ocalałych
 a niewiadomą resztę
 [...]

określa się dziwnym mianem
 zaginionych
 [...]

teraz Pan Cogito
 wchodzi
 na najwyższy chwiejny
 stopień nieokreśloności
 [...]

dane oficjalne
 pomniejszają ich liczbę
 [...]

a przecież w tych sprawach
 konieczna jest akuratność
 [...] ⁴³²

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⁴³² Herbert, *Wiersze zebrane*, 517–522. First published in 1983 in *Raport z oblężonego miasta i inne wiersze*. Translated by John and Bogdana Carpenter in Herbert, *Report from the Besieged City*, 64–68.

MR COGITO ON THE NEED FOR PRECISION

Mr Cogito
 is alarmed by a problem
 in the domain of applied mathematics

the difficulties we encounter
 with operations of simple arithmetic
 [...]

particles of matter have been measured
 heavenly bodies weighed
 and only in human affairs
 inexcusable carelessness reigns supreme
 the lack of precise information

over the immensity of history
 wheels a specter
 the specter of indefiniteness
 [...]

we count those who are saved
 but the unknown remainder
 [...]

is described by a strange term
 the missing
 [...]

now Mr Cogito
 climbs
 to the highest tottering
 step of indefiniteness
 [...]

the official statistics
 reduce their number
 [...]

and yet in these matters
 accuracy is essential
 [...]

From an aesthetic point of view, this is not a poem that immediately appeals to me compared with many of Herbert's others. Perhaps this is because poetry deliberately exploits the vague and suggestive, whereas this poem is quite literal, 'mathematical' even. I have included such a lengthy extract, since it draws on explicitly mathematical imagery and illustrates clearly an issue with which Herbert, through Mr Cogito, seems to be struggling. On the one hand, arithmetic is precise, and used, again, to count and record human victims. But at the same time Mr Cogito is aware of imprecision and vagueness in human affairs: strict counting has its limits, and some victims – the “unknown” remainder – lie beyond knowledge. Precision can also be a defence against socialist obfuscation: Herbert once remarked that ‘Language is an impure tool of expression. [...T]he poets’ dream is to reach to the words’ pristine sense...’.⁴³³ In other words, Mr Cogito is confronted with indefiniteness as a real phenomenon.

In fact, indefiniteness is a feature clearly recognised in mathematics, and it is remarkable that Herbert uses mathematically-suggestive terms throughout this poem, starting from the opening image of a problem in applied mathematics. I will return to Herbert's encounters with concepts from more advanced modern mathematics such as uncertainty and imprecision. But a first step in moving arithmetic and counting away from the concrete and physically verifiable, to a more ‘indefinite’ level, is the introduction of the concepts of zero and infinity.

Zero and Infinity

In mathematics the “natural numbers” begin at one. Numbering systems soon extend to the less tangible concepts of infinity and of zero, from which Herbert apparently recoils.⁴³⁴

I have commented already that in “Mr Cogito Reads the Newspaper”, for Herbert the zero at the end of a number turns it into an abstraction, which then represents a hindrance to emotional identification. This correlation of zero with nothingness, with abstraction and by

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This poem is a good example of the differences in translation that arise when looking through a mathematical lens. The Carpenters translate *nieokreśloności* (fourth stanza here) as ‘indefiniteness’, whereas Valles renders it ‘indeterminacy’ in Herbert, *The Collected Poems*, 404. In mathematics, an indeterminate number in Polish is *nieoznaczony*, and indefinite number *nieokreślony*. (Unbounded is *nieograniczony* and infinite *nieskończony*.) This is one of the reasons I prefer the Carpenter translation in this instance. On the other hand, I prefer Valles's translation of *danych* (third stanza) as of ‘data’ rather than ‘information’, since to me it captures better the scientific element of the poem. Words can acquire very specific, even idiosyncratic, meanings in the shift from ordinary language to mathematical, the range of similar terms does not always find its full counterpart in another language; but, to quote Herbert from this very poem, ‘accuracy is essential’.

⁴³³ Herbert in Barańczak, *A Fugitive from Utopia*, 65–66. See also note 409. An interesting view of precision and poetry is in “Exactitude” in Calvino, *Six Memos for the Next Millennium*.

⁴³⁴ On ‘nothing’ and ‘zero’ in mathematics see for example Rotman, *Signifying Nothing*; Kaplan, *The Nothing That Is*.

extension an absence of human connection, is repeated in one of his later poems “Phone Call” (1998), in which the poet’s meandering thoughts about metaphysics are interrupted by a telephone call. He concludes,

TELEFON
[...]
słaby ze mnie
piastun nicości
nigdy w życiu
nie udało mi się
stworzyć
przyzwoitej abstrakcji ⁴³⁵

For Herbert, abstraction – an inherent feature of metaphysics and also of modern mathematics – can represent nothingness, which is not something that he embraces. As I discussed in the introductory section of this chapter, abstraction for Herbert has complex connotations, and carries the risk of amorality.⁴³⁶ It is also a marked feature of the Symbolist poets, writing two generations before Herbert, who openly admired mathematics.

The unfavourable correlation between metaphysics and more abstract mathematics is evident in an early work, “The Cultivation of Philosophy” (1956), when Herbert mocks a hand-rubbing philosopher:

UPRAWA FILOZOFII
Posiałem na gładkiej roli
drewnianego stolka
ideę nieskończoności
[...]
zmajstrowałem także walec
[...]
walec to przestrzeń
wahadło to czas
[...]
wymyśliłem w końcu słowo byt
słowo twarde i bezbarwne

---

⁴³⁵ Herbert, *Wiersze zebrane*, 675–677. First published in 1998 in the journal *Kwartalnik artystyczny* and then in *Epilog burzy*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 548–549.

PHONE CALL
[...]
I don’t make a very good
custodian of nothingness
never in my life
have I managed
to produce
a decent abstraction.

⁴³⁶ On abstraction, see further note 405.

While the technical mathematical flavour of the poem is less obvious in the original Polish than in this English translation, Herbert develops a mathematical image and, linking it with metaphysics, finds it wanting. For him, the concept of infinity can be aligned with a soulless constructivism, and while constructivist mathematics itself is eminently valid, it is something that is at odds with the humanism of his poetry.

A similar perception of infinity as less than human reappears in “The Seventh Angel” (1957), where in this case infinity is directly associated with the emotionally barren geometer of “Sequoia” and in this case, theoretical physics. The poem describes the angel Shemkel, who is nervous, fallible and imperfect, and contrasts him with the other great angels, including the godlike Azrael:

SIÓDMY ANIOŁ
 Siódmy anioł
 jest zupełnie inny
 nazywa się nawet inaczej
 Szemkel
 [...]
 ani także
 Azrael
 kierowca planet
 geometra nieskończoności
 doskonały znawca fizyki teoretycznej
 [...] 438

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⁴³⁷ Herbert, *Wiersze zebrane*, 46–47. First published in 1956 in *Struna światła*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 34–35.

THE CULTIVATION OF PHILOSOPHY
 I sowed the idea of infinity
 in the unruffled soil
 of a wooden stool
 [...]
 I also knocked together a cylinder
 [...]
 the cylinder is space
 the pendulum is time
 [...]
 finally I came up with the word existence
 a hard and colourless word
 [...]

Valles’s English translation has in some respects added a mathematical tone that was less pronounced in the original Polish: *nalec* is an everyday term referring to a roller, rather than the technical mathematical concept of ‘cylinder’, which in Polish is *cylinder*. Similarly, ‘existence’ as a translation of *był* is possible, but I prefer the more ordinary and short ‘being’, since the more technical term in Polish for existence is *istnienie*.

⁴³⁸ Herbert, *Wiersze zebrane*, 127–128. First published in 1957 in *Hermes, pies i gwiazda*. Translated by Peter Dale Scott in Herbert, *Poezje wybrane*, 19–21.

THE SEVENTH ANGEL
 The seventh angel
 is completely different

In fact, Herbert prefers the fallible Shemkel, and regards infinity as something inhuman.⁴³⁹ (Theoretical physics, a discipline closely tied to modern mathematics, arouses a similar reaction, which I will touch on again in the final poem, “Georg Heym”, where Herbert draws an explicit connection with poetics, or theories of poetry.)

Herbert does not appear to equate infinity with a sense of possibility and imaginative creativity, an association that he recognises in poetry, but to a much lesser degree in mathematics. This may be a widespread view, particularly among those whose interests tend more towards the humanities and arts, but it is not necessarily a view held by mathematics practitioners themselves, and challenging it is one of the underlying motivations of this thesis.⁴⁴⁰

Amorality of Mathematics

The references to mathematics in Herbert’s poetry have so far been quite critical, with their consistent concern that mathematics is devoid of ethical thinking. This viewpoint is revisited in “Mr Cogito Thinks about Blood” (1983), which disparages science. Mr Cogito reflects on the copious and precise volumes of blood spilled in death, particularly during battle, and concludes that science contributes very little to morality.

PAN COGITO MYŚLI O KRWI
[...]
ścisły pomiar
umocnił nihilistów
dał większy rozmach tyranom
[...]
tak więc tryumf nauki
nie przyniósł obroku duchowego
zasady postępowania

---

even his name is different
Shemkel
[...]
he’s also no
Azrael
planet-driver
surveyor of infinity
perfect exponent of theoretical physics
[...]

Note that Scott translates the Polish *geometra* as ‘surveyor’, which convention Valles adopts in her translation of “Sequoia”, see note 430.

⁴³⁹ Herbert also depicts an abstract and unsettling infinity in in “Mr Cogito and Music”, see note 444, and his 1956 “Drży i faluje” (Trembles and Heaves): Herbert, *Wiersze zebrane*, 45.

⁴⁴⁰ For the Greeks, notably Archimedes, and the renaissance mathematicians such as Newton and Leibniz, “infinity” represented unbounded potential. Following the work of the Prussian mathematician and set theorist Georg Cantor, infinity has become as concrete a reality as a circle or a number, albeit with greater philosophical caveats attached. Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*, 778–780.

moralnej normy

to mała pociecha
myśli Pan Cogito
że wysiłki badaczy
nie zmieniają biegu rzeczy

ważą zaledwie tyle
co westchnienie poety

a krew
plynie dalej

przekracza horyzont ciała
granice fantazje
[...] ⁴⁴¹

As I have mentioned already, scientific precision (including that associated with arithmetic and measuring) is associated with nihilism. Until now, it might have been inferred that poetry offers a counterbalance and is more inherently ethical. This piece addresses that assumption directly: while poetry likewise fails to provide significant moral weight, the suggestion is that it is more conducive to a moral framework than the sciences.

The suggestion that mathematics is amoral recurs in “Mr Cogito’s Adventures with Music” (1990). The poem opens with Mr Cogito reflecting on his early love of music but, as

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⁴⁴¹ Herbert, *Wiersze zebrane*, 500–503. First published in 1983 in *Raport z obłąkanego miasta*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 387–389.

MR COGITO THINKS ABOUT BLOOD

[...]
precise measurement
strengthened nihilists

gave tyrants new scope
[...]
the triumph of science
has not fed us in spirit
nor offered a principle
of action a moral norm

it’s a meager consolation
Mr Cogito is thinking
that researchers’ efforts
alter nothing in its course
and barely weigh as much
as the inspiration of a poet

blood
swims on

crosses the body’s horizon
the borders of imagination
[...]

he ages, his subsequent disengagement with what he acknowledges as the both 'hidden and open' character of music, its enticing 'transient lightness'. Mr Cogito, 'doomed to stony speech', ultimately consents to a limited dichotomous view of his moral world.

While on a primary level the poem is about music, mathematics is strongly present through the accumulation of specific images: a triangle; infinity; arithmetic; the reference to Leibniz; and in the implicit association between mathematics and music.⁴⁴² Indeed, the triangle image was added only in the later drafting stages of the poem, suggesting a conscious decision to present the mathematical.⁴⁴³

PANA COGITO PRZYGODY Z MUZYKĄ

[...]
zmieniły się
obroty rzeczy
pola grawitacji
a wraz z nimi
wewnętrzna oś
Pana Cogito
[...]
Estruszkowie chłostali niewolników
przy wtórze piszczałek i fletów

a zatem
moralnie obojętna
jak boki trójkąta
spirale Archimedesesa
anatomia pszczoły

porzuca trzy wymiary
flirtuje z nieskończonością
[...]
łagodny Leibniz pocieszał
że jednak porządkuje
i jest ukrytym
arytmetycznym
ćwiczeniem
duszy
[...]
Pan Cogito
skazany na kamienną mowę
chrapliwe sylaby
adoruje skrycie
ulotną lekkomyślność
[...]
wybrał to co podlega
ziemskim miarom i sądom

---

⁴⁴² Leibniz, the founder of infinitesimal calculus, was a rationalist in the school of Descartes and Spinoza (see Chapter 1). A Pythagorean musical harmony of spheres and the universe is also present in the 1983 "Pan Cogito – zapiski z martwego domu" (Mr Cogito – Notes from the House of the Dead), in Herbert, *Wiersze zebrane*, 525–529.

⁴⁴³ See early manuscript drafts in Herbert, "Utwory Zbigniewa Herberta," Box 17847, folder 1.

by gdy nadejdzie bez godzina
mógł przystać bez szemrania

na próbę kłamstwa i prawdy
na próbę ognia i wody ⁴⁴⁴

Herbert melds his images of music with those of mathematics, creating a rich picture of a rationalist human being (Mr Cogito) struggling with infinity and ambivalence, but finally turning away from them. As in other late poems, particularly “Mr Cogito and the Need for Precision”, the reference to arithmetic includes a sense of the infinite and of possibility, and

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⁴⁴⁴ Herbert, *Wiersze zebrane*, 559–564. First published in 1990 in *Elegia na odejście*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 443–448.

MR COGITO'S ADVENTURES WITH MUSIC

[...]
the orbit of things
was what changed
the field of gravity
and with it
Mr Cogito's inner axis
[...]
the Etruscans flogged slaves
to the accompaniment of pipes and flutes

she [music] is therefore
morally neutral
like the sides of a triangle
the spirals of Archimedes
a bee's anatomy

she flouts the three dimensions
flirts with infinity

[...]
mild Leibniz tutted
said she brings order
and is the clandestine
arithmetical

exercise

of souls

[...]

Mr Cogito
doomed to stony speech
to hoarse syllables
secretly worships
transient lightness

[...]

he [Mr Cogito] chose
what is subject to
earthly measures and judgments

so that when the hour strikes
he assents without a murmur

to the trial of true and false
to the trial of fire and water

Mr Cogito is aware of that. Both mathematics and music represent multiplicity, yet in the end Mr Cogito rejects it, accepting the finality of human judgement. In this case, however, the pessimistic ending is not associated just with mathematics: the potential for truth inherent in mathematics, along with music, is forever imbued with lost promise.

Mathematics as Certain Knowledge

Several of the poems looked at so far have associated mathematics with precision, although Herbert offers a more complex aspect of mathematics in “Mr Cogito and Music”, with its closing, elemental dichotomy between mathematics and music, truth and falsity. In “Mr Cogito on the Need for Precision”, Herbert also introduced the notion of indefiniteness.

The association of mathematical knowledge with certainty can be seen in two quite different poems by Herbert, in which he reflects on the loss of childhood’s certain knowledge. In “A Life” (1957) the poet recalls his childhood innocence, and describes the course of his life, from the wartime destruction of Poland to the subsequent socialist era. The first section of this long poem includes a depiction of lessons in elementary geometry and Latin grammar:

ŻYCIORYS
 [...]
 na pulpicie jego nazwisko
 wzór na objętość stożka

 odmiana *puer bonus*
 i słowo Jadzia
 [...] ⁴⁴⁵

This first section overall is about childhood certainty – which ultimately is lost – and Herbert represents this by what he considers to be certain knowledge: standard geometry; grammar and medieval history.⁴⁴⁶

In “Elegy for the Departure of Pen, Ink and Lamp” (1990), Herbert again uses mathematical concepts learned in his childhood to represent lost certainty:

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⁴⁴⁵ Herbert, *Wiersze zebrane*, 141–146. First published in 1957 in *Hermes, pies i gwiazda*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 109–113.

A LIFE
 [...]
 on the desk his name
 the formula for a cone’s volume
 the declension of *puer bonus*
 and the word Jadzia
 [...]

⁴⁴⁶ Jadwiga, diminutive Jadzia, was a great mediaeval Polish queen who reigned over a cultural renaissance in Poland, including the establishment of the Jagiellonian University in Krakow. The combination of history, Latin and mathematics dates back to the standardised national curriculum referred to in note 393.

ELEGIA NA ODEJŚCIE PIÓRA ATRAMENTU LAMPY

Zaprawdę wielka i trudna do wybaczenia jest moja niewierność
bo nawet nie pamiętam dnia ani godziny
kiedy was opuściłem przyjaciele dzieciństwa
[...]
w żydowskim sklepiku
- skrzypiące schodki dzwonek u drzwi oszklonych –
wybierałem ciebie
[...]
srebrna stalówko
wypustko krytycznego rozumu
posłanko kojącej wiedzy
– że ziemia jest kulista
– że proste równoległe
[...]
wybacz moją niewdzięczność pióro z archaiczną stalówką
i ty kałamarzu – tyle jeszcze było w tobie dobrych myśli
wybacz lampo naftowa – dogasz we wspomnieniach jak opuszczony obóz

zapłaciłem za zdradę
lecz wtedy nie wiedziałem
że odchodzicie na zawsze

i że będzie
ciemno ⁴⁴⁷

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⁴⁴⁷ Herbert, *Wiersze zebrane*, 576–581. First published in *Elegia na odejście*, 1990. Translated by John and Bogdana Carpenter in Herbert, *Poezje wybrane*, 172–181.

ELEGY FOR THE DEPARTURE OF PEN, INK AND LAMP

Truly my betrayal is great and hard to forgive
for I do not even remember the day or hour
when I abandoned you friends of my childhood
[...]
In a Jewish shop
– steps creaking a bell at the glass door –
I chose you
[...]
o silver nib
outlet of the critical mind
messenger of soothing knowledge
– that the globe is round
– that parallel lines never meet
[...]
pen with an ancient nib forgive my unfaithfulness
and you inkwell – there are still so many good thoughts in you
forgive me kerosene lamp – you are dying in my memory like a deserted campsite

I paid for the betrayal
but I did not know then
you were leaving forever

and that it will be
dark

Valles translates *proste równoległe* (third stanza here) more literally as ‘of straight and parallel lines’, in Herbert, *The Collected Poems*, 458. The issue of meeting, or non-meeting, parallel lines is in fact central to the evolution of non-Euclidean geometries, as discussed in previous chapters, and again later in this chapter, see note 465. In this case,

Unlike “A Life”, however, where Herbert deploys a schoolboy geometry lesson to depict certain knowledge, by the time of the “Elegy” in 1990, Herbert has introduced the notion that these mathematical certainties themselves might be under question. I will return to this, particularly in the context of modern geometry and parallelism.

Moving from childhood to death, in a piece from his late “Prayer” (1998) cycle, Herbert petitions God for knowledge stemming from what he views as universal scientific laws; in other words knowledge that is infallible and comforting:

BREWIARZ [II]

[...]
 Panie,
 obdarz mnie siłą i zręcznością tych, którzy
 budują zdania długie rozłożyste jak dąb pojemne
 [...]
 także aby zdanie główne panowało pewnie nad podrzędnymi
 [...]
 trwało niewzruszenie nad ruchem elementów, aby przyciągało je jak
 jądro przyciąga elektrony siła niewidocznych praw grawitacji
 [...]⁴⁴⁸

This poem explores Herbert’s enduring preoccupation with the struggle to write, articulated in specific figures drawn from grammar, composition and scientific laws. In “Prayer”, the connection is made particularly evocatively, suggesting that by the end of his life Herbert embraced, to some extent, the universal and imaginative truth of physics.

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the Carpenters – whether consciously or not - have taken a liberty in expressing mathematical detail that is not in fact suggested by Herbert.

The translation of *obóz*, by both the Carpenters and Valles as ‘campsite’, is also of interest. I prefer ‘camp’, it carries a possible connotation of the concentration camps that is also present in the original Polish; hence giving meaning to the ‘ultimate betrayal’.

⁴⁴⁸ Herbert, *Wiersze zebrane*, 638. First published in 1998 in the journal *Odra* and in 1998, posthumously, in *Epilog burzy*. Translated by John and Bogdana Carpenter in Herbert, *Poezje wybrane*, 201. The Polish title *Breviarz* is translated more literally and, I think, evocatively by Valles as ‘Breviary’.

PRAYER (II)

[...]
 Lord, bestow on me the strength and agility of those who build long sentences spread out like an oak,
 capacious
 [...]
 so that the main clause firmly governs the subordinate clauses
 [...]
 endures inexorably over the movement of the elements, so it attracts them as a nucleus attracts electrons
 with the force of invisible laws of gravitation
 [...]

(It would appear in this case that Herbert was conflating electric and gravitational forces.)

This notion is sustained through the series: in another “Prayer” he has regained his early appreciation of music, lost in “Mr Cogito and Music”, and likewise he reflects again on the creative potential of infinity:

BREWIARZ [IV]
Panie
wiem że dni moje są policzone
zostało ich niewiele
[...]
życie moje
powinno zatoczyć koło
[...]
dlaczego
życie moje
nie było jak kręgi na wodzie
obudzonym w nieskończonych głębiach
[...]⁴⁴⁹

Herbert has come full circle, from his childhood belief in the scientific-like laws governing life, through a lament for such a lost belief as being naïve and mistakenly simplistic. Eventually he returns to a hope that such laws might indeed prevail, but his understanding this time is enriched by his knowledge of their complexity and intricacy.⁴⁵⁰

Geometry, Clarity and Exactness

Several of the poems discussed already have touched on mathematical geometry, starting with the geometer in the very first poem of this selection, “Sequoia”. Geometry is largely deployed as an image of certainty, precision and clarity. I look now at one visible aspect of geometry – shapes – which Herbert presents as almost primordial building blocks, not only in a physical sense but also suggesting something beyond that.

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⁴⁴⁹ Herbert, *Wiersze zebrane*, 640–641. First published in 1998 in the journal *Tygodnik powszechny* and in 1998, posthumously, in *Epilog burzy*. Translated by John and Bogdana Carpenter in Herbert, *Poezje wybrane*, 203.

PRAYER [IV]
Lord
I know that my days are numbered
only a few are left
[...]
my life should have made a circle
concluded like a well made sonata
[...]
why
was my life
not like circles on water
awakened in the infinite depths
[...]

⁴⁵⁰ That circles represent perfection is a common trope of the overtly mathematical poet, Emily Dickinson: see Chapter 2.

Herbert had a personal interest in architecture, writing a number of essays on the subject. In the poem “Architecture” (1956) he offers a paean to perfect, straight forms.

ARCHITEKTURA
[...]
gdzie prostokąty bardzo ściśle
obok marzącej perspektywy

gdzie ornamentem obudzony
strumień na cichym polu płaszczyzn

gdzie ruch z bezruchem linia z krzykiem
niepewność drżąca prosta jasność
[...]
wygnaniec kształtów oczywistych
głoszę twój taniec nieruchomy ⁴⁵¹

The poem certainly presents an image of perfection, yet the ‘trembling uncertainty’ is a hint of the final stanza: that Herbert himself is distanced from this almost abstract flawlessness; its very perfection is too sterile for the poet’s comfort.

This sense of perfect, sterile, geometries is sustained in “Winter Garden” (1969), where Herbert laments the departure of ‘stickiness’ and life from a garden over winter, describing it as pared back to its essential shapes formed from precise geometric structures:

ZIMOWY OGRÓD [II]
[...]
nie ma już ziemi lepkich łap
które się grzebią w trupach kwiatów
[...]

---

⁴⁵¹ Herbert, *Wiersze zebrane*, 32–33. First published in 1956 in *Struna światła*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 23.

ARCHITECTURE
[...]
where there are perfect squares
next to a dreaming perspective

where an ornament wakes a stream
in a tranquil field of level surfaces

motion with stillness a line with a cry
trembling uncertainty simple clarity
[...]
I the exile of self-evident forms
proclaim your motionless dance

Valles’s translation is interesting: the ‘perfect squares’ (first stanza here) are in the original *prostokąty* more literally rectangles; and not an allusion to Pythagorean perfect squares in arithmetic. On the other hand, the ‘level surfaces’ (second stanza), corresponding to the *płaszczyzn*, do have a technical meaning in the original Polish, in the sense of surface ‘planes’, but – as in the English homophone – can also be ‘plains’, a homonym in Polish that Valles oddly does not retain.

z rombów trójkątów ostrosłupów
na przekór – niespokojnej linii
włosów przez które cieknie krew
jedwabiom w nierozumnych faldach
zielonej trumnie dla motyla –
z rombów trójkątów ostrosłupów
odbudowano mądry ogród
[...] ⁴⁵²

The mathematical shapes, familiar from any school-level geometry lesson, in fact render the garden dead. It is worth remarking that early drafts of this poem do not repeat the line ‘from rhomboids triangles pyramids’; the stunning – monotonous – repetition is a later addition.⁴⁵³ The impression left by these poems is of a mathematical geometry that is sterile, with the implication that a good poem reaches beyond this.

In “Architecture” and “Winter Garden”, geometric imagery is used to suggest clear lines and a fundamental underlying structure, even if the poet himself prefers what might grow on these structures. In Herbert’s poetics it is what comes after the fundamental grammar and syntax that is important. (This is less so for the Symbolists, which perhaps explains his use of a Symbolist-redolent style to describe the sterile aspects of the previous section.)

This correlation between language and geometry – which, as I discussed in the introductory section, was of interest to Herbert – is also evident in both “Prayer” and “Sequoia”, which introduces a geometer for whom syntax alone is insufficient to express adjectives conveying emotions such as terror. A similar image is developed in “Mr Cogito Tells

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⁴⁵² Herbert, *Wiersze zebrane*, 328. First published 1969 in *Napis*. (Herbert published another, quite separate, “Winter Garden” in 1956, which – in a manner redolent of the Symbolists - equates quietness with a ‘perfect line’ and constellations in the sky. Refer “Zimowy ogród” in *Ibid.*, 56.) Translated by Alissa Valles in Herbert, *The Collected Poems*, 235.

WINTER GARDEN [II]
[...]
gone is the earth of sticky paws
digging in the remains of flowers
[...]
from rhomboids triangles pyramids
despite the quivering line of hair
through which blood is dripping
despite the silks in mindless folds
and a green coffin for a butterfly –

from rhomboids triangles pyramids
the wise garden was reconstructed
[...]

Difficult to transmit in translation, and not explicitly noted by Valles, are the phonetic similarities in Polish between *kniatach* (‘of flowers’, first stanza) and *kwadrat* (‘square’).

⁴⁵³ Herbert, “Utwory Zbigniewa Herberta,” Box 17955, folder 62, notebook, 59. This notebook is dated 1956/57, implying the 1969 published version of the poem was drafted at the same time as “Winter Garden [I]”, which would make sense, given the early Symbolist-like aspect of this poem.

about the 'Temptation of Spinoza' (1973), where Mr Cogito has God address Spinoza, acknowledging the value in his rational argumentation but going on to extol human frailty, love and emotion as apparently higher virtues. The identification of mathematics and syntax is still, in this poem, suggestive of a lack of something more deeply emotional: the 'Truly Great' includes human love.

PAN COGITO OPOWIADA O KUSZENIU SPINOZY

[...]
- mówisz ładnie Baruch
lubię twoją geometryczną łacinę
a także jasną składnię
symetrię wywodów
[...]
pomówmy jednak
o Rzeczach Naprawdę
Wielkich
[...]
- dbaj o dochody
jak twój kolega Kartezjusz

- bądź przebiegły
jak Erazm
[...]
teraz zasłona opada
Spinoza zostaje sam
[...]
słyszy skrzypienie schodów
kroki schodzące w dół ⁴⁵⁴

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⁴⁵⁴ Herbert, *Wiersze zebrane*, 419–421. First published in 1973 in the journal *Nurt* and then in 1974 in *Pan Cogito*. Translated by John and Bogdana Carpenter in Herbert, *Poezje wybrane*, 74–79.

MR COGITO TELLS ABOUT THE TEMPTATION OF SPINOZA

[...]
– You talk nicely Baruch
I like your geometric Latin
and the clear syntax
the symmetry of your arguments
[...]
let's speak however
about Things Truly
Great
[...]
look after your income
like your colleague Descartes

be cunning
like Erasmus
[...]
now the curtain falls
Spinoza remains alone
[...]
he hears the creaking of the stairs
footsteps going down.

Herbert relates mathematics with logical rationalism, reinforced more explicitly in the poem by disparaging references to Descartes and Erasmus. The poem ends with a solitary and lonely Spinoza, who lacks what for Herbert – and possibly Mr Cogito also – is the more important attribute of human emotion and the knowledge of ‘things truly great’.

While exactitude in language is viewed somewhat slightly in “Spinoza”, in the next poem, “Mr Cogito and the Imagination” (1983), Mr Cogito seeks it. He spurns metaphor, for its ultimate vagueness and imprecision and instead takes an isomorphic and more literal approach to language, seeking the perfect, exact expression. Again, he likens such exactitude to geometrical shapes: flat/horizontal and vertical lines in this case.

PAN COGITO I WYOBRAŻNIA

[...]

unosił się rzadko
na skrzydłach metafory

[...]

uwielbiał tautologie
tłumaczenie
idem per idem

że ptak jest ptakiem
niewola niewolą
nóż jest nożem
śmierć śmiercią

kochał
płaski horyzont
linię prostą
przyciąganie ziemi
[...]
pragnął pojąć do końca
[...]
wyobrażenia Pana Cogito
ma ruch wahadłowy

przebiega precyzyjnie
od cierpienia do cierpienia

nie ma w niej miejsca
na sztuczne ognie poezji

chciałby pozostać wierny

The Carpenters translate *nywodów* (first stanza here) as ‘arguments’; Valles uses ‘proofs’ in her translation in Herbert, *The Collected Poems*, 314. The philosophical-mathematical ‘deductions’ would also be a reasonable and literal translation, but what is interesting is that both translators have retained a mathematical connotation: obviously so in the case of Valles, but also in the case of the Carpenters (whether deliberately or not), in that ‘argument’ as well as a logical premise in debate, is also the term for the angle between the imaginary and real axes in complex numbers.

“Mr Cogito and the Imagination” is a popular poem of Herbert’s, and much analysed by his literary critics. Adam Zagajewski considers that it represents dreams and abstractions that Mr Cogito is aware of, but cannot fully comprehend.⁴⁵⁶ Sharon Wood argues that the poem encompasses the uncertainty and disorder of modern science. She also makes the link with Herbert’s political engagement and language. Describing his literalness and precision in language as reflecting his belief in the need to be grounded in reality, she recognises that tautology (or stating the obvious with a laconic literalness) was for Herbert a form of political dissidence, given the prevailing obfuscation in communist Poland.⁴⁵⁷

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⁴⁵⁵ Herbert, *Wiersze zebrane*, 460–462. First published in 1983 in *Raport z oblężonego miasta*. Translated by John and Bogdana Carpenter in Herbert, *Report from the Besieged City*, 17–19.

MR COGITO AND THE IMAGINATION

[...]
he would rarely soar
on the wings of a metaphor

[...]
he adored tautologies
explanations
idem per idem

that a bird is a bird
slavery means slavery
a knife is a knife
death remains death

[...]
he loved the flat horizon
a straight line
the gravity of the earth

[...]
he wanted to understand to the very end

[...]
Mr Cogito’s imagination
has the motion of a pendulum

it crosses with precision
from suffering to suffering

there is no place in it
for the artificial fires of poetry

he would like to remain faithful
to uncertain clarity.

⁴⁵⁶ Herbert, *The Collected Poems*, introduction.

⁴⁵⁷ Wood, “The Reflections of Mr Palomar and Mr Cogito.” Such apparent tautologies are particularly apparent in the short poem “The Pebble”, see note 406. As an aside, Seamus Heaney remarks that in Italo Calvino’s *Mr Palomar*, ‘Symmetries and arithmetics have always tempted Italo Calvino’s imagination to grow flirtatious and to begin its fantastic displays.’ Yet Heaney does not advance any further thoughts on his mathematical terminology. Heaney, “Italo Calvino’s Mr Palomar,” 391.)

As could be seen in “Mr Cogito Reads the Newspaper”, the ‘imagination’ suggests human feeling and inspiration. For me it is significant in this case that poetry does not satisfy Mr Cogito’s desire for the perfect expression, or fulfilment of the imagination, but Herbert is apparently not critical of Mr Cogito’s response. (A similar dissatisfaction with poetry was suggested in “Mr Cogito thinks about Blood”.) The clear inference is that Mr Cogito’s mathematical-like, geometrical, desired expression is no longer necessarily inferior to the poetic one.

The poem ends with an echo of both “Architecture” and “I would like to describe”, in positing ‘uncertain clarity’ as a paradoxical feature of exactness.⁴⁵⁸ In fact, uncertain clarity is a feature of modern mathematics.

Uncertainty

Mathematics does represent certainty on one level, but in modern mathematics certainty is not always attainable. Herbert’s poems touch on such uncertainty, and it becomes apparent that he is consciously aware of these ambiguities, and makes an identification with poetry, where ambiguity is normal.

Uncertainty as a demonstrated mathematical phenomenon came about through developments in several fields of modern mathematics. In 1932 the German mathematical physicist, Werner Heisenberg (1901-1976), won the Nobel Prize in Physics, for his work in quantum physics. He established what is now termed ‘Heisenberg’s uncertainty principle’ which asserts the inherent impossibility of exactly determining both position and momentum of a particle simultaneously. That is, he demonstrated a fundamental presence of uncertainty in physical measurement.

He was not alone in uncovering this unexpected uncertainty. Critically, in pure mathematics, in 1931 the Austrian-Czech, Kurt Gödel (1906-1978) published his ‘incompleteness theorems’. These demonstrate that no meaningful mathematical system can ever be complete, or be entirely proven, based on its own axioms.⁴⁵⁹ Gödel’s work was a fundamental achievement of twentieth-century mathematics. It directly challenged the work of the mathematician David Hilbert and others who until then had been focussing on building up an infallible and fully-proven structure of all mathematics, and it changed the direction of future research in a number of fields.⁴⁶⁰

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⁴⁵⁸ See notes 415 and 451.

⁴⁵⁹ ‘Meaningful’ is in the sense of an axiomatic system powerful enough to describe the natural numbers.

⁴⁶⁰ A Jew, Gödel escaped Vienna in the 1930s and settled in the US where he became a close friend of Einstein. See further in chapter 5.

Between them, Gödel and Heisenberg introduced into modern mathematics demonstrated phenomena of fundamental incompleteness, unprovableness and uncertainty. The (separate) discoveries of both Heisenberg and Gödel were well disseminated at the time, most obviously in mathematical circles, and by extension and with some alteration ‘in translation’, to the wider Central European intellectual classes, Polish included.

Herbert makes specific reference to Heisenberg in his 1961 poem, “Revelation”:

OBJAWIENIE

dwa może trzy
razy
byłem pewny
że dotknę istoty rzeczy
i będę wiedział

tkanka mojej formuły
z aluzji jak w *Fedonie*
miała także ścisłość
równania Heisenberga

siedziałem nieruchomo
[...]
czułem jak stos pacierzowy
wypełnia trzeźwa pewność

ziemia stanęła
niebo stanęło
[...]
jeśli zdarzy mi się to raz jeszcze
[...]
będę siedział
nieruchomy
zapatrzony
w serce rzeczy

martwą gwiazdę

czarną kroplę nieskończoności ⁴⁶¹

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⁴⁶¹ Herbert, *Wiersze zebrane*, 291–292. First published in 1961 in *Studium przedmiotu*. Translated by Czesław Miłosz in Herbert, *The Collected Poems*, 201–202.

REVELATION

Two perhaps three
times
I was sure
I would touch the essence
and would know

the web of my formula
made of allusions as in the *Phaedo*
had also the rigor
of Heisenberg’s equation

“Revelation” is about reaching the essence of knowledge: something that was a major preoccupation of poetry in Herbert’s time. His play with Heisenberg, ‘formula’, ‘certitude’ and just touching on knowledge – in the way that given the uncertainty principle one never quite wholly reaches the full determination of the momentum of a particle – and finally ‘infinity’, is fascinating. It also marks a departure from some of Herbert’s more ambivalent representations of these concepts, including infinity, which I have already looked at.

Having said that, it should be noted that the reference to Heisenberg’s uncertainty principle *per se* may itself be oblique. First, the Polish *pewność* used here translates as ‘certainty’ (and likewise *niepewności* in “Mr Cogito and the Imagination” as ‘uncertainty’) yet in the case of Heisenberg’s principle, the standard technical term in Polish for that uncertainty is *nieoznaczoności*, which more literally could be translated ‘unknowability’.⁴⁶² As I have said before, however, Herbert was not a mathematician and his knowledge of Heisenberg’s uncertainty concepts will have been indirect, and conveyed in language that may already have been adjusted to non-specialist audiences.

Second, Heisenberg’s ‘equation’ here could more directly refer to his well-known equation of motion, rather than the uncertainty principle, which would tie in with the following images of spinning and immobility.⁴⁶³ Either way, the presentation of all these concepts in the

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I was sitting immobile
[...]
I felt my backbone
fill with quiet certitude

earth stood still
heaven stood still
[...]
heaven and earth
started to spin again
[...]
If it happens to me once more
[...]

I shall sit
immobile
my eyes fixed
upon the heart of things

a dead star
a black drop of infinity

(Plato’s *Phaedo* (second stanza), known for its presentation of duality in human and universal existence, depicts the death of Socrates.)

⁴⁶² In some narrative contexts Heisenberg’s uncertainty is described using the term *niekreśloności*, which more technically translates as ‘indefinite’ or ‘unbounded’, see note 432.

⁴⁶³ See Kukin, “Heisenberg Representation.”

one poem is striking, and says a great deal about the evocativeness of mathematical imagery in poetry.⁴⁶⁴

Non-Euclidean geometry, parallel lines and multiplicity

Twentieth-century discoveries in mathematics were not the first shock to the modern mathematical system. As discussed in previous chapters, in the early nineteenth century mathematics underwent an upheaval with the discovery by the Russian Nikolai Lobachevsky and Hungarian János Bolyai of ‘non-Euclidean geometries’.⁴⁶⁵ The new geometries gave rise to interpretations of multiply-possible worlds, and to a universe or universes at odds with a hitherto held view of unique anthropocentricism. This multiplicity is present in “Path” (1969), where Herbert acknowledges that it may be possible after all to combine multiplicity and unity, specificity and abstraction:

ŚCIEŻKA
[...]
Czy naprawdę nie można mieć zarazem
źródła i wzgórza idei i liścia
i przelać wielość bez szatańskich pieców
ciemnej alchemii zbyt jasnej abstrakcji ⁴⁶⁶

In this case, Herbert embraces multiplicity but, in keeping with what I have already discussed, he remains ambivalent towards what he considers ‘too much’ clarity and abstraction.

Mathematically, the descriptions of the existence of non-Euclidean geometries derived from a negation of Euclid’s so-called ‘parallel postulate’, that only one unique line can be drawn

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⁴⁶⁴ Heisenberg visited Poland in 1943, delivering a talk in German-occupied Krakow on quantum physics to German scientists at the invitation of the notoriously brutal Nazi Governor, Hans Frank. This visit was uncovered relatively recently, in 2004: Bernstein, “Heisenberg in Poland”; Gottstein, “Comment on ‘Heisenberg in Poland’ by Jeremy Bernstein.” While criticism of Heisenberg’s other dealings with the Third Reich has been around for a long time, there is no evidence that in 1961 Herbert would have been aware of it. (For an interesting and nuanced discussion of Heisenberg’s more general interactions with Third Reich powers see Cassidy, “Heisenberg, German Science, and the Third Reich.”)

⁴⁶⁵ Non-Euclidean geometries have been discussed in all three preceding chapters.

⁴⁶⁶ Herbert, *Wiersze zebrane*, 325. First published in 1969 in *Napis*. Translated by John and Bogdana Carpenter in Herbert, *Selected Poems*, 1977, 13.

PATH
[...]
Is it truly impossible to have at the same time
the source and the hill the idea and the leaf
and to pour multiplicity without devils’ ovens
of dark alchemy of too clear an abstraction

Valles translates *wielość* as ‘plurality’ (Herbert, *The Collected Poems*, 232). I prefer ‘multiplicity’ with its more complex connotations of multi-facetedness. In Polish, *wielościán* is a polyhedron.

though a given point and parallel to another given line, or alternatively that in other cases a line might never be parallel to another.

Reference to ‘parallel lines’ can therefore to a modern writer or reader denote an awareness of an unsettling new interpretation of existence. That parallel lines might in some possible world meet, is strongly suggested in Herbert’s “Elegy” (1990), examined earlier; at least in the Carpenter translation. The Polish original, more literally translated by Alissa Valles, is less explicit, but it is plausible to assert that Herbert may nonetheless have assumed that his Polish readers would have understood the implications of ‘parallel lines’. Miłosz, for example, in his wartime poem “Song of a Citizen”, which depicts the devastation of the Warsaw ghetto, makes explicit reference to the uncertainties inherent in non-Euclidean geometry.

In 1983 Herbert published “In Memoriam Nagy László”, a poem dedicated to his Hungarian translator and poet.⁴⁶⁷ Herbert and László never met, and Herbert reflects on the relationship, which was physically distant, but in other respects – as one poet thinking about another’s deepest thoughts – close:

IN MEMORIAM NAGY LÁSZLÓ
[...]
przestrzeń która nas dzieli jest jak całun
[...]
nasze dalsze współżycie ułoży się zapewne
more geometrico – dwie proste równoległe
pozaziemska cierpliwość i nieludzka wierność ⁴⁶⁸

The *more geometrico* directly recalls Sponzoza’s work on ethics, *Ethica Ordine Geometrico Demonstrata* or *Ethica More Geometrico Demonstrata*, that is, God’s laws according to a logical, ‘geometric’ pattern. Given the preceding discussion, it is questionable whether Herbert in fact embraced such a view of ethics. While it was tempting, particularly in light of Miłosz, to see the reference to parallel lines in “Elegy” as an acknowledgement of modern geometries, it is difficult to justify such an interpretation in this case. The word ‘parallel’ (*równoległe*) was not

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⁴⁶⁷ That Laszlo was one of Herbert’s translators is noted in Herbert, *The Collected Poems*, 577, notes; Herbert, *Wiersze zebrane*, 745, notes.

⁴⁶⁸ Herbert, *Wiersze zebrane*, 463. First published in 1983, in *Raport z oblężonego miasta*. Translated by Alissa Valles in Herbert, *The Collected Poems*, 355.

IN MEMORIAM NAGY LÁSZLÓ
[...]
the space dividing us is like a shroud
[...]
our further life together will no doubt take shape
more geometrico – two unbending parallel lines
unearthly patience and inhuman fidelity

even present in Herbert's drafts: the lines were simply 'straight' (*proste*), with the parallel configuration implicit in an earlier alternative title of this poem, "Tren" ('Train').⁴⁶⁹ The mathematical reference would appear, in this case, to be a relatively straightforward one of geometric rules and perceived inevitability through universal laws.⁴⁷⁰

A Scientific Theory of Poetry

I end with a poem by Herbert, "Georg Heym – the Almost Metaphysical Adventure" (1971), that is most explicit about the impact on poetics of notions from modern physics such as simultaneity, non-causality, non-determinism:

GEORG HEYM – PRZYGODA PRAWIE METAFIZYCZNA

Jeśli jest prawda
że obraz wyprzedza myśl
można mniemać
[...]
był tu i tam
krążył wokół ruchomego centrum
[...]
- względność ruchu
lustrzane przenikanie układów
[...]
- obalenie determinizmu
cudowna koegzystencja możliwości

- moja wielkość –
[...]
polega na odkryciu
że w świecie współczesnym
nie ma wynikania
tyranii następstw
dyktatury związków przyczynowych

wszystkie myśli
działania
przedmioty
zjawiska
leżą obok siebie
jak ślady łyżew
na białej
powierzchni

stwierdzenie ważne
dla fizyki teoretycznej
stwierdzenie groźne

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⁴⁶⁹ Herbert, "Utwory Zbigniewa Herberta," Box 17846, folder 1, notebook VIII/10, 74–77.

⁴⁷⁰ Note further that Valles's translation inadvertently adds to a mathematical flavour in the 'take shape': the original Polish *ułożyć się* could just as well be translated 'arrange itself' or 'work out'.

dla teorii poezji ⁴⁷¹
[...]

Here the Herbert papers held in the National Library at Warsaw are particularly enlightening. Under the handwritten draft of “Georg Heym” Herbert has copied out two citations, the first from Heym himself: *Es gibt wenig Nacheinander. Das meiste liegt in einer Ebene. Es ist alles ein Nebeneinander.*⁴⁷² The second quotation is from Cato the elder: *rem tenere verba*

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⁴⁷¹ Herbert, *Wiersze zebrane*, 422–24. First published in 1971 in the journal *Twórczość*, then in 1974 in *Pan Cogito*. Georg Heym was a German expressionist writer who died in an ice-skating accident. Translated by John and Bogdana Carpenter in Herbert, *Selected Poems*, 1977, 54–57.

GEORG HEYM – THE ALMOST METAPHYSICAL ADVENTURE

If it is true
an image precedes thought
one would believe
[...]
he was there and here
he circled around the moving centre
[...]
– the relativity of movement
mirror-like interpenetration of systems
[...]
the overthrow of determinism
marvellous coexistence of possibilities

– my greatness –
[...]
is based on the discovery
that in the contemporary world
there are no direct results
no tyranny of sequence
dictatorship of causality
all thoughts
actions
objects
phenomena
lie side by side
like the traces of skates
on a white surface

a weighty assertion
for theoretical physics
a dangerous assertion
for the theory of poetry
[...]

Względności (third stanza here) is the standard term used in Polish for (Einsteinian) relativity. Valles translates *następstw* (sixth stanza here) not as ‘sequence’ but as ‘consequences’, which is appropriate in this case, since a mathematical ‘sequence’ in Polish is usually denoted by *ciąg*.

⁴⁷² Herbert, “Utwory Zbigniewa Herberta,” Box 17845, folder 1, notes, 115.

There is not much after-one-another. Most things lie in a plane. Everything is a next-to-one-another.

Heym is probably responding to Gotthold Lessing’s distinction between poetry (which for him renders the *nacheinander*) and painting (the *nebeneinander*). Lessing was in turn arguing against Horace’s *ut pictura poesis*, which argues that poetry should be rendered like painting, see note 687 in Chapter 5. So Heym is in fact commenting

sequentur.⁴⁷³ A third note makes a very brief and scribbled reference to the Romanian philosopher Mircea Eliade, and the evolution of society and religion.

What might Herbert have been thinking about with these three references? In the first one, Heym is indirectly questioning causality, and this has been very clearly translated by Herbert into his poem.⁴⁷⁴ As for the second by Cato, is Herbert reflecting that Cato's maxim becomes impossible in the poetics described by Herbert/Heym? In Cato's poetics, the subject comes first; whereas the 'danger' of modern metaphysical poetry as referred to in Herbert's last stanza is perhaps that neither the image nor the thought nor the writing precede one or the other: they all coexist.

I would not have thought such a concept would unnerve Herbert unduly, but perhaps it does because he sees poetry's role as essentially to comment on human behaviour and the human condition, implying in particular human responsibility, something out of keeping with a fundamentally acausal metaphysics. The Eliade reference in my opinion underscores Herbert's belief in some kind of social purpose to poetics.

In "Georg Heym" Herbert has made a very explicit connection between modern mathematics – or more precisely theoretical physics – and poetry. He explicitly acknowledges the relativity, coexistence and multiplicity inherent in modern science, but interestingly retains clear misgivings as to any application to poetry. Herbert's theory of poetry rests on human ethics, and so the 'dangerous assertion' is that the human is in fact not central. The result, for me, is an engaging poem, made all the more engaging as it fits within a greater 'web' of other poems that slowly weave together and build up an aggregation of disparate poetic images emanating from mathematical concepts.

Concluding remarks: 'a dangerous assertion for the theory of poetry'

Zbigniew Herbert lived through major social and political upheavals in Poland: the Nazi occupation during the Second World War, the Holocaust, and Soviet socialist rule. He was a political poet, preoccupied with his time, human morality and the truthful representation of the human condition in his time. He was not a mathematical poet by design, and expressed no particular affinity for the subject. Yet he was trained in related areas that prompt ways of

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that his preference lies firmly for painting (the *nebeneinander*). See further in Lessing, *Laocoon: An Essay on the Limits of Painting and Poetry*; Bridgwater, *Poet of Expressionist Berlin: The Life and Work of Georg Heym*.

⁴⁷³ Herbert, "Utwory Zbigniewa Herberta," Box 17845, folder 1, notes, 115.

Grasp the subject and the words will follow.

⁴⁷⁴ I did initially wonder whether *nacheinander* might also refer to 'sequence' in the mathematical sense. It can do, but mathematical 'sequence' in German is *folge* or *sequenz*, so not directly denoted here.

perceiving and thinking of the world that do have clear affinities with mathematics, namely architecture, technical drawing, finance and economics.

His economics studies in particular exposed him to the ‘scientist’ approach in socialist thinking, and Herbert sustained a long-held distrust of scientific determinism and the hypocrisy of a manipulated state and society that he experienced at first-hand.

As a writer, he was confronted with the need to act as witness to his society while both maintaining a degree of objective distance in order to describe, and at the same time participating in and engaging with that same society in which he lived. This duality is particularly evident in his use of metaphor, where it is a culmination of and eventual compromise with the tension inherent in language. On the one hand, metaphor succeeds in overcoming restriction precisely because it hints and therefore is unbounded. On the other hand, metaphor can be an acknowledgement that language is not always sufficiently descriptive in its direct form, as exemplified at its worst by clichés of courage as a lion.⁴⁷⁵

Mathematics and poetry amply represent these same tensions. Mathematics, as Herbert often portrays it, is a distant and objective language, whereas poetry is inherently participatory. At the same time, the two feed on one another, and – as I have discussed – move in and out of a relationship which hints at greater potential identification.

Herbert’s poetry confronts a tension between abstraction and an empirical concreteness, and between reality and idealism, as well as the tensions within the role and limitations of poetic language in describing his own and an external world, and within the (alarming, but on occasion sought after) concept of morality as an absolute certainty. These concerns are apparent across Herbert’s poetry, including those poems that touch on mathematics, pure and applied.

Many of the poems that touch on mathematics depict it as cold and impersonal, and suggest its practitioners are unable to use language for any purpose beyond methodical counting. The mathematician lacks the qualities that a poet employs – the full and intricate use of words that render complex human feeling, and ‘speak to the imagination’ in a way that numbers and geometrical lines and figures do not. Abstraction is amoral, concepts such as infinity and zero are at odds with the humanism of Herbert’s poetics; constructivist mathematical-linguistics are little more than a basis for poetics, and mathematics as a whole is devoid of human ethical thinking.

Such an impoverished view of mathematics is not wholly sustained however. In later poems Herbert returns to these same features of mathematics and acknowledges their own

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⁴⁷⁵ See note 415.

duality and deeper potential. He lauds the capacity of mathematical accuracy to provide precision, in counterbalance to what can be too much vagueness in human concerns, and reflects that poetry may also fail to provide moral weight. In associating mathematics with music, Herbert opens up an interpretation of mathematics that, like music, may be ordered and abstract, but is far from sterile and univocal. Eventually he engages with modern mathematics, particularly in its well-known applications to theoretical physics, and reflects that mathematics' demonstrated concepts of uncertainty, incompleteness, relativity, multiplicity and intrinsic ambivalence at the very least speak to human understanding in a way that was unacknowledged in traditional, simple, views of arithmetic. Finally, Herbert turns to universal laws in theoretical physics as a solace for human existence.

However, it is never clear to what extent Herbert was consciously and deliberately engaging with the intricacies of mathematics: at times it seems almost accidental, as if in thinking as deeply about the world as he did, he inadvertently found himself on the evocative edges of a more conscious connection between mathematics and poetics. Certainly, in the one poem "Georg Heym", where Herbert very explicitly links the two, his reaction to the thought that poetry might respond to scientific theory, leaves him deeply concerned.

I consider that Herbert fits beautifully into a series, or web, of 'mathematical poets'. His understanding of modern mathematics extends far deeper into his poetic works than Milosz's, who engaged with mathematics and science largely only in his prose, yet at the same time Herbert's engagement is impressionistic and far from 'scientific' in its multiple layers of almost fleeting encounters. While often only hinting at an comprehension that mathematics, like poetry, can be creative and imaginative, his poetry is deeply appealing.

Verley

Human beings
we are pretty much in control
consciousness belongs to us

Koschitz zu Magdalena

Vomosi: jak doznani ni kłose
kózz, bófi, brant : brel
kamei : gwatko
Złota zynofort
Tule spelmieci
milkzemi
tylko wille
rappineci
milkzemi kóze

Zbigniew Herbert in company with leading members of *Solidarność*, summer of 1981, preceding the imposition of Martial law in Poland that winter. (*Gazeta Wyborcza* archives)

Zbigniew Herbert in later years (http://www.pwf.cz/archivy/texts/cafe-central/zbigniew-herbert-a-knocker_8368.html)

CHAPTER FIVE

Ion Barbu's "Ut algebra poesis": the Mathematical Poetics of Dan Barbilian⁴⁷⁶

MOD

Te smulgi cu zugrăviții, scris în zid,
La gama turelor acelor locuri,
Întreci orașul pietrei, limpezit
De roua harului arzând pe blocuri.

O, ceasuri verticale, frunți târzii !
Cer simplu, timpul. Dimensiunea, două ;
Iar sufletul impur, în calorii,
Și ochiul, unghi și lumea-aceasta - nouă.

- Înaltă în vint te frânge, să mă aștern
O, iarba mea din toate mai frumoasă.
Noroasa pata-aceasta de infern !
Dar ceasul - sus ; trec valea răcoroasă.

Ion Barbu ⁴⁷⁷

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⁴⁷⁶ An abbreviated version of this chapter is in press: Kempthorne, Loveday, "Ut Algebra Poesis: Dan Barbilian and the Application of a Mathematical Method to Poetics." "Ut algebra poesis" is the title of a semi-autobiographical poem by Barbu, see note 683.

⁴⁷⁷ Barbu, *Poezii*, 166. See note 669 for translation into English.

Unless otherwise stated, all translations from Romanian into English in this chapter are my own, with the assistance of Romanian native-speaker Alina Savin. They are intended as a study guide only. Very little of Barbilian's work has been translated into English, with rather more translated into French, including the entire collection *Joc secund*. On the matter of the few translations into English, refer personal correspondence Mugur to Kempthorne, "Re: Ion Barbu and Nina Cassian." Likewise, in a 2007 letter to the Romanian literary review, *Istorie Literară*, Solomon Marcus noted that very little of Barbu's poetry had been translated into English, and so drew attention to Sarah Glaz's recent translation in *American Mathematical Monthly* of Barbu's "Ut Algebra Poesis" (see note 683): Marcus, "O poezie de Ion Barbu într-o revistă americană de matematică." The two complete translations into French of *Joc secund* that I have consulted for my own translations are by Yvonne Stratt (1974) and Constantin Frosin (1956). Barbu, *Joc Secund Jeu Second*; Barbu, *Poeme / Poèmes*. Both were published by Romanian publishing houses, each collection with a mix of more and less lyrical and literal translations. I have found both styles illuminating, but for the purposes of this thesis have preferred a more literal approach, with the result that the strong rhythm and rhyme of the original has largely been lost.

Abstract

Dan Barbilian (1895-1961) was a Romanian Professor of Algebra at Bucharest University who, under the name Ion Barbu, published highly acclaimed poetry that is still today included in the canons of Romanian literature. His last and major publication of poetry was in 1930, and for the following thirty years he devoted his professional time to mathematics, claiming that he was unable successfully to combine both fields and that poetry had got the better of him. He continued, however, to develop and write about his theory of poetics, seeking to articulate an ‘axiomatisation’ of poetry in a universally representative ‘pure’ form. His method was inspired and informed by contemporary advances in mathematics, notably the development of algebraic group theory and formal attempts to systematise and unify hitherto disparate areas of research across several fields of pure mathematics. He eventually extended his theory of poetics into a view that mathematics – properly and creatively understood – should form the base of all human learning.

This chapter examines Barbilian’s theory of a mathematical poetics, demonstrating how mathematics and poetry interact in the mind of one individual seriously engaged in both fields.

Introduction: the Mathematical Zeitgeist of 1920s Göttingen

Ion Barbu was born Dan Barbilian in 1895 at Câmpulung in northern Romania.⁴⁷⁸ He studied mathematics at school and, although not always an outstanding student, at around the age of 14 he moved without his parents (not uncommon for the time) to a mathematics secondary school in Bucharest, where he did not always concentrate on his studies, and began

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⁴⁷⁸ Much of the existing commentary of Barbilian/Barbu is written from a literary perspective, and refers to him as Barbu. In this article I usually refer to him by the name under which he originally published. While not always consistent, in most cases, this was Dan Barbilian, aside from the primary poems and poetry collections themselves, in which case he is Ion Barbu.

The first full study of Barbu the poet was published in 1935 by his close friend the literary critic Tudor Vianu: Vianu, *Ion Barbu*. In English see the full-length 1981 study (first published as an English translation in the US, then later published in its original Romanian in 1996): Cioranescu, *Ion Barbu*. The majority of later accounts draw on these sources for their biographical detail. A highly regarded more recent work is Petrescu, *Ion Barbu și poezia postmodernismului*.

using narcotics.⁴⁷⁹ At age 15, he won a competition in the Romanian *Gazeta Matematică*.⁴⁸⁰ In 1914 he began university studies in Bucharest. He was conscripted into the Romanian army during the First World War, but avoided active service. He published his first poems in 1918 under the name Ion Barbu, an ancestral form of his own family name. He completed his undergraduate degree, in mathematics, in 1921 and that same year published his first, small, poetry booklet *După melci* (In the manner of snails). In 1922 Barbilian won a doctoral grant to study number theory under Edmund Landau at Göttingen.

As discussed in chapter 1, the early twentieth century was a highpoint of a modernist transformation in mathematics, associated with a more rigorous, formalist and abstract approach to the discipline. Göttingen itself was a great centre of modern mathematics, led in Barbilian's time there by the highly influential mathematician David Hilbert.

In his later prose works, Barbilian pays homage to a number of eminent Göttingen mathematicians.⁴⁸¹ One of the earliest is Carl Friedrich Gauss (1777-1855).⁴⁸² Gauss made significant contributions in a number of fields, including in number theory – which Barbilian initially went to study at Göttingen – as well as in algebra and differential geometry. As Barbilian himself notes, Gauss is now known to have formulated a concept of non-Euclidean geometry before Lobachevsky and Bolyai, but he hesitated to publish.⁴⁸³ Indeed Gauss was well-known for his considered and often very brief final product, in which much of the preliminary working was omitted.⁴⁸⁴ It is this style to which Barbilian draws particular attention, attributing to him the adage:

un minim de formule oarbe unit cu un maxim de idei vizionare.⁴⁸⁵

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⁴⁷⁹ The motivations behind Barbilian's turn to drug use are not clear, but later remarks on an 'ecstatic' state induced by certain fields of higher mathematics, which Barbilian likens directly to opiates, are suggestive: see note 496. Regardless, Barbilian was apparently troubled through much of his adolescence, with erratic behaviour that was sometimes markedly antisocial. He also had very little money to live on, and opiates were cheap at the time. See Cioranescu, *Ion Barbu*, 18–26.

⁴⁸⁰ Barbilian's early publication in *Gazeta Matematică* is often cited by his biographers as an indication of remarkable mathematical talent, which it is. Notwithstanding, as mentioned already in chapter 1, the main purpose of *Gazeta Matematică* was to attract high school students into a mathematics career, and so Barbilian's publication therefore remains noteworthy, but is not quite as precocious as some accounts imply.

⁴⁸¹ Barbilian's collected prose writings were compiled in 1968 by Dinu Pillat as *Pagini de Proză*. Pillat's collection was the first to unearth and bring together some quite disparate items, including, for example, previously unpublished professional notes from Bucharest University. Pillat was also a student of the Romanian mathematician Solomon Marcus, see note 644.

⁴⁸² Excellent histories of Göttingen mathematicians can be found in Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*. See also chapter 1.

⁴⁸³ See chapter 1 on non-Euclidean geometry. On the exact nature and timing of Gauss's contribution and non-publication in the development of non-Euclidean geometries, see Gray, *Plato's Ghost*, 45.

⁴⁸⁴ Gauss's renowned *Disquisitiones Arithmeticae* explores his commitment to brevity.

⁴⁸⁵ "A minimum of blind formulae combined with a maximum of visionary ideas."

In fact it was Minkowski who first said this in reference to Dirichlet, both of whom were at Göttingen. Gustav Dirichlet (1805-1859) was first a student of and then succeeded Gauss in number theory and analysis, and Hermann Minkowski (1864-1909), born in then Polish Lithuania, is remembered for his relativistic distance metric.

For Barbilian this encapsulates not only Gauss's style, but it also touches on deeper issues around the dismissal of formulae in favour of broader conceptual ideas in mathematics, which becomes a recurring theme for Barbilian.⁴⁸⁶ In the case of Gauss, he explicitly links this style to the arts:

Am pomenit de ermetismul teoremelor lui Gauss. El derivă dintr-o anumită concepție a artei teoremei, pe care Gauss o vedea ca un text august, ca o inscripție, al cărei laconism e însăși garanția durabilității ei.⁴⁸⁷

This citation is interesting, since it immediately suggests a two-way relationship between mathematics and poetry: Hermeticism is a quality or type of poetry which Barbu himself ascribes to his later work, particularly *Joc secund*.⁴⁸⁸

Another mathematician frequently mentioned by Barbilian is Bernhard Riemann (1826-1866). Riemann studied under Gauss and, like him, made lasting contributions to analysis and number theory. His legacy is perhaps most profound in the area of differential geometry and he devised one of the first metrics for non-Euclidean geometry, thereby finally giving credence to the hitherto less widely adopted innovations of Bolyai and Lobachevsky.⁴⁸⁹ The Riemannian metric was essential in the formulation by Einstein of relativity theory. In this respect Riemann is closely associated with the move in mathematics towards conceptual thought, arguing for a reformulation of geometry as being about spaces, and he became one of the most important figures of the Göttingen group. Having been taught by Gauss, Riemann in turn taught Felix Klein.

Felix Klein (1849-1925) is noteworthy, among other things, for his work towards unifying mathematics, by combining group theory with geometry in what forms part of the so-called Erlangen Programme. The Erlangen Programme was first articulated by Klein in an 1871 pamphlet where he spoke about the importance of developing pure and applied mathematics together, of maintaining the connections between various fields of knowledge, and set out systematised directions of geometrical research, feeling that work in geometry had

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Cited by Barbilian in "Carl Friedrich Gauss", first published in *Gazetă Matematică*, May 1955. See Barbu, *Pagini de proză*, 192.

⁴⁸⁶ See note 542.

⁴⁸⁷ Barbu, *Joc secund*, xvi.

I have noted Gauss's hermeticism in his theorems. This derives from a particular concept in art theory, by which Gauss sees that a wise text, like an inscription, is brief and it is this that guarantees its durability.

⁴⁸⁸ See note 566.

⁴⁸⁹ Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*, 137. Gray, *Plato's Ghost*, 18. See also chapter 1.

become too fragmented. Klein laments that critics had too literally interpreted ‘measure of curvature’ to be a concrete property of space. Using the hitherto little-known field of group theory, Klein demonstrated that geometry can be viewed as the properties of space invariant under a given group of transformations, and so introduced the notion of projective geometry as a means to correct misassumptions and better to conceive of non-Euclidean geometry. The often-depicted “Klein bottle” is a depiction of such a space.⁴⁹⁰

By the time Barbilian arrived in Göttingen in the 1920s, the Erlangen Programme had acquired an almost legendary status, and its manifesto had been widely translated from the German into English, French, Polish, Russian and Italian. Barbilian clearly states his indebtedness to the Programme, explicitly likening it to his poetic approach:

Personal mă consider un reprezentant al programului de la Erlangen, al acelei mișcări de idei care [...] poate fi asemuit Discursului Metodei sau Reformei însăși. Specializării strâmte ori tehnicității opace, de dinainte de Erlangen, se substituie un eclectism luminat. El continuă adâncirea fiecărei teorii în parte, fără să piardă din vedere omogenitatea și unitatea întregului. Astfel cercetarea matematică majoră primește o organizare și orientare învecinate cu aceea a funcțiunii poetice, care, apropiind prin metaforă elemente disjuncte, desfășură structura identică a universului sensibil. La fel, prin fundarea axiomatică sau grupul-teoretică, matematicile asimilează doctrinele diverse și slujesc scopul ridicat de a instrui de unitatea universului moral al conceptelor. În acest chip ele încetează de a mai fi o laborioasă barbarie ci, participând la desăvârșirea figurii armonioase a lumii, devin umanismul cel nou.⁴⁹¹

On inspection, this is a richly comprehensive remark and over the course of this chapter I examine its various aspects. Barbilian’s conception of a universe describable through unified theories captures much of what for him relates poetry with mathematics, and his reflections on metaphor as a means of bringing together otherwise disparate terms and concepts are particularly interesting. Under Klein, Göttingen became a focus of science within

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⁴⁹⁰ Gray, *Plato’s Ghost*, 116–117.

⁴⁹¹ Barbu, *Pagini de proză*, 160–161. From ‘Autobiografia omului de știință’, in *Notă asupra lucrărilor științifice*, Bucharest 1940:

I personally consider myself a representative of the Erlangen Programme, that movement of ideas that [...] can be compared with the Discourse on the Method [Descartes] or with the Reformation itself. The Erlangen Programme substitutes narrow and technical specialisations for illuminating eclecticism. It pursues the depth of each theory, while not losing sight of a unified and homogenous whole. Thus, major mathematical research attains an organisation and orientation close to the poetical function, which, by approaching through metaphor disjoint terms, lays out the identical structure of the perceivable universe. Similarly, through axiomatic or group-theoretic foundations, mathematics assimilates diverse doctrines and serves a higher purpose of instructing us on the unity of the moral universe of concepts. In this way, it [mathematics] ceases being a laborious barbarism and, participating in the perfection of a harmonious image of the world, becomes the new humanism.

Translation (modified) taken from Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 30.

Germany and one of the world's leading mathematical centres; it was he who appointed David Hilbert to Göttingen.⁴⁹²

David Hilbert (1862-1943) led significant advances in various fields in mathematics, including invariant theory, functional analysis and set theory. In 1899 he published *Grundlagen der Geometrie* (Foundations of Geometry), which, building on the work of his predecessors, set out a new and axiomatic approach to the field.⁴⁹³ Prompted by Euclid's geometry and the realisation through non-Euclidean geometry that different axiomatic formulations could be independently consistent, Hilbert was the first to construct a complete and axiomatic system for Euclidean and hyperbolic geometries (in which the angles in a triangle sum to less than two right angles).

In 1900 at the International Congress of Mathematicians Hilbert put forward a list of some 23 unsolved problems in mathematics, thereby setting the direction of much mathematical research over the next century. Hilbert was committed to developing a new rigour in mathematical methods, and became one of the founders of proof theory and mathematical logic and of formalism in mathematics, characterised by its abstract focus on symbols and formal rules, entailing a shift of its foundations towards syntax and away from semantics. Conceived in this manner, Hilbert's ultimate axiomatic goal was eventually demonstrated by the Austrian mathematician, Kurt Gödel, to be impossible (or at least with inherent limitations), but the formalist approach to mathematics begun by Hilbert remained fruitful and influential.⁴⁹⁴

Barbilian attended Hilbert's lectures at Göttingen and developed a deep admiration for him and his work, praising his 'purely logical foundation to mathematics'.⁴⁹⁵ When Hilbert died in 1943, Barbilian praised his method of demonstration, proof and his invention of

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⁴⁹² Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*, 783.

⁴⁹³ In this area, Hilbert built on the work in particular of several other key mathematicians: Julius Dedekind (1831-1916), a student of Gauss, Dirichlet and Riemann at Göttingen, who later moved to Brunswick and specialised in number theory; Giuseppe Peano (1858-1932), who worked closely with Dedekind and spent his career at Turin in Italy, developing systems of notations and symbols that would avoid the uncertainties of language and geometry – Peano also tried to invent a 'perfect' language, in a similar fashion to the better known Esperanto; and Moritz Pasch (1843-1930) who came from Breslau (now Wrocław in Poland), taught at Giessen, and published an influential treatise on projective geometry. See Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*; Gray, *Plato's Ghost*.

⁴⁹⁴ Kurt Gödel (1906-1978) published his 'incompleteness theorems' in 1931, a year after Barbu published his final collection of poetry. Gödel raises issues of truth and provability in mathematics, and was a pioneer in analysing semantics as opposed to syntax. Gödel was considered by Barbilian to be the logical successor of much of what the earlier mathematicians had accomplished. Aware of the contradictions, Barbilian singles out Gödel among Hilbert's 'successors', in cementing the axiomatic approach.

⁴⁹⁵ From a letter written in 1921 from Barbilian to his supervisor, Țițeica, cited in Boskoff, Dao, and Suceavă, "From Felix Klein's Erlangen Program to Secondary Game," 19.

‘systems’ above discoveries in any particular field. He asserted that Hilbert had been seeking in mathematics a highest status for geometry (*starea de geometrie*), likening this to the search for an ultimate opiate (*opiu*).⁴⁹⁶

The most recent Göttingen mathematician frequently mentioned by Barbilian is Emmy Noether (1882-1935), one of the most important women in mathematical history.⁴⁹⁷ Born in Erlangen, Germany, she was invited to Göttingen by Klein and Hilbert, where, as a woman, she was initially obliged by the university to teach under Hilbert’s name. She was a founder of modern abstract algebra, particularly group theory, and led efforts to incorporate algebra into all fields of mathematics. Noether’s conservation theorems demonstrate that within a system, the conserved properties – for example energy – correspond to symmetries in the mathematical (group-theoretic) construction of that system. Her theorems have become fundamental to both Newtonian and quantum mechanics. She was particularly interested in ring theory and the behaviour of ideals, homomorphisms and isomorphisms. Noether’s work in the establishment of structural algebra was in turn taken up most notably by the French Bourbaki, notably Alexander Grothendieck, a contributor to the *Séminaire Bourbaki* in the 1950s and 1960s, whose work on homological algebra and category theory remains influential today.⁴⁹⁸

Barbilian took a particular interest in group theory and, along with Hilbert’s, Noether’s classes were the ones he most attended and respected at Göttingen.⁴⁹⁹ The poem “Ut algebra poesis”, given to the title of this chapter, is in part an expression of his admiration for Noether’s work.⁵⁰⁰

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⁴⁹⁶ Obituary delivered to the Bucharest Mathematical Society, 3 May 1943. Barbu, *Pagini de proză*, 175.

⁴⁹⁷ On her death in 1935 Einstein wrote in the *New York Times*:

In the judgment of the most competent living mathematicians, Fräulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began.

Interestingly, in this same letter Einstein remarks:

Pure mathematics is, in its way, the poetry of logical ideas. One seeks the most general ideas of operation which will bring together in simple, logical and unified form the largest possible circle of formal relationships. In this effort toward logical beauty spiritual formulas are discovered necessary for the deeper penetration into the laws of nature.

Einstein, “Emmy Noether.”

⁴⁹⁸ The work of Bourbaki and their legacy, including influence in Romania, is discussed in chapter 1. See also note 665. Jeremy Gray describes Göttingen and Bourbaki as the ‘dynasties’ of structural mathematics, enduring from the early part of the century until well after the Second World War. Gray, *Plato’s Ghost*, 453. (Category Theory is returned to in the conclusion of this thesis.)

⁴⁹⁹ See Boskoff and Suceavă, “The History of Barbilian’s Metrization Procedure,” 3. This interest in group theory and the work of Klein entailed an interest in non-Euclidean geometry, as noted in Bantaş and Brânzei, “Dan Barbilian-fereastră de înțelegere a lui Ion Barbu.” The authors do not explicitly mention it, but it is interesting that one of the founders of non-Euclidean geometry was the Transylvanian Janos Bolyai, from Cluj in present-day Romania.

⁵⁰⁰ Opening with a reference to Gauss, and closing with Noether (hence in part my selection of mathematicians here), that poem is discussed at the end of this chapter: see note 683.

The work of the Göttingen mathematicians was central to longstanding discussions about the nature of mathematics, intuition (instinctive) versus deduction, truth and proof, symbols and notation, and generalised abstraction. It is notable that with very few exceptions, and despite the French influence more generally prevalent in Romanian mathematics, Barbilian demonstrates an almost exclusive concentration on the German school at Göttingen.⁵⁰¹ That is, of the major fields of mathematics operating in the first half of the twentieth century, Barbu aligns himself almost exclusively with developments in abstract algebra and geometry. Analysis and number theory he mentions only rarely, and indeed there is little evidence of these in his poems.⁵⁰² Indeed, one former mathematics colleague remarked that Barbilian took the axiomatic approach in mathematics to an ‘extreme’.⁵⁰³

Barbilian the adult mathematician

Barbilian did not complete his doctoral studies in Göttingen, and instead became immersed in German literary circles. In mid-1924 he returned to Romania, and initially spent some months in a Bucharest hospital being treated for a drug addiction and psychological illness. In 1925 he began to teach secondary school mathematics, along with his German wife, Gerda, who taught German literature. In 1929 he eventually received his doctorate from Bucharest University, in analytical geometry drawing on group theory: *Reprezentarea canonică a adunării funcțiilor ipereliptice: grupuri finite discontinue* (Canonical representations of hyperelliptic

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⁵⁰¹ The French influence on Romanian mathematics is discussed in chapter 1. The Göttingen dominance could be explained in part by the fact at the end of the 19th century, it was the Germans in particular, and far less so the French, who had developed a concerted interest in the place of mathematics and mathematicians in their country; it was this dominance that the French Bourbaki was trying to counter. However of far greater import, I believe, is that the very abstract nature of Göttingen algebra and geometry is what particularly appealed to Barbu.

⁵⁰² One exception is when Barbu discusses contemporary literary reform alongside mathematical reform, and using mathematical analysis as an example, compares the critical approach of Edgar Allan Poe with that of Euler, Lagrange and Laplace. Barbu’s argument is that Poe’s literary approach was nascent, in the way that Cauchy’s method of analysis was a precursor to, but had not yet arrived at an axiomatic foundation for mathematics. Barbu, *Pagini de proză*, 122–123. These comments on analysis are, however, rare in Barbu’s writings.

The two other mathematicians mentioned more than once by Barbilian, but not at great length, are Galois and Lie, both of them group theorists. See ‘Autobiografia omului de știință’, in *Notă asupra lucrărilor științifice*, in Ibid., 156–161. Évariste Galois (1811–1832) is a key figure in the foundations of group theory, which, combined with ideas of number fields, he used to answer fundamental questions about solutions of equations. Galois died young, following a duel near Paris. Sophus Lie (1842–1899) was a Norwegian who spent most of his career in Oslo and Leipzig, but briefly travelled to Göttingen where he met and began a long-term collaboration with Felix Klein. They later disagreed and fell out over Klein’s Erlangen Programme, whose focus on invariants Lie criticised. Lie initiated major advances in theories of transformation groups, now called Lie groups.

⁵⁰³ Gheorghe Șt. Andonie, cited by Pillat in Barbu, *Pagini de proză*, 28.

additive functions: finite discontinuous groups), under the tutelage of one of the founding members of the Romanian school of geometry, Gheorghe Țițeica.⁵⁰⁴

In 1930 Barbilian returned to full-time mathematics and joined the professional teaching staff at Bucharest University. His name has been given to a particular metric in non-Euclidean geometry that is an attempt to generalise projective geometry. He also later developed an axiomatic algebraic approach in ring theory, resulting in what some have termed “Barbilian spaces”.⁵⁰⁵ Barbilian first described his metric in 1934, in a paper presented at a German-language mathematics conference in Prague. Only two pages long, Barbilian’s style in this paper is quite descriptive, with little precise mathematical detail. He defines a metric construction using a logarithmic oscillation function, notes that this generates various geometries that are generalisations of Kleinian projective space, and then states four special cases such as the Poincaré disc in hyperbolic geometry.⁵⁰⁶

The first occasion that the spaces appear to have been termed “Barbilian” is in a 1938 monograph by L.M. Blumenthal, who was then at Princeton’s Institute for Advanced Study.⁵⁰⁷ Blumenthal devotes a full page to Barbilian spaces, expanding on Barbilian’s own brief description with more traditional mathematical precision. He observes:

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⁵⁰⁴ The development of a Romanian school of mathematics is discussed in chapter 1. Gheorghe Țițeica (1873–1939) was one of the first students of the influential mathematicians Haret and Emmanuel. Țițeica took his doctorate at the Sorbonne, where he made significant contributions in centro-affine and projective differential geometry. On return to Romania, he had a profound influence on the study of mathematics there in the late nineteenth and early twentieth centuries, particularly in establishing geometry. His close colleague and associate, Alexandru Myller, had taken his doctorate at Göttingen in differential geometry, and established the group of fundamental and group geometry at Iași: Teodorescu, “First Creators of the Romanian School of Mathematics”; Șt Andonie, *Istoria științelor în România*; Iacob, “The Solid Foundations of Tradition.”

⁵⁰⁵ The terminology around “Barbilian” metric and spaces is not consistent across the secondary literature and so can be confusing. Kelly, for example (see note 509), calls the metric “Barbilian geometry”, whereas “Barbilian spaces” refer to his later and relatively distinct work on the algebraic theory of geometry over rings. Barbilian himself never called the metric “Barbilian”; referring to it as “Apollonian”, a term that has also been picked up by others. (Apollonius was a Greek geometer whose work on mutually tangent circles was taken up by Descartes and then by group theorists, see Fuchs, “Strong Approximation in the Apollonian Group.”)

⁵⁰⁶ Barbilian, “Einordnung von Lobatschewsky’s Maßbestimmung in gewisse allgemeine Metrik der Jordanschen Bereiche.” (Classification of Lobachevsky’s metric in a generalised Jordanian space.) For a general description see Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 22. The Poincaré disc can be visually represented in many ways, with one of the most common being along the lines of:

<http://mathforum.org/sketchpad/gsp.gallery/poincare/poincare.html>

⁵⁰⁷ Blumenthal, *Distance Geometries; a Study of the Development of Abstract Metrics*, 13:27–28. Blumenthal was an American geometer and topologist based predominantly at Missouri, and from 1933 to 1936 was at Princeton’s Institute for Advanced Study (see Institute for Advanced Study, “Blumenthal, Leonard M.”). The Institute hosted a wide range of top mathematicians, and it is very possible that someone from the Institute, if not Blumenthal himself, would have attended the conference in Prague. Aside from this, there is no indication that Blumenthal had a personal connection with Barbilian; in fact it is unlikely. Boskoff and Suceavă credit Blumenthal with having ‘introduced’ the terminology of “Barbilian” spaces: Boskoff and Suceavă, “The History of Barbilian’s Metrization Procedure,” 3.

In a short note, containing no proofs, D. Barbilian introduced and stated some properties of the following interesting space:

Denote by K the subset of the plane interior to the simple, closed, plane curve J (the holomorph of a circle). To each pair of points A, B of K the number

$$d(A, B) = \log \left(\max_{P \in J} \frac{PA}{PB} \right) / \left(\min_{P \in J} \frac{PA}{PB} \right)$$

is attached, where PA, PB denote Euclidean distances. This expression, given by D. Barbilian for the distance of two points of K , can easily be put into the more convenient form:

$$d(A, B) = \max_{P, Q \in J} \log \left[\left(\frac{PA}{PB} \right) \left(\frac{QA}{QB} \right) \right]$$

[...] ⁵⁰⁸

Blumenthal goes on to give a short proof, remarking that the Barbilian space K reduces to the Poincaré model of the hyperbolic plane in the case where J is a circle.

Barbilian was unaware of this attribution and Blumenthal's work until a few years before his death, when in 1954 an article by the geometer Paul Kelly *specifically on Barbilian geometries* appeared in the *American Mathematical Monthly*. ⁵⁰⁹ In his article Kelly repeats Blumenthal's observation that Barbilian's 1934 paper was very short with no proofs, stating properties and only outlining results. Of the spaces themselves, Kelly remarks:

one of the stated properties is that a Barbilian space has a unique geodesic connection of each pair of its points when and only when it coincides with the Poincare [sic] model of hyperbolic geometry. From this point of view, general Barbilian spaces are not geometrically fruitful. However, it seems to the author that the Barbilian approach to the Poincare model has certain advantages of simplicity and generality. ⁵¹⁰

While not entirely complimentary about Barbilian's brevity of style, Kelly does praise the 'simplicity' and 'generality' of the Barbilian space, and goes on to examine and illustrate these advantages in his own paper.

Barbilian did not have access to Kelly's original article, only a review of it by Blumenthal. ⁵¹¹ But having been made aware of it, *Barbilian responded in 1959 by submitting two papers to the Romanian-language Studii și cercetări matematice (Mathematical studies and research), this time*

⁵⁰⁸ Blumenthal, *Distance Geometries; a Study of the Development of Abstract Metrics*, 13:27.

⁵⁰⁹ Kelly (a former student of Blumenthal) specifically credits Blumenthal's 1938 *Distance Geometries* for having pointed out the comparison between Barbilian, Hilbert and Poincaré and does not reference, nor indicate the existence of, any other work referring to them as Barbilian spaces: Kelly, "Barbilian Geometry and the Poincare Model," 315, notes.

⁵¹⁰ Ibid., 311. In a short appendix to a larger introductory-level text book published in 1981, Kelly continues to refer to "Barbilian geometries" 'defined by D. Barbilian in 1934' but still with no indication of how widespread the terminology is, beyond its use by Blumenthal: Kelly and Matthews, *The Non-Euclidean Hyperbolic Plane*, 319.

⁵¹¹ As observed in Boskoff and Suceavă, "Barbilian Spaces: The History of a Geometric Idea," 223. That said, Barbilian did develop his thinking on this metric in his lecture notes for students on elementary and descriptive geometry, during the 1930s. See Boskoff and Suceavă, "The History of Barbilian's Metrization Procedure," 8, note 2.

*elaborating significantly on his somewhat sketchy original paper from 1934 and emphasising the fact that the spaces are a generalised metrization procedure that can in some cases be reduced to a formal distance.*⁵¹²

Barbilian begins by explaining the hiatus from 1934 to 1959 in his work on ‘Barbilian’ spaces, noting the impact on him of the references in Blumenthal and Kelly. Referring to the 1934 paper, Barbilian remarks:

Since then, this topic was not in our [my] attention. But between 1934 and 1939 we have speculated a lot on this idea, without publishing anything. [...] the long article we have projected was not written in the end, due to the war and due to our change of interest toward algebra and number theory. [...] [R]econstructing [...] after the brief notes that we kept [w]e are able to see that the viewpoint of the 1934 generalization can be surpassed by far [...]⁵¹³

The paper continues:

Definition. Let K, J be two arbitrary sets and (PA) a function of the pair $P \in K, A \in J$ with real and positive values. We call (PA) the influence of the set K over the set J . The only hypothesis satisfied by the influence is the following: The extremum requirement. For $A, B \in J$ fixed and $P \in K$ variable, the ratio of influences $(PA) : (PB)$ reaches a maximum M (obviously finite and positive). This yields the following.

Consequence. The ratio of influences also reaches a minimum m . [...] Here are a few constructions of the requirement of extremum:

1. Our construction from Prague. K = a closed simple curve (Jordanian curve). J = the interior domain on K . The influence = the Euclidean distance (PA) .

[...]

which Barbilian successively refines to:

4. The new construction. K = a compact set in a topological space $T, K \subset T$, J = an arbitrary abstract set. The influence = a positive function $(PA), P \in K, A \in J$ continuous on K (with respect to P), but otherwise arbitrary.

[...]

Fundamental Theorem. Let (PA) be the influence of the set K over an arbitrary set J , satisfying the extremum requirement. Then, the logarithmic oscillation

$$AB = \log \frac{M}{m}$$

of the ratio of influences, $\frac{(PA)}{(PB)}$ with $A, B \in J$ fixed and $P \in K$ variable, defines in J a weak distance.⁵¹⁴

That is, Barbilian has provided a quite typical and concise mathematical exposition of a particular concept in modern geometry, constructing a generalised and abstract model for examination.

⁵¹² Barbilian, “Asupra unui principiu de metrizare.”

⁵¹³ This English translation is from Boskoff and Suceavă, “The History of Barbilian’s Metrization Procedure,” 4.

⁵¹⁴ Ibid., 6–7. (A ‘weak distance’ is what today is usually termed a pseudometric.)

In 1960 Blumenthal briefly reviewed Barbilian's new paper. Repeating his earlier assessment, he remarks that in 1934 Barbilian had:

introduced and stated without proof some properties of the metric space obtained by attaching to each two points a, b of the interior of a simple closed plane K the distance

$$d(a, b) = \max_{p, q \in K} \ln \left[\left(\frac{pa}{pb} \right) \left(\frac{qb}{qa} \right) \right]$$

The present [Barbilian's 1959] paper greatly extends this metrization procedure and investigates in detail the resulting space.⁵¹⁵

But apart from this very brief summary, Blumenthal makes no further comment.⁵¹⁶ Barbilian went on to publish two further papers on his metric in *Studii și cercetări matematice*, in 1960 and (posthumously) in 1962, which attracted some, if limited, attention.⁵¹⁷

His 1934 contribution is included in the heavily French-German centred history of the evolution of twentieth-century mathematics edited by Jean-Paul Pier, based on a colloquium held in Luxemburg in 1992.⁵¹⁸

Barbilian remarks that he had left his own metric on one side for more than twenty years, and this is certainly the case, but he did continue to publish in a loosely related area.⁵¹⁹ In 1940 and 1941, for example, he published two articles in the German-language *Jahresbericht der Deutschen Mathematiker-Vereinigung* (Annual Report of the German Mathematical Society) on projective planes using ring coordinates.⁵²⁰ This is a generalisation of projective geometry in an algebraic direction, compared with his earlier topological approach. Dutch mathematician Ferdinand Veldkamp observes that Barbilian is to be credited with initiating the 'systematic study of projective planes over large classes of associative rings'.⁵²¹ Veldkamp remarks,

⁵¹⁵ Blumenthal, "Sur un principe de metrisation" by Dan Barbilian," 1.

⁵¹⁶ This may well be because the original article itself was in Romanian, with only summaries in Russian and French. See: Barbilian, "Asupra unui principiu de metrizare," 112–116.

⁵¹⁷ In explanation, Boskoff and Suceavă remark that Barbilian chose to publish in Romanian, despite his fluency in other languages, that this would have hindered the dissemination of his ideas, also through his relative isolation behind the Iron Curtain, and hence 'disruption of personal and institutional contacts in academic life'. Notwithstanding, Boskoff and Suceavă describe an 'increased attention' to Barbilian spaces in recent years, listing some 5 authors (in addition to Boskoff and Suceavă themselves) across 17 publications: Boskoff and Suceavă, "The History of Barbilian's Metrization Procedure," 3. (In fact, these five authors all use Barbilian's preferred term, "Apollonian metric space", and do not call them "Barbilian spaces".) Suceavă has extended the mathematical work of Barbilian spaces in at least three other papers: Suceavă, Bogdan D., "Distances Generated by Barbilian's Metrization Procedure by Oscillation of Sublogarithmic Functions"; Boskoff, Ciucă, and Suceavă, "Distances Induced by Barbilian's Metrization Procedure"; Boskoff, Ciucă, and Suceavă, "Revisiting the Foundations of Barbilian's Metrization Procedure."

⁵¹⁸ "Guidelines" in Pier, *Development of Mathematics 1900-1950*, 20.

⁵¹⁹ Hence in some cases the confusion in terminology between "Barbilian spaces" and a "Barbilian metric", see note 505.

⁵²⁰ Barbilian, "Zur Axiomatik der projectiven ebenen Ringgeometrien." (Ring theory is a branch of abstract algebra building closely on group theory and, as remarked upon earlier, is particularly associated with the mathematician Emmy Noether.)

⁵²¹ Veldkamp, "Geometry over Rings," 1035.

however, that Barbilian's approach was possibly too general, that it mixed geometric axioms with algebraic and was 'rather unsatisfactory', with 'a number of difficulties which Barbilian could not overcome'.⁵²² Veldkamp sets out an approach that he hopes will deal with some of these issues, drawing on and extending Barbilian's own earlier work on metrics. In fact, Veldkamp returns to the Barbilian metric itself, noting that the terminology referring to a *Barbilian space* or *Barbilian plane* is not consistent, and so confusing in the existing literature. He consequently sets out his own definition for a Barbilian space and Barbilian domain.⁵²³

What is interesting about this 1940 paper in our context is that in the introduction to an otherwise entirely mathematical article on the axiomatic basis of projective ring geometry, Barbilian comments:

Genau wie in der Ästhetik das äußerst Lyrische als antipoetisch erkannt wird, so können wir mit Recht das äußerst Ideale als antigeometrisch erklären. Eine vernünftige Einschränkung des Ringbegriffes empfindet man für unsere geometrischen Grundlegungen als höchst notwendig.⁵²⁴

It is significant that in a purely mathematical paper Barbilian has inserted his views on poetry, assuming that the mathematical reader will understand the analogy. In doing so, Barbilian alludes to what will later transpire to be one of his poetic precepts, namely that the limitations in place defining allowable method and style are essential. Further, in keeping with his view on the unity of mathematics, Barbilian is at the same time deliberately mixing a geometric simile with an algebraic one. The paper goes on to describe how to build up a set of axioms for a certain type of algebraic geometric structure (projective ring geometry). Barbilian's introductory remark therefore hints at a theory of poetry constructed from well-defined axioms, and hence subject to certain rules.

In 1942 Barbilian was appointed full Professor.⁵²⁵ During his mathematics career he published some 80 research papers, primarily in axiomatic foundations and group-theoretic approaches to geometry, including on operator groups based on Kleinian topology; non-commutative algebras drawing on the work of Noether; axiomatic foundations and group-

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⁵²² Ibid.

⁵²³ Ibid., 1045, 1075, definitions 4.1, 12.2. These definitions draw on more recent developments in matrix theory, but essentially reflect the work of Kelly and Blumenthal, as well as Barbilian himself.

⁵²⁴ Barbilian, "Zur Axiomatik der projectiven ebenen Ringgeometrien," 179.

Just as in aesthetics the extremely lyrical is considered anti-poetic, so we can justly describe the extreme Ideal as anti-geometric. We feel that a reasonable restriction on the notion of a ring is of the utmost necessity for our geometric foundations.

My working translation. In ring theory, an *ideal* is a subset of elements with particular properties, namely that when operated upon by any other element of the larger set (ring), the result remains in the original ideal.

⁵²⁵ This promotion was due particularly to the help of Grigore Moisil, the first President of the Romanian Scientific Society (refer chapter 1), see Zamfir, "Căderea poetului."

theoretic geometry; ring theory, particularly as applied to projective geometry; and number theory (infinity of prime numbers).⁵²⁶ He died of liver cancer in 1961. Barbilian is counted among Romania's early prominent mathematicians.⁵²⁷ What is ever present in his mathematical work is a preoccupation with brevity, systematisation, an abstract and axiomatic (algebraic) approach to mathematics, alongside a fascination with modern forms of geometry and the eventual unification of both modern geometry and algebra into new mathematical discoveries and constructs. These characteristics contribute to his vision of a conjunction between mathematics and poetry.

Barbilian and his mathematical literary theory

Geometry meets poetry

In 1930 Barbu published his major collection, *Joc secund*, containing some 35 of his total output of around 100 poems, most of which had previously been published in various journals and literary newsletters. The collection met with widespread critical acclaim, and Barbu was rapidly deemed a pioneer in Romanian-language modernist poetics.⁵²⁸ After that, he did not publish any more poetry. Indeed, the year 1930 was also when he joined the mathematics staff at Bucharest. In one sense, those were the final words of Barbu the poet, but he continued to discuss and write about poetry and his mathematical poetic vision.

Mathematically, Barbilian regarded geometry as the pre-eminent field, identifying in it an abstract, systematic, rational and logical axiomatic approach.⁵²⁹ In 1927, he gave an interview in which he describes the mix of mathematician and poet within himself, repeatedly returning to an image of geometry to illustrate where the two intersect:

Mă stimez mai mult ca practicant al matematicelor și prea puțin ca poet, și numai atât cât poezia amintește de geometrie. Oricât ar părea de contradictorii acești doi termeni la prima vedere, există undeva, în domeniul înalt al geometrie, un loc luminos unde se întâlnește cu poezia.⁵³⁰

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⁵²⁶ Bantaș and Brânzei, "Dan Barbilian-fereastră de înțelegere a lui Ion Barbu." Refer also the searchable online collection of published articles and reviews American Mathematical Society, "MathSciNet: Mathematical Reviews." This has a good, even if partial, coverage of Barbilian's work published in Romanian.

⁵²⁷ Iacob lists some 20 or so second-generation prominent students of these early pioneers in Romanian mathematics, among whom Barbilian is one. Iacob, "The Solid Foundations of Tradition."

⁵²⁸ Boskoff and Suceavă, "The History of Barbilian's Metrization Procedure," 1.

⁵²⁹ As evidenced in the discussion of his mathematics, Barbilian was of course also an algebraist, but I argue that it is geometry that he held most dear, including to the extent of its development *through* algebraic methods.

⁵³⁰ Barbu, *Pagini de proză*, 39. From an interview with the critic I. Valerian (Valeriu Ionescu), first published as "Valerian : De Vorbă cu D-l Ion Barbu", *Viața literară*, 5 February 1927:

I consider myself more of a practitioner of mathematics and less of a poet, and that only insofar as poetry recalls geometry. No matter how contradictory these two terms might seem at first sight, there is somewhere in the high realm of geometry a bright spot where it meets poetry.

Here Barbilian demonstrates an almost spiritual conception of geometry and poetry as elevated forms of understanding, equally capable of expressing transcendent and abstract concepts. The implication that the two are ultimately interrelated, rather than say poetry being subject to mathematical influences, is significant, since it goes far beyond an understanding of ‘mathematical poetry’ which merely employs mathematical images to enrich a given insight or concept.⁵³¹ The timing is also interesting: in 1927 Barbilian was in the midst of what might have been considered his poetic period – his major collection *Joc secund* came out in 1930 – yet he was also by now teaching mathematics and probably working on his doctorate (completed in 1929). Here in early 1927, before the publication of *Joc secund*, Barbilian’s remarks suggest that he was already on the way to seeing his eventual calling as that of a mathematician.

In his interview Barbilian goes on to describe developments from Euclidean and non-Euclidean geometry as archetypical of mathematical progress, asserting that in the same way that Einstein developed and took inspiration from Euclidean geometry in imagining an abstract universe, so should others be similarly inspired, ‘in imagining possible worlds’.⁵³² As the interview continues, so a deeper impression emerges of what are the features of geometry that Barbilian considers so appealing:

Ca și în geometrie, înțeleg prin poezie o anumită simbolică pentru reprezentarea formelor posibile de existență. [...] Pentru mine poezia este o prelungire a geometriei, astfel încât, rămânând poet, n-am părăsit niciodată domeniul divin al geometriei.⁵³³

Barbilian sees both geometry and poetry as symbolic means of representing multiple forms of existence, coming together in mutually enriching moments. Geometry prompts in Barbilian a response that allows him to conceive of multiple possibilities, in a manner that for him is quite spiritual, or transcendent. The symbolism in poetry can have that same effect.

The mathematical references so far have been to geometry, but also by the late 1920s, mathematical work in unifying geometry and algebra, particularly through group theory, was well advanced. In 1927, Barbilian used an explicit algebraic metaphor to describe his preferred form of poetry, invoking invariant theory of groups:

Poezia trebuie să păstreze invariație față de anume grupuri de transformări verbale.⁵³⁴

Translation (modified) draws from Mihăescu, “Ion Barbu or the Mathematics of Poetry,” 54.

⁵³¹ See for example introductory comments in chapter 2.

⁵³² Barbu, *Pagini de proză*; Mihăescu, “Ion Barbu or the Mathematics of Poetry,” 54.

⁵³³ Barbu, *Pagini de proză*, 39–40.

As in geometry, I understand through poetry a particular symbolism for representing the possible forms of existence. [...] For me poetry is a prolongation of geometry, so that, while remaining a poet, I have never abandoned the divine domain of geometry.

Translation (modified) from Mihăescu, “Ion Barbu or the Mathematics of Poetry,” 54; Cioranescu, *Ion Barbu*, Note 2.

⁵³⁴ From “Pro Domo”, first published 1927, Barbu, *Poezii*, 383.

Poetry should preserve invariants when faced with certain groups of verbal transformations.

In operations of a group, certain characteristics need to be preserved, while the elements, or words themselves, may move or be otherwise manipulated. The suggestion here is that the formation of poetry can be seen as a permutation or juxtaposition of elements that are words: the writer presents blocks of ideas, or images, and from their conjunction and relation with one another, the reader may draw various inferences, all the while within the bounds of what is possible within that ‘group’ of allowable permutations; that is, preserving invariants. This is an important feature to bear in mind when examining Barbu’s actual verse.

The Symbolist influence on Barbu the poet is significant, and Barbilian devoted several essays to the examination of Symbolist poets, making specific comparison with particular mathematicians.⁵³⁵ Again in 1927, another interview with Barbilian appeared in the literary press; this time in which he approvingly compares the poets Paul Valéry (1871-1945) and Stéphane Mallarmé (1842-1898) with the mathematicians Hilbert and Gauss, but at the same time noting their essential dissimilarity:

Valéry plătește un bir trecutului analitic și didactic [...] Experiența lui Mallarmé se așează într-un Absolut, într-un antiistorism, care interzice o prea mare apropiere poeziei lui Valéry.⁵³⁶

Barbilian is making a distinction between a traditional analytic (Cartesian) approach, which he would associate with the mathematics – as well as philosophy – of the previous century, and the modern abstract and experimental method being foreshadowed by Mallarmé.

I mentioned earlier Barbilian’s preference for geometry and algebra over other fields of mathematics, notably analysis.⁵³⁷ In explaining his decision to abandon his doctorate in number theory at Göttingen, Barbilian had explained that he was looking for a much broader vision of mathematics than that encompassed in what he derided as ‘a race for asymptotic formulae’.⁵³⁸

This view is borne out here when Valéry is criticised for too heavy a reliance on analysis, whereas Mallarmé is praised for having reached an absolute, which by implication lies beyond the everyday world of mathematical analysis. (Barbilian mentions analysis in ostensibly a non-

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⁵³⁵ See for example Barbilian’s juxtaposing of French poets with mathematicians - Pascal, Galois, Rimbaud and Riemann – in “Rimbaud” first published in 1941, in *Ibid.*, 339–342. Barbu wrote that Arthur Rimbaud (1854 – 1891) had a visionary, ‘scientific’ spirit. Barbu, *Pagini de proză*, 31. Symbolism’s relation to mathematics is discussed in chapter 2.

⁵³⁶ First appeared in «De Vorbă cu Ion Barbu», *Viața literară*, 15 October 1927: Barbu, *Pagini de proză*, 48. Valéry pays tribute to an analytic and didactic past [...] Mallarmé situates himself within an Absolute, within an anti-historicism, that precludes too close a comparison with the poetry of Valéry.

⁵³⁷ See further notes 486 and 502.

⁵³⁸ Cited in Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 30.

specialist sense here, but for him, the multi-faceted allusive poet, there can be little doubt that the specialist sense would also hold.)

In 1929, Barbilian wrote about the Romanian poet and philosopher Lucian Blaga (1895-1961), commenting that Blaga ‘knew exactly’ where poetry should seek its inspiration: the poetic principle must be a ‘spiritual vision’. Furthermore, remarks Barbilian, Blaga has encapsulated that spiritual vision in his overtly religious expression, ‘*Geometrie înaltă și sfântă*’.⁵³⁹ Alongside the spiritual, Barbilian extols Blaga’s ‘just and pure’ vocabulary, and his ‘calm’ state of mind, suggesting a poetry that, like mathematics, is the outcome of slow and measured consideration.⁵⁴⁰ Again, there are clear signs here of what it is about mathematics that appeals to Barbilian, and how he sees that as equally present in poetry.

In an article published in 1930, Barbilian compared poetic figures in Novalis with mathematical ones:

Ar fi deci între *figurație* și *alegorie* deosebirea cunoscută între *operație* și *formulă*. Operația : transformare, liberă permutare de chipuri în domeniul aceluiași grup. Formula: doar memoria consemnată a uneia singure din aceste operații.⁵⁴¹

The notion of algebraic operation again situates Barbilian’s remark firmly within the domain of modern mathematics. It also emphasises his mathematical preferences, and his reservations about viewing mathematics as formulae, to which I drew attention earlier.⁵⁴²

Clearly, certain methods in mathematics appeal to Barbilian. In a piece from 1932, in which he discusses his literary beliefs, he is given to compare the process of scientific understanding with that of literary exegesis, and so asks himself whether a poet should be required to explain his or her work. His response reveals an conception of scientific rationalism (notably physics) that suggests that while an observed phenomenon has a rational model, there is a deeper essence that exceeds rationalism:

Poetul trebuie și poate să-și explice opera ? Răspunsul : nu trebuie *neapărat*, dar poate foarte bine și-o explice. Analogia cu fizica. Poezia întocmai ca un fenomen fizic admite un model mecanic, tot așa stările de raritate și de vis ale poeziei pot fi reduse la un model rațional [...] Dacă o poezie admite o explicație, rațional admite atunci o infinitate. O exegeză nu poate deci fi în nici un caz absolută.⁵⁴³

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⁵³⁹ Barbu, *Pagini de proză*, 95. From “Legenda și somnul în poezia lui Blaga”, first published in *Ultima Oră*, 24 February 1929:

Geometry on high and most holy.

⁵⁴⁰ This notion of purity, related to ascetic spiritualism, was sustained twenty years later, when in the late 1940s Barbilian wrote a series of pieces on French Symbolist poets. See note 551.

⁵⁴¹ Barbu, *Poezii*, 336. “Salut in Novalis”, first published 1930.

The difference between the terms ‘figurative’ and ‘allegory’ should be understood as between ‘operation’ and ‘formula’. Operation is a transformation or free permutation of objects taken freely from a particular domain or group. Formula is simply an imprint of a single operation.

On Novalis (Friedrich von Hardenberg), see chapter 2.

⁵⁴² See note 486.

⁵⁴³ “Note pentru o mărturisire literară”, dated 1932, in Barbu, *Pagini de proză*, 54.

That is, poetry can also share the qualities of rationalism most associated with science, but such an understanding must be comprehensive and take into account the ultimate unknowability of the infinite and of the absolute. Barbilian adds:

Un poet prevăzut cu oarecare matematici poate da nu una, nu două ci un mare număr de explicații unei poezii mai ascunse. [...] În cazul de față vom face alegerea în vederea unei cuprinderi spirituale cât mai mari.⁵⁴⁴

A greater knowledge of mathematics opens up multiple, otherwise hidden, poetic interpretations, and broadens the possible meaning in the same way that a mathematical theorem or theory opens itself to multiple applications despite its expression being abstract and minimal. Barbilian is indicating that what he enjoys most about both mathematics and poetry is when they are far from immediately obvious, and instead require the reader to recognise, reflect and make inferences, and draw a multitude of implications. This is an activity that requires the exercise of intangible spiritual faculties:

Matematicile pun în joc puteri sufletești nu mult diferite de cele solicitate de poezie și artă.⁵⁴⁵

Related to this is a feature of mathematics and poetry that I have not specifically touched upon as yet, and that is their visual form on the page. As was noted in Chapter 2, the written form and aspect of a poem and a mathematical exposition are important in both cases. Mathematics is almost invariably written, allowing for slow and careful scrutiny of the various definitions, and logical development of proofs. For Barbilian, the writing of mathematics was essential:

Nu există matematice vorbite [...] Un adevăr matematic nu poate fi primit ca achiziționat decât dacă e prezentat scris și dacă rezistă verificării oamenilor competenți.⁵⁴⁶

This view of mathematics as a written, and hence visual, form is relatively common, and one that is rarely contested.⁵⁴⁷ Poetry, however, is quite different, however, in that many poets write intending their poetry to be read aloud, and so it has an important aural and oral

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Should a poet be able to explain his work? The reply: one does not have to *reveal* it, but should be able to explain it very well. Analogous with Physics. Poetry just like a physical phenomenon admits a mechanical model, as can rare and dream states of poetry be reduced to a rational model. If a poem were to admit explanation, then the rational would admit infinity. An exegesis can therefore in no case be absolute.

⁵⁴⁴ Ibid., 54–55.

A poet exposed to certain mathematics will give not one or two but a great number of explanations to a more obscure poem. [...] In this case we choose mindful of a much greater spiritual coverage.

⁵⁴⁵ Ibid., 234.

Mathematics brings into play the powers of the soul, not so differently from that evinced through poetry and art.

⁵⁴⁶ Ibid., 235. Undated.

A spoken mathematics does not exist. A mathematical truth cannot be received and acted upon unless it is in written form and has withstood the examination of competent others.

⁵⁴⁷ See for example “The language of mathematics is a written one, not a spoken one”, in Pledger, “Note for Tutors,” 1. As an exception, note the discussion in chapter 2 of a performative aspect to mathematics, in: Sha, “Differential Geometrical Performance and Poiesis.”

form. What Barbu's intention was with respect to his poetry is not explicitly recorded, but a number of factors indicate that he also preferred the ideal poem to be written. He remarks, for example, on the appearance of mathematics on the page:

În matematică de exemplu, fizionomia unei pagini ar fi sălbatecă și respingătoare, dacă s-ar restabili, în vederea unei clarități totale, încheieturile cele mai mici ale raționamentului. E adevărat însă că în matematică cheia se poate găsi oricând, pe cale de *gnoză*, de analiză. Câștigarea sensului unei poezii ermetice e mai întâmplătoare.⁵⁴⁸

By implication, hermetic poetry employs a comparable condensed form, but it is less clear that the gaps will be consistently filled in by interpretation. Barbilian acknowledges that the oral is indeed a feature of poetry, but one that in his view can cloud the essence of an ideal poem. It is this last point that leads most strongly to the assumption that Barbilian, the firm advocate of mathematics in a written form, desired the same for his ideal poetics.

This short passage is significant, since it also draws attention to Barbilian's belief in mathematics as a spiritual exercise: the choice of the theological term *gnosis* (knowledge of spiritual mystery) is deliberate.⁵⁴⁹ It also sheds additional light on his ambivalence towards analysis as a mathematical field. Barbilian associates analysis with an excessively pedantic and detailed approach to mathematics that, like formulae, is necessary, but not to his own liking. Indeed, mathematical analysis is not the primary purpose of written mathematics; it is a process that follows on from, and after, the initial written statements, or, according to Barbilian's preferences, axioms.⁵⁵⁰

Returning to the Symbolists, Barbilian's 1947 prose piece, "Jean Moréas", is rich with references to geometry, and offers pointers to Barbilian's literary theory. Jean Moréas (1856-1910) was a literary critic and one of the earliest Symbolist poets. Barbilian praises him as the finest of French poets, for his 'clear and melodic formulations', and as one who 'purified' and 'reduced' rather than invented.⁵⁵¹ Comparing his style directly with that of a mathematician, Barbilian suggests that geometry represents a pure and aesthetically pleasing form of expression and understanding:

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⁵⁴⁸ "Note pentru o mărturisire literară" in Barbu, *Pagini de proză*, 55.

In mathematics for example, the physiognomy of a page would be savage and repulsive, if every smallest point and connection of logical reasoning were restored to complete clarity. It is true that in mathematics, the connection can be found at any time, through a process of *gnosis*, of analysis. Grasping the meaning of a hermetic poem is more haphazard. (Emphasis in original.)

⁵⁴⁹ See further note 567.

⁵⁵⁰ See also note 502.

⁵⁵¹ Barbu, *Pagini de proză*, 119-120.

Le domaine de la poésie n'est pas l'âme intégrale, mais seulement cette région privilégiée où résonnent les actes de la lyre. C'est le lieu de toute beauté intelligible: l'entendement pur, honneur des géomètres.⁵⁵²

Geometry, according to Barbilian, is not only spiritually resonant, but more than this, it occupies a unique position in the spiritual realm. He expands this reference to the spiritual in a later interview:

[I had] more of a religious rather than an artistic soul, I wanted to give through my verses the equivalent of a state of vision and intellect; the state of geometry and above it ecstasy. I never understood the melodic cries of the poets.⁵⁵³

In distancing himself from poetic musicality *per se*, Barbilian is drawing on a Platonist view of mathematics; that it is there to be discovered, not created. This is inherent in his rejection of 'invention'.⁵⁵⁴ Barbilian is reaching for a form beyond what he sees as mere melody, which aspires to an abstract and transcendent existence. For Barbu the poet, a melody is something that has been created, to delight terrestrial human ears, but for Barbilian the Platonist mathematician, it is not for the poet to create such a thing; but rather the task of the reader to make the connections, based on a string, or set, of words (as in mathematics, algebraic objects or axioms) that have been placed and juxtaposed with only limited preconceived conceptions of how they should come together as a whole. And this is the nature of modern geometry: the expression of possibilities that do not immediately make empirical sense in the manner of classical geometry – it becomes a state of pure understanding, a place of multiple representations and a pinnacle of spirituality, to the point of being divine.

Barbilian also likens Moréas's approach to the 'formalism' of Klein and the 'pure logic' of Hilbert:

C'est le formalisme de Félix [sic] Klein ou plutôt le purisme logicien de Hilbert, qu'il évoque inlassablement. [...] En effet, *Die Grundlagen der Geometrie*, que certains nomment «le nouvel Euclide» [...] balancera toujours dans notre esprit le livre immortel de Moréas. Car les *Stances* ne sont-elles pas *Les Fondements* et l'illustration de la poésie la plus pure?⁵⁵⁵

⁵⁵² Ibid., 125. "Jean Moréas" was originally written in French, for a Romanian Francophone salon in Bucharest:

The domain of poetry is not the entire soul, but only that privileged place where lyres can be heard.

It is the place of all intelligible beauty: pure understanding, the honour of geometries.

English translation (modified) from Băjenaru, "Ion Barbu or the Revelation of the Sublime," 186.

Domeniul poeziei nu este sufletul integral, ci numai această zonă privilegiată, unde răsună actele lirei. Este locul oricărei frumuseți inteligibile: înțelegerea pură, onorarea geometriilor.

Standard Romanian translation from Balotă, "Ion Barbu între poezie și geometrie," 17.

⁵⁵³ Taken directly from Băjenaru, "Ion Barbu or the Revelation of the Sublime," 192–193.

⁵⁵⁴ See further note 694.

⁵⁵⁵ Barbu, *Pagini de proză*, 120.

He tirelessly evokes the formalism of Felix Klein, or rather the logician's purism of Hilbert. Indeed *Die Grundlagen der Geometrie* (*Foundations of Geometry*) that some call "the new Euclid" will always balance in our spirit the immortal book of Moréas. For are the *Stances* [of Moréas] not the *Foundations* and illustration of purest poetry?

See also Oulipo's admiration for Hilbert's *Grundlagen*, in chapter 2.

In mathematics, the search for universal theories is closely associated with the algebraic and geometric work of the Göttingen mathematicians. Praising their approach towards establishing the foundations of mathematics, Barbilian considers that Moréas has done the same for poetics:

Ce qui préoccupe Hilbert, c'est le dénombrement exhaustif des idées génératrices d'une doctrine, d'où celle-ci découle par simple développement logique. C'est un problème de fondation autonome, un problème de purisme.⁵⁵⁶

The reference to purism here recalls Barbilian's view of geometry as possessing spiritual purity; in this case the same qualities are equally present in the work of Klein and Hilbert. In calling Hilbert the "new Euclid" Barbilian is referring to Hilbert's careful and enumerated approach to setting out geometry, for which Euclid's *Elements* are renowned. He sees Hilbert as continuing in a modernist form, but not breaking with, a stylistic tradition. That is, axiomatic algebra and the careful search for the foundations of mathematics can, for Barbilian, be directly compared with the nature and purpose of poetry. His poems themselves adopt this method: they are constructed from a generating set of repeated ideas, or images, whose meaning can be inferred by logical analysis.

What then does Barbilian mean by a mathematical approach to poetry? He understands it to include the perceived divine and transcendental nature of geometry, the axiomatic and fundamental approach of modern algebra, and a focus on putting together words in a logical and structured manner, seeing them as elements obeying certain universal rules.

Mathematical humanism

Towards the end of his life, Barbilian turned also to what he saw as the unique and essential place of mathematics in education. He was convinced that mathematical training leads to a more rigorous, systematic and polysemous understanding and exploration of the immense potential, not only of poetry, but of all knowledge.

Holding that a classical arts education ought to have mathematical education as a basis, Barbilian argues that an education in the logic and originality of mathematical thinking was an

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⁵⁵⁶ Ibid., 123.

What preoccupies Hilbert is the exhaustive enumeration of ideas generating a theory, which latter ensues by simple logical development. This is a question of autonomous foundation, a question of purism.

essential attribute to classical thinking. Modern literary training had, in his view, lost sight of that way of thinking, and exposure to mathematical methods might regain it.

While many poets and literary critics might understandably disagree, Barbilian contends that literary criticism has yet to focus on universal theories in the way that mathematics has, and that too much attention is concentrated on specific periods and genres. In this way, literature is not unlike pre-20th century mathematics, which was also relatively compartmentalised.⁵⁵⁷ He concludes that poetry still needs to acquire some of the ‘finesse’ of mathematics.⁵⁵⁸ Barbilian claims that in mathematics it is impossible to think in the way that he considers characteristic of most literary writers: to do this would be akin to a modern geometer refusing to incorporate the thinking of Lobachevsky with that of Euclid. In other words, a mathematical humanist approaches matters in a complex spirit of inquiry.⁵⁵⁹

He goes on to construct his notion of ‘*umanism modern*’, based on mathematics:

Ce distinge umanismul matematic de umanismul clasic? În două vorbe : o anume modestie de spirit și supunerea la obiect. O formațiune matematică, chiar dacă se valorifică literar, aduce un anume respect pentru condițiile create în afară de noi, pentru colaborarea cu materialul dat.⁵⁶⁰

For him, mathematics requires one to put aside the personal and particular, and to concentrate on external patterns. It develops a sense of modesty about one’s own place in the world, and a spirit of objectivity. Barbilian does not suggest that such a method is always easy. He asserts, for example, that even elementary mathematical terms such as curve and convergence are replete with technical meanings, his point being that mathematical language is always complex. Notwithstanding, he asks himself how one might popularise such ideas, noting recent mathematical developments in areas such as algebra that work on grand theories.⁵⁶¹ He concedes that while a unified mathematics must exist, it is not possible to reach it, partly because of the very complex nature of mathematics.

The first clear articulation of ‘mathematical humanism’ comes in Barbilian’s “Formația matematică” (My Mathematical Background), written around 1958, describing his thoughts on

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⁵⁵⁷ Interestingly, this return in modern mathematics to a complexity more prevalent in earlier years is repeated in Milosz’s thoughts on twentieth century science compared with the Newtonian period.

⁵⁵⁸ Barbu, *Pagini de proză*, 228.

⁵⁵⁹ Barbu, *Poezii*, 328.

⁵⁶⁰ Barbu, *Pagini de proză*, 231.

What distinguishes mathematical humanism from classical humanism? In two words: a certain modesty of spirit and submission to the objective. A mathematical education, even if it is ultimately valorised through a literary one, adds a certain respect for circumstances created outside ourselves, and for collaborating with given material.

⁵⁶¹ On the pitfalls of popularising mathematics, see further Solomon Marcus.

the value of mathematics in general education.⁵⁶² Opening with an acknowledgement of the place of Euclid's *Elements* in a classical, 'humanist' education, Barbilian argues that his new form of education does not simply require some mathematics, but should be 'founded' on it:

un sistem complet de cunoștințe capabil să formeze omul, bazat însă pe matematică.⁵⁶³

He adds that given other similar mindsets, the mathematical (geometric) will always prevail:

între două spirite din toate punctele de vedere asemenea cel care are de partea lui geometria va triumfa totdeauna.⁵⁶⁴

In Barbilian's view, the mathematically trained mind is superior. It is in this context that he lauded in turn Gauss, Riemann, Klein and Noether, and commending mathematics for its resistance to 'vulgarisation', suggested that the same approach should be taken to poetry.⁵⁶⁵

Barbu's poetry viewed by his critics

To this point, I have given a largely chronological account of the development of Barbilian's work, both mathematical and literary, from his own perspective. I turn now to a discussion of how his writings have been considered by literary critics.

Barbu's hermetic poetics: approaching the mathematical

Barbu described his late, and for him most mathematically satisfying, poetry as 'hermetic', and it is this period that predominates in *Joc secund*. Hermeticism is an abstract style of European poetry that favours the subjective interpretation of language and imagery, where the suggestive power of the word is as important as its more ostensible meaning, and it carries

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⁵⁶² "Formația matematică", first published, posthumously, in *Secolul 20*, February 1964 and *Luceafărul*, April 1965. There is some disagreement about when this was written. According to Boskoff and Suceavă, Barbilian wrote this in 1940 as part of his *Notes on my scientific works*, in the context of his promotion application: Boskoff, Dao, and Suceavă, "From Felix Klein's Erlangen Program to Secondary Game," 29. Yet both Pillat and Vulpescu determine that the "Formația" was written in 1958: Barbu, *Pagini de proză*, 32–33; Barbu, *Poezii*, 329, notes 3,7. The confusion probably arises from Barbilian's reference in the text to the 'past 44 years' of his life since a 'door opened' for him: *Ibid.*, 326. Dating from his birth in 1895, that would be 1940; but Vulpescu concludes – I think correctly – that he is referring to 1914, when he began his university mathematics studies (see introduction to this chapter), which would bring the period to 1958.

While articulated as such only later in his life, a 'new humanism' was foreshadowed as early as 1940: having declared himself an adept of the Erlangen programme, Barbilian concludes that that 'becomes the new humanism.' Barbu, *Pagini de proză*, 160–161. For full quotation see note 491.

⁵⁶³ Barbu, *Pagini de proză*, 230.

A complex system of knowledge capable of forming the man (sic), yet based on mathematics.

⁵⁶⁴ *Ibid.*

Given two souls that are in all respects the same, the one with geometry within will always prevail.

⁵⁶⁵ *Ibid.*, 221. "Direcții de cercetare în matematicile contemporane" (Directions of research in contemporary mathematics), first published in *Tribuna*, 17 May 1958.

marked difficulties in understanding.⁵⁶⁶ Although it has ancient roots, it is closely associated with the Symbolist movement in poetry: Mallarmé is credited with having revived ‘hermeticism’ in modern times.⁵⁶⁷ Barbu’s hermetic phase straddles the 1920s, a period that was also a highpoint in Romanian Symbolism.⁵⁶⁸

What exactly hermeticism means for Barbu’s poetry has been interpreted in various ways by literary critics, and quite what Barbu understood by a mathematical method is not always accurately or comprehensively discussed. It is of course inherently difficult for any one scholar to possess a deep academic understanding of both fields, as discussed in Chapter 1.⁵⁶⁹ Mathematics is difficult for a non-mathematician, and even one field of mathematics can be challenging for a colleague from another field. It is also a fundamental issue in the analysis of the interrelationship between mathematics and poetry.

Critics have termed Barbu’s poetry obscure, and consequently also mathematical. But these mathematical qualities are often described in a not very specific manner. Petroveanu argues that Barbu was attracted to the hermetic style in reaction to the changes in Romanian society following the end of the first world war, when Romania became in essence a fascist dictatorship, and hence more obscure and oblique forms of expression became necessary.⁵⁷⁰ Cornis-Pope describes Barbu’s poetry as ‘programmatic’, indeed the most programmatic of all Romanian-language writers, in the sense that he lays a very deliberate emphasis on so-called ‘pure’ language itself, on syntax, on the relationship between subject and object, and between the idea and the word.⁵⁷¹

Alexandru Rosetti and Liviu Calin edited the 1966 edition of *Joc secund*, the first edited edition to be published after Barbilian’s death.⁵⁷² They remark on his obscurity of meaning and ostensible ambiguity, arguing that Barbu demonstrates a desire to uncover and reveal a ‘hidden’ or ‘generalised’ truth, by renouncing the perceived ordinary limits of language in an

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⁵⁶⁶ Cuddon, *A Dictionary of Literary Terms and Literary Theory*, 378.

⁵⁶⁷ The *Hermetica*, or *Corpus Hermeticum*, derives from multiple traditions: Coptic; Syriac; Armenian and Arabic, and includes the Gnostic tracts, see note 549.

Romanian literary critic Mihail Petroveanu describes hermeticism, as it is understood by Barbu, as deriving from the Greek tradition of hermeticism that considered there to be correspondences between the microcosm and macrocosm, but that these correspondences were not apparent through discursive reasoning. It was necessary instead to employ some kind of code of analogies to discern that great unity: Petroveanu, “A Brief Survey of Ion Barbu’s Poetry,” 31.

⁵⁶⁸ Băjenaru, “Ion Barbu or the Revelation of the Sublime.”

⁵⁶⁹ Dr Moma Momescu, holder of the Nicolae Iorga Chair in Romanian Studies at Columbia University in New York, noted in a personal interview with the author that in teaching Barbu’s poetry literary academics rarely delve into the mathematics in any detail, beyond repeated references to his mathematical training: Momescu, Ion Barbu and his mathematical poetry.

⁵⁷⁰ Petroveanu, “A Brief Survey of Ion Barbu’s Poetry.” In fact Barbilian was briefly a member of the Romanian fascist Iron Guard, see further at note 700. Italian hermeticism has also been associated with the fascist movement.

⁵⁷¹ Cornis-Pope, “Ion Barbu (Dan Barbilian),” 50.

⁵⁷² Rosetti and Calin produced several such edited editions of the works of well-known Romanian writers.

effort to achieve absolute clarity of written expression. The ‘real world’ is a representation of a copy of a perfect prototype that exists outside the tangible world.⁵⁷³ Andrei Bodiū remarks that like many, if not most poets, Barbu is a creator of worlds. In his case he harks back to a Platonist ideal, and seeks an ‘alternative truth’ (*altfel adevărat*): a unifying abstraction which could reconcile the ‘pure ideal’ with sensuality.⁵⁷⁴ Bodiū notes in particular that in his 1928 article, “*Poezia leneșă*” (Lazy poetry) Barbu was presenting a vehement criticism of contemporary poetry.

The Romanian literary critics Antonia Constantinescu and Ileana Littera perceive an absence of relational terms that might limit interpretation of Barbu’s poems, tending instead to consist of a string of words whose individual meanings are determinable, albeit polyvalent, but as a whole the poem is left deliberately ambiguous. Grammatical and syntactic norms are at times avoided, in favour of starkness.⁵⁷⁵ Eugen Dorcescu emphasises metaphor as a profound component of Barbu’s poetry, as it characteristically carries very full linguistic meaning.⁵⁷⁶ Going further, the mathematicians Wladimir Boskoff and Bogdan Suceavă conclude that Barbu made a conscious effort to ‘eliminate all accessible meanings’ from his poetry.⁵⁷⁷

Ioana Petrescu argues that in Romanian literature Ion Barbu was a writer without precursors (*fără precursori*), and she outlines a number of ideas on poetic Modernism that are inherent in Barbu’s poetic theory.⁵⁷⁸ Petrescu contends that his poetics were revolutionary and ‘courageous’, underpinning a non-figurative poetry that transcends the individual and subjective. She observes nonetheless that his stylistic innovations were presaged by similar fundamental changes of thought in writers such as Nietzsche, Mallarmé, Valéry, James Joyce and T.S. Eliot, and in the work of the Romanian sculptor Brâncuși, with his clear lines and abstract forms, and an absence of ‘sentimentality’ (*sentimentalitate*). Recalling, like Bodiū, Barbu’s “*Poezia leneșă*”, Petrescu remarks that Barbu called for a *poezia sinceră* (sincere poetry), and *lirismul absolut* (absolute lyricism) in modern Romanian poetry.⁵⁷⁹

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⁵⁷³ Barbu, *Joc secund*, introduction. This is in keeping with mathematical Platonism.

⁵⁷⁴ Bodiū, “Poezia lumilor posibile.” Andrei Bodiū is a poet and literary critic at Braşov University.

⁵⁷⁵ Constantinescu and Littera, “Indici de predictabilitate,” 163–168.

⁵⁷⁶ Dorcescu, “Semiotica metaforei în poezia lui Barbu,” 7.

⁵⁷⁷ Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 21.

⁵⁷⁸ Petrescu, *Ion Barbu și poezia postmodernismului*, 7. Ioana Em. Petrescu was a literary critic at the University of Cluj, who published two major works on the celebrated Romanian Romantic poet Mihai Eminescu. Her work on Ion Barbu in the context of postmodernism was published posthumously, and among literary scholars of Barbu was considered a definitive monograph.

⁵⁷⁹ Ibid., 21. In fact, this ‘absolute lyricism’ contrasts with Barbilian’s remark in his 1940 mathematics paper, that absolute lyricsm is not desirable. See note 524.

Petrescu's monograph on Barbu opens with two epigraphs. Both are instructive. The first is an extract from Wittgenstein's *Tractatus logico-philosophicus* that alludes to his effort to construct all truths into a single and universal descriptive model. This is a well-chosen reference, recalling that the universal and descriptive model in mathematics (through axioms) is central to Barbilian's thought. The second citation is by Valéry: *Ce poate fi mai misterios decât claritatea?*⁵⁸⁰ While some may accuse Barbu of obscurity in his poems, it is clear that he himself was aiming for a 'perfect clarity', in the same way that Hilbert and others were aiming to restructure and redefine the fundamentals of mathematics, with a view to achieving ultimate clarity. Unfortunately, in both instances it is often the case that the result is far from obvious to a non-specialist reader.⁵⁸¹

Valéry is articulating here one of the central tenets of his poetic Symbolism, in particular an explicit interest in mathematics, and Barbu's indebtedness to the symbolists is frequently remarked upon. Barbu is described variously as an adept of 'pure poetry' like Mallarmé and Valéry⁵⁸²; it has been noted that like Mallarmé, Barbu also aspired to creating a 'unique book' in which somehow 'all arts unite in an artistic whole'⁵⁸³; like Mallarmé, Barbu sought an elusive 'essential and erudite' organisation of ideas.⁵⁸⁴ Like Poe and Valéry, Barbu's poetry was concerned with 'absolute truth', which should be reachable through a particular method⁵⁸⁵; and he made significant steps in addressing Valéry's lament that poetry was in a 'crisis of language' in need of discovering some form of 'pure intellect'.⁵⁸⁶

However, Barbu was by no means an uncritical acolyte of the Symbolists. Basarab Nicolescu claims for example that Barbu's work had more relation to 'pre-existing' meanings than that of Mallarmé.⁵⁸⁷ The implication here is that Barbu was moving closer towards a Platonic ideal, compared with a more conventional inventive and constructivist approach. Cioranescu suggests that compared with Mallarmé, Barbu aimed for even greater simplicity, remarking that he had criticised Mallarmé for using overly complex form in his syntactical experiments.⁵⁸⁸ The poet Nina Cassian contends that his work 'revolutionised' language and the perception of poetry, with a 'hermeticism' exceeding that of, again, Mallarmé.⁵⁸⁹

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⁵⁸⁰ Qu'est-ce qu'il y a de plus mystérieux que la clarté? "What could be more mysterious than clarity?" From Valéry's *Eupalinos ou l'architecte* in Valéry, *Oeuvres*, 366.

⁵⁸¹ See chapters 1 and 2.

⁵⁸² Barbu, *Joc secund*, xv.

⁵⁸³ Băjenaru, "Ion Barbu or the Revelation of the Sublime," 190.

⁵⁸⁴ Nicolescu, "A Poetic Method," 70–71.

⁵⁸⁵ Cornis-Pope, "Ion Barbu (Dan Barbilian)."

⁵⁸⁶ Constantinescu and Littera, "Indici de predictabilitate," 163.

⁵⁸⁷ Nicolescu, "A Poetic Method," 70–71. On Nicolescu, see note 625.

⁵⁸⁸ Cioranescu, *Ion Barbu*, Note 29, Ch 3.

⁵⁸⁹ Cassian, "Notes on Romanian Poetry."

These qualities of Barbu's poetry – the esoteric playing with language, conscious obscurity, and focus on an abstract ideal – are not universally admired. While *Joc secund* was popular with critics, it omitted those poems whose meaning was more obvious to a general reader, and as a collection it was less popular than individual poems had been.⁵⁹⁰ In 1934, shortly following the publication of *Joc secund*, his compatriot the playwright Eugène Ionesco published a collection of essays on Romanian literature and politics, which was critical of Barbu's poetry, finding it too derivative of the French Symbolists, particularly Mallarmé and Valéry. For Ionesco, Barbu's 'hermetical' meant that his poetry was simply existing in isolation, contained within its 'own universe'.⁵⁹¹ Barbilian's friend, the poet Nina Cassian, on the other hand, dismisses Ionesco's opinion as unmerited. She comments that Barbu:

enriched poetry's vocabulary by introducing scientific concepts and animating poetic expression with an intellectual acuity never registered before.⁵⁹²

But Cassian has also commented that she did not herself like, or understand, Barbu's later, hermetic (i.e. the mathematical) period.⁵⁹³

In a more recent overview of modern Romanian poetry, the Romanian literary critic (and one-time political and cultural activist) Nicolae Manolescu explains his lack of enthusiasm for Barbu's other-worldliness, commenting that some poets search for 'a meaning of life', and a 'mirror' for an internal concept; whereas others try to escape this interior concept and look instead for meaning in language. Manolescu terms Barbu an archetype of this second approach, and considers that such poets' creative hyper-awareness destroys any spontaneity, and that the poets fail to escape from themselves and their egos.⁵⁹⁴

These not always well-defined 'hermetic' qualities are what many literary critics conclude constitute the mathematical nature of Barbu's poetry. Others expand on this to some extent, but their comments concerning mathematics are often somewhat vague.

The remarks of Barbu's editors, Rosetti and Calin⁵⁹⁵, on the mathematical nature of Barbu's poetry are fairly typical, in that they are interesting and insightful, but not always mathematically correct. They describe Barbu's poetry as possessing a 'perfect clarity' (*perfectă claritate*) with connections between words that are governed by 'strict logic' (*logica severă*), and

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⁵⁹⁰ Cioranescu, *Ion Barbu*.

⁵⁹¹ Teodorescu, "'Nu, Nu and Nu': Ionesco's 'No!' To Romanian Literature and Politics." (Ionesco is also dismissive of Barbu's attempts to draw on orientalism and tie it back to Christianity.)

⁵⁹² Cassian, "Notes on Romanian Poetry," 8. On Nina Cassian, see note 684.

⁵⁹³ Cassian, Conversation with Nina Cassian.

⁵⁹⁴ Firan and Doru Mugur, *Born in Utopia*, 342. Nicolae Manolescu, "The Metamorphoses of Poetry."

⁵⁹⁵ See note 572.

that suggest Barbu was seeking some kind of ‘formula’ in his poetry.⁵⁹⁶ This last remark is revealing, given Barbu’s expressed antipathy towards formulae.

Similarly, the Romanian literary critic Ion Pop comments that Barbu demonstrates a ‘quasi-mathematical rigour’ in expression and, likening him to Mallarmé and the sculptor Brâncuși, recognises his attraction to ‘elementary forms’.⁵⁹⁷ Pop goes on to remark that Barbu is considered as part of the Romanian constructivist school, which is a fair comment in relation to his structural methodology, but Pop fails to add that an essential point for Barbu was that he took a very Platonist view of mathematics, and so would have seen his poetry as ‘discovering’ a pure reality, rather than constructing one.

The critic Eugen Lovinescu argues that Barbu was creating through poetry a world that was ‘pure’, and related to the ‘ideal world of mathematics’.⁵⁹⁸ Valentin Mihaescu remarks that Barbu aimed to circumscribe ‘limited polyhedral perfections’, expressing a ‘cold beauty of pure ideas’.⁵⁹⁹ Using similarly mathematical-like vocabulary, George Băjenaru observes that Barbu ‘assumes the risk of a complete poetry by encoding the word’, and that his poetry had an ‘interior geometry’ through his deep structures and ‘maximum concentration’.⁶⁰⁰ In fact, none of these critics goes on to elaborate his assessment in a more mathematical manner, nor engages in a discussion of the precise fields of mathematics that exhibit such characteristics.

Barbu’s biographer, Alexandre Cioranescu, makes a more sustained attempt to investigate the mathematical nature of Barbu’s poetry, making the caveat that for most literary critics, including himself, it is not possible to analyse the level of mathematics in Barbu’s poetry beyond references to more elementary images such as triangles and hexagons.⁶⁰¹ Cioranescu touches on many issues, particularly in his chapter “Between Mathematics and Poetry”, but does not expand upon them. This is the case for example when he remarks on the Symbolist influences in Barbu’s poetry, noting that the Symbolists were drawn to mathematics and that Barbu took an interest in the work of Edgar Allan Poe, in particular his interest in the relationship between literature and science.⁶⁰² But this reference fails to identify or acknowledge the important distinction between literature and science, and poetry and mathematics.⁶⁰³

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⁵⁹⁶ Barbu, *Joc secund*, introduction, xvi–xvii, xi. (Other readers of the time would have argued that the poems were in fact far from clear.)

⁵⁹⁷ Pop, “Roumanie,” 556.

⁵⁹⁸ Cited in Băjenaru, “Ion Barbu or the Revelation of the Sublime,” 195.

⁵⁹⁹ Mihaescu, “Ion Barbu or the Mathematics of Poetry,” 54.

⁶⁰⁰ Băjenaru, “Ion Barbu or the Revelation of the Sublime,” 194–195.

⁶⁰¹ Cioranescu, *Ion Barbu*, chapter 2.

⁶⁰² In fact the accuracy of Poe’s scientific understanding is now disputed, see for example mathematician Kevin S. Brown’s: Brown, “The Thought of a Thought - Edgar Allan Poe.”

⁶⁰³ See chapter 2.

Cioranescu remarks that Barbu saw mathematics and poetry as ‘one identity’, namely the representation of an abstract universe through a shared symbolic code, associated in particular with abstract geometry. Touching on Barbu’s attention to abstract conceptual mathematics, he writes, perceptively:

His work was not that of a researcher; it was strategic. As [Barbilian] himself says, he was interested in mathematical morphology, that is, a scientific and philosophical instrumentation of pieces of knowledge considered especially in the articulation of their relation.⁶⁰⁴

Cioranescu argues that Gauss’s maxim of maximum thought with minimum words had a direct impact on Barbu, and is a significant mathematical component of Barbu’s poetics. He adds that a more mathematically-literate reader would pick up on references such as the group in *Joc secund* and draw on its implied technical meaning. He notes that one specialist critic (Nicolescu, see below) identified only eleven poems with more advanced mathematical references, and that of these only three have been examined in any detail.⁶⁰⁵ In one sense this is odd, because like earlier critics, Cioranescu seems to be missing the point: obvious references to mathematical shapes and images was not in fact what Barbu was trying to do.

Cioranescu does make an interesting observation about the process of Barbu’s poetic writing: based on what remains of Barbu’s manuscripts, he states that in fact the more technical mathematical references in *Joc secund*, namely ‘group’, ‘summation’ and ‘inverse’, were added at the editorial stage; in other words, they were ‘consciously grafted on’ to the existing poetical image.⁶⁰⁶ Cioranescu sees this as a weakness, and evidence that the mathematics and poetry do not mix very naturally in Barbu’s work. However, Cioranescu argues that both fields nonetheless existed as a duality within Barbu’s own ‘mental universe’, that the connections were ‘prospected’ by him, and that both geometry and poetry were a result of his careful thinking, and ‘excogitation’.⁶⁰⁷

Cioranescu, unlike many others, attempts to draw a causal pattern of influence from poetry towards mathematics. He wonders whether a form of ‘sensibility’, heightened by poetry,

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⁶⁰⁴ Cioranescu, *Ion Barbu*, 38. English translation from Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 18. ‘Morphology’ in science, particularly biology, refers to external shapes and structures, and relations between these. In linguistics, morphology refers to changes within words, including most commonly inflections, and prefixes and suffixes. See “Morphology, N.” In Barbu’s case, I would understand morphology as referring to both, with a preference towards inflections. In his 1958 piece, “Direcții de cercetare în matematică contemporană”, Barbilian mentions a mathematical ‘integrated morphology’ in the context of Emmy Noether’s contributions to unifying the ‘global’ and ‘atomistic’ in mathematical algebra. Barbu, *Pagini de proză*, 227.

⁶⁰⁵ The 11 poems identified by Basarab Nicolescu are “Din ceas dedus...”, “Timbru”, “Grup”, “Inecatul”, “Poartă”, “Lemn sfânt”, “Mod”, “Margini de seară”, “Dioptrie”, “Paznicii”, “Falduri”. Cioranescu, *Ion Barbu*, 142, note 22. See later section on analysis of selected poems.

⁶⁰⁶ Ibid., 48. Comprehensive early manuscripts of *Joc secund* have not survived. Vulpescu’s annotated edition was perforce based on more haphazard scraps of drafts: Petrescu, *Ion Barbu și poetica postmodernismului*, 171.

⁶⁰⁷ Cioranescu, *Ion Barbu*, 50.

might have influenced Barbilian's mathematics. But Cioranescu does not expand on this, nor does he draw explicit links with specific areas of mathematics.

Similar insights are expressed succinctly by Constantinescu and Littera, who identify Barbu's poetry with infinitely multiple possibilities of combination. They note that it is possible for a reader to determine contradictory semantic links of association between strings of words, in a manner that is very deliberate and planned. They explicitly liken this synonymy and juxtaposition of metaphors to the deductive method of logic.⁶⁰⁸

Literary theorist Nicolae Balotă is another who made a sustained attempt to analyse the mathematical nature of Barbu's poetry. Balotă discusses the Erlangen programme, noting that under it, geometry lost its traditional property of 'invariable' figures, in favour of multiple possibilities, and that it removed for ever the privileged position of Euclidean geometry.⁶⁰⁹ Making an explicit link with poetry, Balotă argues that Barbu understood the deductive geometric system of organising elements to be comparable to poetry's disjunctive ordering of verbal elements through metaphor, and that this diversity resembled a group-theoretic method, with metaphors seen as akin to symbols. Balotă asserts that for Barbu, intellectual contemplation was essential to both mathematics and poetry, and he makes an explicit comparison between abstract features of mathematics and of poetry:

poezia se refuză ca reprezentare a fenomenelor. Asemenea geometriei (și împreună cu ea),
poezia vizează universal infinit al posibilelor.⁶¹⁰

Balotă draws on his earlier remarks about the multiplicity inherent in modern geometries. In rejecting phenomenological concepts, he is referring to Barbu's preference for an abstract ideal, as opposed to an empirical and anthropocentrist view; a preference that matches Barbu's other statements and reflects his affinity to literary Symbolism. As for that Symbolism, Balotă cites Barbu's explicit drawing of a link between the abstraction of mathematical symbolism and its less well-defined counterpart in Symbolist poetry:

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⁶⁰⁸ Constantinescu and Littera, "Indici de predictabilitate." Constantinescu and Littera do not state it explicitly, but probably expect that Romanian readers of the time will make the immediate connection between mathematical logic and linguistic formalism. (As discussed briefly in the section on Hilbert's mathematics, particularly following Gödel, see note 494.) Another literary critic who has explicitly drawn the link between the philosophical changes in mathematics after Gödel, and (inter alia) the experimental poetics of the Symbolists is the French-born American George Steiner: Steiner, *Real Presences*.

⁶⁰⁹ In fact, as was noted earlier (see note 491), mathematical invariance was at the heart of the Erlangen programme, so Balotă's choice of word 'invariable' in this context is understandable, but somewhat unfortunate.

⁶¹⁰ Balotă, "Ton Barbu între poezie și geometrie," 18.

Poetry refuses to be a sensory representation of appearances. As with geometry (and together with it), poetry envisages a universal infinity of possibilities.
The vocabulary here is closely linked with philosophical phenomenology, most likely that of Kant and Husserl.

Abstracțiunile matematice ca și figurația poetică au – în mod egal – nevoie de simboluri concrete în reflectarea unui cosmos unitar.⁶¹¹

To further understand Barbilian's mathematics, Balotă refers to Solomon Marcus (who has been mentioned already and is discussed in more detail later in this chapter) and briefly lists Barbilian's mathematical fields of interest. Citing Marcus, Balotă notes Barbilian's enthusiasm for the capacity of non-algorithmic algebra to open up thinking, and his view of calculus as a useful and heuristic method, but not something that leads to an essential or pure understanding ('nu poate să ajungă la esențe'⁶¹²).

Other than this short summary of Marcus, Balotă does not address the issue of Barbilian's mathematics in its traditional symbolic form, but he does a lot more than most. His is one of the most comprehensive and directed attempts among literary critics to address Barbu's mathematics. The features that he examines which establish parallels between the two modes of thinking are significant, and indicative of the degree to which the two fields are interrelated. Balotă concludes that Barbu's poetic position was inspired by Emmy Noether's school of mathematical purism, as well as by the purism and abstraction of Mallarmé.

Gyorgy Mandics is a Hungarian literary theorist who in 1984 published a monograph on Barbilian, originally in Hungarian. Mandics asserts that in order fully to understand either Barbilian's mathematics or Barbu's poetry, the reader must first comprehend both fields.⁶¹³ He remarks in particular that the reader of the poetry should be aware of Barbilian's interest in geometry and algebra, and also the 'axiomatic' style in mathematics, a discipline that Mandics argues is heavily Platonist, with its own particular beauty. Mandics also comments on a desirable aspect of 'homogeneity' in Barbu's poetry, associating this with *more geometrico*, by which Mandics is presumably referring to the 'axiomatic' and philosophico-logical style adopted by Spinoza in outlining his philosophy of ethics.⁶¹⁴

In this context, Mandics cites Barbu:

limitele posibilităților și preferințele autorului: un fel abstract de a gândi clase izomorfe unit cu preocuparea modelului canonic.⁶¹⁵

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⁶¹¹ Ibid.

Mathematical abstractions and poetic figures both – in equal measure – need concrete symbols to reflect a unitary cosmos.

⁶¹² Ibid.

⁶¹³ In particular, Mandics refers here to Umberto Eco's writings on the epistemological metaphor.

⁶¹⁴ Mandics, *Ion Barbu "Gest închis,"* 33. Spinoza's *Ethica Ordine Geometrico Demonstrata* or *Ethica More Geometrico Demonstrata* was published in 1677, and takes a 'propositional' style, in keeping with that of Euclid. Spinoza's style is heavily Euclidean, and Mandics indeed refers to the fact that ancient mathematics was written in poetic verse, as a mnemonic. Spinoza (1632-1677) is often associated with his predecessor Descartes (1596-1650), and both are invoked, often disparagingly, by Herbert and Milosz, see chapters 3 and 4.

⁶¹⁵ Ibid.

In mathematics, the ‘canonical’ form is the orthodox, most standard one. Barbu is suggesting here that as a writer of poetry his limits are imposed by mathematical convention. That is, the limits of what he can say, or what a reader can infer, are similar to the limits imposed by say the operations of a mathematical group.⁶¹⁶

Re-iterating points already made, Mandics adds that for Barbu, plural non-Euclidean spaces, rather than one space, are important, and he also repeats the frequently quoted comment deriving from Gauss, via Minkowski, about the importance of establishing minimalist expression, in this case in poetry. The ideas of the algebraic-geometers Gauss, Riemann, Bolyai and Lobachevsky, Mandics asserts, run in parallel with those of the French Symbolists Mallarmé and Valéry.

In his foreword to Mandics’s work, Dan Grigorescu remarks that Barbu’s poetry fits into a concept of logos, which sees language as open to interpretation, and that he takes a structuralist approach that is to some extent present also in James Joyce and T.S. Eliot.⁶¹⁷

I have mentioned already the work of the critic Ioana Em. Petrescu. She also recognises the importance of non-Euclidean geometry, arguing that the first revolutionary idea in ‘new science’ was non-Euclidean geometry, and she references Bolyai-Lobachevsky and Riemann in particular. Petrescu remarks that this resulted in an abandoning of the intuitive model of space, and having to accept through reason, rather than empirically, another type of space where – as Petrescu puts it – parallel lines may meet.⁶¹⁸ She argues that Barbu abandoned the anthropocentric and individualist model of the Renaissance, together with the classical concepts of science.⁶¹⁹

Turning to mathematical group theory, Petrescu characterises this as diverse mathematical objects corresponding to intuition and the imagination, rather than experiments and objects; in other words a continuation of the downgrading of the empirical model inherent in the new geometries. She remarks that Barbu made a very clear distinction between geometry

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the limits of possibilities and an author’s preferences: an abstract way of thinking of isomorphic classes combined with a preoccupation with the canonical model.

⁶¹⁶ This is in keeping with the remark Barbilian made in his 1940 mathematics paper, on ‘extreme’ Ideals, and how far they can be taken. See note 524.

⁶¹⁷ Mandics, *Ion Barbu “Gest închis,”* introduction.

⁶¹⁸ This is probably not the same understanding of intuition as held by the Dutch mathematician Brouwer, see chapter 1.

⁶¹⁹ This loss of the individual is characteristic of Modernism, and Petrescu argues that non-anthropocentrism is almost a definition of current scientific thought. In fact, this is not necessarily so in for example quantum mechanics where the role of the observer is very important. Indeed Petrescu herself refers explicitly to the work of Niels Bohr in quantum mechanics, the participating observer and hence disappearance of a universal authorial voice. It is interesting that in support of her views Petrescu cites Gaston Bachelard’s 1934 *Le nouvel esprit scientifique* as a key text, in other words she draws on the work of a French philosopher (who did have an early background in Physics), but there is nothing to suggest that Barbu would have been an adherent of Bachelard’s philosophy.

and physics, akin to that between intellectual constructivism and the constraints of empirical data, and notes Barbu's view of Einstein as a geometer and not a physicist. Petrescu considers that Barbu drew in particular from Einsteinian relativity the notion of changing frames of reference and three-dimensionality in a four-dimensional universe, which Petrescu sees reflected in the shell and spiral images in his poetry, which suggest multiple dimensions coiled into fewer dimensions.⁶²⁰

These insights aid a greater understanding of the mathematical nature of Barbu's poetry, but it is also particularly interesting to see how mathematicians have analysed Barbu the poet.

Mathematical critics

Mathematicians who have explicitly examined Barbu's poetic work for its mathematical content are relatively few.

Romanian algebraist Mihai Brescan published an article discussing mathematics and poetry in 2009, part of which I have discussed elsewhere.⁶²¹ Like others, he takes Dan Barbilian as an exemplar of practitioners who cross both fields, and also notes the critical scholarship of Solomon Marcus, Basarab Nicolescu and Gyorgy Mandics. Of Mandics's *Gest închis*, Brescan claims that Mandics sets out to demonstrate that the collection *Joc secund* is structured like Kleinian geometry, with transformations and invariants of a fundamental set. This is a reference to the repeated, but permuted (interchanged) images across the collection. Brescan's evaluation of Mandics is perhaps a little overstated, but Brescan's short article is nonetheless worthwhile, not least for the fact that it is written by a practising mathematician.

Gheorghe Bantaş and Dan Brânzei are also Romanian mathematicians. Their notes on Barbilian's areas of mathematical expertise are included in an earlier section of this chapter.⁶²² On his poetry, they say relatively little, but drawing in particular on the work of Solomon Marcus (see below), Bantaş and Brânzei remark that the 'essence' (*esența*) is what characterises Barbu's poetry and Barbilian's preferred areas of mathematics.⁶²³

Wladimir Boskoff and Bogdan Suceavă are currently practising mathematicians who have also turned their attention to Dan Barbilian. Their several articles are perhaps the most explicitly mathematical, in that they give a clear exposition of the development of Barbilian's

⁶²⁰ Barbu's first poetry booklet, published in 1921, was a single poem, entitled '*După melci*' (In the manner of snails)

⁶²¹ Brescan, "Mathematics and Art." See chapter 2.

⁶²² See notes 499, 504, 526.

⁶²³ Bantaş and Brânzei, "Dan Barbilian-fereastră de înțelegere a lui Ion Barbu," 22.

metrisation procedure, attempting thereby to explain connections between the mathematics and Barbu's poetry. While such connections remain elusive, Boskoff and Suceavă conclude:

The mathematical idea of the metrization procedure is not at all too different from the idea poetically expressed in *Secondary Game* [...] These verses are expressing the quest for the unifying vision of a fundamental principle, of an ultimate generating source. In this sense, the poetry is a form of knowledge, an attempt to extract the essential, of eliminating the unnecessary weight, a repetitive and pointless technicality, of what Barbilian ironically describes as 'laborious barbarism'.⁶²⁴

Boskoff and Suceavă are picking up on the abstract characteristics of Barbilian's mathematics, as opposed to technical or mechanical detail, and their work has made a considerable contribution to the continued recognition of Barbilian in contemporary literary and mathematical culture, both within and outside Romania.

Basarab Nicolescu is a Romanian physicist who established a virtual project on 'transdisciplinarity' (the *Centre International de Recherches et Études Transdisciplinaires*), which he describes as a means of better understanding various otherwise dissociated academic fields of thought, drawing on the work, in physics and mathematics, of Heisenberg, Pauli, Bohr and Gödel, and recent developments in consciousness theory.⁶²⁵ Nicolescu has taken a particular interest in the work of Dan Barbilian, and his 1968 *Ion Barbu: cosmologia "Jocului secund"* was the first published monograph aimed at an explicitly mathematical approach.

Nicolescu devotes considerable attention to how Barbu sets about creating his poetry, using mathematical-like techniques. He remarks that Barbu applies an 'axiomatic' approach to poetry in that he takes a number of ideas or concepts, and then builds up the poem, through 'aedral operations', with its numerous allusions.⁶²⁶ Nicolescu makes the direct link with Erlangen in this regard, which he understands as a method of 'enlightened eclecticism', and with Hilbert, for his (citing Barbilian) 'exhaustive enumeration of ideas generated from one doctrine', constituting 'problems of fundamental autonomy and of purism'.⁶²⁷ Nicolescu observes that Barbu's surviving manuscript drafts demonstrate that he consciously worked towards eliminating 'redundant' words in his poems, and furthermore that he would deliberately replace an initial word choice with one that had greater scientific resonance. With

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⁶²⁴ Boskoff, Dao, and Suceavă, "From Felix Klein's Erlangen Program to Secondary Game," 31. On this 'laborious barbarism' reference see note 491.

⁶²⁵ Alvarenga, "Interview given by Basarab Nicolescu to Professor Augusta Thereza de Alvarenga."

⁶²⁶ By 'aedral', I understand Nicolescu to be alluding to a building up, or cumulative construction, of operations. (Refer the Latin *aedicula*.) This approach becomes evident when looking at the repeated use of images in the poems themselves.

⁶²⁷ Nicolescu, *Ion Barbu*, 126. 'numărătoarea exhaustivă a ideilor generatoare ale unei doctrine', 'o problemă de fundamentare autonomă, o problemă de purism.'

reference to Gauss's maxim, Nicolescu remarks on Barbilian's hermetic style; this removal of redundant words leaving 'sources' of ideas:

[Barbu] makes ample use of scientific terms which associated with simple words convey a maximum of meaning with the most condensed means of expression [... Thus he] attempted and brilliantly achieved an "axiomatisation" of poetry; he elaborated a system and a poetic method extracting his substance from the very spirit of science but appealing to the most complex sensibilities.⁶²⁸

Barbu's poetry presents concise words, apparently deliberately chosen with a scientific allusion, which the reader is then left to interpret. But the interpretation, from minimalist references, nonetheless rests on an understanding of multiple associations, just as the axiomatic approach to mathematics captures in the briefest and pithiest of formulations, a statement that provokes multiple associations.

Discussing the role of science, Nicolescu remarks that Barbilian's work had significant consequences for the 'degree of expression of our language', and that his poetry which encapsulates a scientific understanding of the complex capabilities of the human mind, can be described as a 'scientific humanist' approach.⁶²⁹ Addressing the criticism of writers such as Ionesco or Manolescu⁶³⁰, he disagrees that Barbu is hermetic in a sterile sense; instead he offers a humanist insight, using a scientifically-inspired method. Nicolescu also contributes a mathematical understanding of Barbu's poetry that is not necessarily evident to a non-mathematician: he notes that whereas the poet Valéry found science alluring for its supposed demonstration of a 'refined', 'essentialised' mind, in the case of Barbu he understood mathematics as original and creative within its own field.⁶³¹

With this in mind, Nicolescu examines Barbilian's teaching materials, consulting a surviving course-text written by Barbilian for undergraduate mathematics students, the 1947-48 "Course of Lectures in Axiomatic Algebra", in which Barbilian explains – in the third person – what it is that appeals to him in the field:

Algebra axiomatică e o abstragere a algebrei algoritmice – arată profesorul Dan Barbilian. Ea reține *operația în sine*, indiferent de orice idee de reprezentare, așadar indiferent de domeniul căruia operația se aplică.⁶³²

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⁶²⁸ Nicolescu, "A Poetic Method," 70–71.

⁶²⁹ Ibid., 71.

⁶³⁰ See notes 591 and 594.

⁶³¹ Nicolescu, "A Poetic Method," 71.

⁶³² Nicolescu, *Ion Barbu*, 125.

Axiomatic algebra is an abstraction of algorithmic algebra, demonstrates Professor Dan Barbilian. It retains *operations in themselves*, regardless of any notion of representation, similarly regardless of the domain in which the operation is applied.

That is, the operations can be seen as existing independently of any specific application.⁶³³ Barbilian's point as applied to poetry is that the way that words interact with one another is more important than the meaning of the words themselves, which he perceives as undesirably personal, or 'phenomenological'.⁶³⁴ This interaction depends, however, on how the individual words are defined, or to put it in a mathematical context: the way that a member of a group may behave is limited by the initial construction of that group and its operator function.

Nicolescu identifies certain mathematical characteristics in Barbu's poetry, but it is not always clear that he, a physicist and not a mathematician, has fully absorbed Barbilian's distinction between modern algebra and more classical analysis, as at times he conflates terminology from the two fields. At no point does Nicolescu acknowledge, for example, that calculus was not one of Barbilian's preferred areas of mathematics, evidenced in the latter's discussion of the following passage from "Jean Moréas":

[Moréas] achieves the real "reform" of poetry which ... corresponds to a more developed moment of the critical conscience [...] in the manner that the geometers' axiomatic thought and global researches ... complete the mere methodological preoccupations and the local, infinitesimal studies of their forerunners.⁶³⁵

Barbilian is focussing here on the shift of emphasis from minutiae to broad principle, and care needs to be taken in conflating the 'infinitesimal' in calculus, with the groundbreaking work on infinities, begun by Cantor.⁶³⁶ Nicolescu, however, infers the change and movement from calculus, which was concerned with the local and infinitesimal, to abstract algebra, which tended towards a more universal and generalised focus. Declaring that Barbilian developed an 'exhaustive unified theory' of poetry and mathematics, Nicolescu argues that this is directly comparable to the assimilation in mathematics of disparate elements through axiomatisation and group theory, serving 'the high aim of making known the unity of the moral universe of concepts'.⁶³⁷ But his detailed discussion can become confusing.

Nicolescu argues that as in the methods of calculus, the incremental and syntactical relationship of words and phrases in Barbu's poetry are of prime importance, that the

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⁶³³ In fact, this is a characteristic of the field of category theory in mathematics, also known as universal algebra, that was developed in the 1940s (i.e. after the publication of *Joc secund*, but still during Barbilian's lifetime). See the discussion in the Conclusion of this thesis.

⁶³⁴ On phenomenology and representation, see note 610.

⁶³⁵ Nicolescu, "A Poetic Method," 69.

⁶³⁶ The Russian-Prussian Georg Cantor (1845-1918) also studied at Göttingen and is remembered for his revolutionary creation of transfinite cardinal numbers, which led to the modern precision in considering differing concepts of infinities.

⁶³⁷ Nicolescu, "A Poetic Method," 69. This wording comes directly from Barbilian's remark on the Erlangen programme, and a 'new humanism', refer note 491.

‘infinitesimal’ for Barbilian is a reference to a ‘thought structure of great energy’, touching on ‘margins’ [limits].⁶³⁸ Poetry, particularly symbolist, takes a small number of symbols to compose a ‘vast ritual’ of ‘erudite configurations’⁶³⁹, exhibiting ‘limit conditions of “critical points”’.⁶⁴⁰

This is not unreasonable, but in mathematics, ‘critical points’ are a feature most commonly associated with calculus and analysis; and it was not calculus in itself that most appealed to Barbilian. It was rather an appreciation of the revolutionary style of classical calculus at the time, in its methodical and innovative style (due particularly to Leibniz), and its essential work in the definition and treatment of limits. This should be borne in mind when Nicolescu notes that Barbilian explicitly compares Rimbaud with Galois, in that they both undertook ‘daring ventures taking place at the borders of the spirit’.⁶⁴¹

Notwithstanding the possible confusion around calculus, Nicolescu’s examination of Barbilian is informed and insightful, including his examination of the role of metaphor. He comments that through metaphor Barbilian brought together separate elements, evidencing a comprehensive and meaningful structure of the universe. However, the precision of meaning in mathematics does not transfer across to poetry: concepts ‘suffered’ through semantic transfer from mathematics to poetry, to the extent that the definite is transformed into the indefinite, and notions are converted into ‘symbols of a trans-language capturing the vibrations of the ineffable’.⁶⁴² These are all very accurate observations.

Furthermore, in a tantalisingly brief aside, Nicolescu states that Barbilian’s mathematical method follows a poetic one, noting that his mathematical language is more metaphorical than that of other mathematicians, and across both his fields of work the two styles of language approach a midpoint.⁶⁴³ Nicolescu is saying that the long-standing and central use of metaphor in poetry is a way of thinking and conceiving of broad ideas that only later, with modern algebra, entered mathematics, which is an interesting observation unfortunately not expanded upon in any detail.

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⁶³⁸ Ibid.

⁶³⁹ Ibid.

⁶⁴⁰ Nicolescu, *Ion Barbu*, 124.

⁶⁴¹ Nicolescu, “A Poetic Method,” 69.

⁶⁴² See discussion of Nicolescu’s *Cosmologia* in Dincă, “Stages in the Configuration of Basarab Nicolescu’s Transdisciplinary Project,” 121. Whether or not that is a ‘loss’ as such, is debatable; some might argue that poetry offers a broader and deeper scope for personal interpretation.

⁶⁴³ A good example of this is Barbilian’s mathematical paper discussed in note 524. Nicolescu is also drawing directly on the work of Solomon Marcus, see below.

Solomon Marcus is a professor emeritus in Mathematics at the University of Bucharest, specialising in Analysis, Computer Science, Linguistics and Semiotics. His general writing on mathematics and poetics has been discussed at some length in chapter 2, and those ideas need to be borne in mind when reading much of the present chapter. Barbilian was on the staff at Bucharest University when Marcus first joined the mathematics department as a student in 1944, and Marcus acknowledges his influence on his own work.⁶⁴⁴ Marcus is by general agreement the pre-eminent mathematically-trained Barbilian scholar, and his work on mathematics and poetry more generally is extremely relevant for this thesis.

In 1987 Marcus published *Șocul matematicii* (*The Shock of Mathematics*), in which he remarks:

Ion Barbu left ineffaceable traces on Dan Barbilian and vice versa: Ion Barbu's work is incomprehensible without grasping the essence of Dan Barbilian's thinking and work.⁶⁴⁵

What precise influence Barbu the poet might have on Barbilian the mathematician is not spelt out. Marcus does state, however, that Barbu 'asserted his poetical creed' four years before Gödel's publications on incompleteness, suggesting that the poetic thinking predated the mathematical in this case, and he comes to a tentative conclusion that the two fields 'leave traces' on one another, with a discovery in one being either followed or preceded by similar developments in the other, not necessarily with a direct causal link.⁶⁴⁶

Marcus does not always agree with Nicolescu. In his "Two Poles of the Human Language", Marcus notes that Nicolescu, and others, consider Barbu's poetry to be atypical in that its semantics are not open, and that if one can succeed in understanding the complex mathematical allusions (not in itself an easy task) there is no ambiguity. Marcus takes issue with Nicolescu's interpretation of both mathematics and Barbu in this respect, arguing that Nicolescu's interpretation is as a physicist, and although complex and scientifically literate, it is, however, not the only one. As Marcus points out, mathematics too is not necessarily semantically closed and he cites a number of French scholars in this regard who have argued that mathematical expressions are equally subject to particular cultural and individual contextual interpretations.⁶⁴⁷

Marcus looks at semantic openness in language, and argues that the Mallarméan (Symbolist) pleasure in linguistic suggestiveness is pervasive in Barbu's poetry and that he expected the readers of his poems to fully recognise this in their response. Marcus furthermore links this characteristic directly with Gauss's maxim on the desirability of a maximum of

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⁶⁴⁴ Froda, Moisil, and Ghika, "Interview."

⁶⁴⁵ Brescan, "Mathematics and Art," 110. English translation by Brescan.

⁶⁴⁶ Non-causality in the relations between science and literature is discussed particularly well by Gillian Beer, see chapter 2. On Gödel, see note 494.

⁶⁴⁷ Marcus, "Two Poles of the Human Language." See chapter 2.

meaning in a minimum of words, and remarks favourably on the laconic style of many written theorems in mathematics as an example of the style Barbu wanted to maintain in his poetry.

On the other hand, Marcus accepts Nicolescu's argument that Barbu is more univocal and less ambiguous than say Mallarmé, to the extent that Barbu's work as a whole has a certain univocality about it. This is a reference to Barbu's underlying preference for areas of modern mathematics that concentrated on unified and global fundamentals, and I suggest it is also referring to Barbu's repeated themes and images across his poems and his careful construction of *Joc secund* as a standalone and self-referential collection. This will become more evident in the course of the poetical analyses in the next section.

Marcus observes in Barbu a tension between ambiguity and precision, noting that this is a general poetic paradox, in that suggestion nonetheless requires lexical precision. In this context he remarks on what both mathematics and, by analogy, poetry are representing: the 'essence of mathematics' consists in 'the absolute freedom of its language'; freedom being related to 'absence of any connection to the real'.⁶⁴⁸ This is an important basic concept of Barbu's poetics: he sees mathematics as offering the greatest potential for the concept of maximum freedom of interpretation through a minimum of words, that in themselves (and herein lies an ostensible paradox) are chosen with great care and attention to existing mathematical structures and conventions.

Joc secund

Joc secund is Barbu's major collection of poetry, published in 1930. Barbu declared that the lyrical potential of the Romanian language was being stifled under the assimilated poetic convention of the time.⁶⁴⁹ *Joc secund* was an attempt to address this; after which he no longer published any poems.⁶⁵⁰

Joc secund literally translates as "second game", and the notion of striving towards another reality, or an external ideal, is examined by a number of Barbu's critics. Boskoff and Suceavă for example describe the second game as an 'overthrow of reality' and subsequent transformation into an underlying and hidden play.⁶⁵¹ Petrescu considers the second game to refer to transcendence.⁶⁵² Cassian argues that it refers to life mirroring itself in art.⁶⁵³

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⁶⁴⁸ Cited in Brescan, "Mathematics and Art," 116–117.

⁶⁴⁹ Nicolescu, "A Poetic Method."

⁶⁵⁰ He continued to write some verse, but primarily for himself.

⁶⁵¹ Boskoff, Dao, and Suceavă, "From Felix Klein's Erlangen Program to Secondary Game."

⁶⁵² Petrescu, *Ion Barbu și poetica postmodernismului*.

⁶⁵³ Cassian, "Notes on Romanian Poetry." Secondariness can also be compared to the process of translation, and so in this context, translation from mathematics to poetry.

Petroveanu claims that *Joc secund* rejects any immediate temporality and historical context in favour of a timelessness, and that Barbu saw this as a way to access an ideal human ‘essence’.⁶⁵⁴

Secondariness, especially the thought of mirroring or reflection, is also present in symmetry, the central concept in group theory, and the mathematical nature of *Joc secund* is very strong. The pieces in the collection, some previously published, were carefully chosen and ordered, and this selection and construction is important, as it is a reflection of his commitment within mathematics towards unity, concision and brevity, all characteristics of the modern mathematics most admired by Barbilian the mathematician.

The building up, in an ‘aedral’ manner⁶⁵⁵, of repeated and complementary images within the collection is also an important feature. In the way that axioms or postulates are the basis of an axiomatic approach to mathematics, so too do the core images form a common, albeit differentiated, basis for many of Barbu’s poems. This poetic style is an elaboration of a type of ‘axiomatic’ poetics, whereby short and concise words and expressions are presented to the reader for interpretation. In this way, Barbu is drawing on an understanding of Hilbertian ‘exhaustively’ defined axioms that allow for the maximum of interpretation, towards an absolute ideal, but subject to the various limits and restrictions on the possibilities allowable within that axiomatic system. Whenever possible, the particular and personal is not stated, but only inferred from the axioms.

For that reason, suggestion and allusion are very significant, since the reader is presented with discrete and multiple images, leaving their full interpretation to the cumulative effect of multiple poems that complement and build upon one another. *Joc secund* attempts to indicate an external ideal through suggestion; and this is what lies behind the book’s epigraph: Stéphane Mallarmé’s *ne fût-ce que pour vous en donner l’idée*.⁶⁵⁶

These multifaceted features are best evident by viewing the collection as a whole, but here I analyse seven poems. The order reflects their original ordering by Barbu within the collection.

[DIN CEAS, DEDUS...]

Din ceas, dedus adâncul acestei calme creste,
Intrată prin oglindă în mântuit azur,
Tăind pe înecarea cirezilor agreste,
În grupurile apei, un joc secund, mai pur.

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⁶⁵⁴ Petroveanu, “A Brief Survey of Ion Barbu’s Poetry,” 33.

⁶⁵⁵ This is Nicolescu’s term, see note 626.

⁶⁵⁶ Were it only to give you the idea.

From “Villiers de L’Isle-Adam” in Mallarmé, *Oeuvres complètes*, 495. Games, chance, and algebraic combinations are concepts that are specifically raised by Mallarmé in his *Un coup de dés*: see epigraph; also chapter 2.

Nadir latent ! Poetul ridică însumarea
 De harfe resfirate ce-în sbor invers le pierzi
 Și cântec istovește : ascuns, cum numai marea,
 Meduzele când plimbă sub clopotele verzi. ⁶⁵⁷

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⁶⁵⁷ Written in 1929 and first published in *Joc secund* 1930, using material dating from 1920. Originally untitled, this poem is often titled “Joc secund”, see for example Rosetti and Calin’s 1966 edition: Barbu, *Joc secund*, 63. But Barbu’s textual notes suggest that he preferred either the first-line title “Din ceas, dedus...” or to leave it untitled. Several earlier versions of this poem, with substantive alternatives, survive: Barbu, *Poezii*, 154, Vulpescu notes. Unlike most, this poem has been translated into English several times. My preferred translation, particularly for the purposes of this study, is the quite literal one taken (with minor spelling modifications) from Băjenaru, “Ton Barbu or the Revelation of the Sublime,” 193. George Băjenaru is a US-Romanian poet, literary critic and translator.

FROM TIME, DEDUCED

From time, deduced the depths of this calm crest
 Entering through the mirror the redeemed azure,
 Cutting on the sinking of the great rustic herds,
 In groups of water, a second game, more pure.

Latent Nadir! The poet lifts up the sum
 Of harps dispersed you lose in inverse flight
 And song exhausts: hidden as only the sea hides
 Medusas as they walk underneath the green chimes

An alternative translation into English is that by Paul Doru Mugur and Alina Savin in Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 20.

SECONDARY GAME

From time inferred, the depth of this calm peak
 Through mirror crossed into redeemed azure.
 The herds’ immersion cutting on the cheek
 Of water groups, a second game, more pure.

Latent nadir! The poet lifts the tree
 Of scattered harps that fade in reverse flight,
 And song exhausts: it’s hidden like the sea
 Under medusas’ drifting bells of light.

And still further, another by Liviu Georgescu in Firan and Doru Mugur, *Born in Utopia*, 33.

A SECOND GAME

From time, abstracted the depth of this peaceful crest,
 Gone through the mirror into redeemed azure
 Engraving on the sinking flocks of rustic fest
 Out of the water groups, a second game, more pure.

Latent Nadir! The poet elevates summation
 Of spread out harps you lose in a reverted flight
 And painfully distils a song: hidden, as only sea’s cremation
 Sways its Medusas under the greenish bells of light.

“Din ceas, dedus ...” is the originally untitled poem that opens *Joc secund*. It describes Barbu’s attempt to reach a ‘second game’ or alternative and transcendent reality, through a summation of images. The attempt is ultimately unsuccessful, as acknowledged by Barbilian of his overall theory of a mathematical poetics, since the poet’s music and songs are lost and dispersed in the ocean’s depths and under the weight of water, but there nonetheless remains a very strong suggestion of the heights to which the poet was trying to reach.⁶⁵⁸

The images of water are important, and they are a common feature of many of Barbu’s other poems, suggesting weight and drowning, but also in some instances light, reflection and diffraction. For him, water represents sight – or vision, in its many senses – enhanced and enriched, even if ultimately distorted.⁶⁵⁹

These are all central concepts in Barbilian’s understanding of mathematics, but in addition he also uses overtly mathematical imagery. The ‘summation’ of images I have mentioned already; the opening reference to time is evocative, since its simple translation ‘from time’ (*din ceas*), carries in Romanian not only connotations of ‘from time to time’, or occasionality, but also a moving out from within time. Like the references to light and optics, time in the 1920s immediately brings to mind Einstein’s relativity and his rejection of time as an invariable. This poem is doing the same, suggesting Barbu’s ultimate aim of reaching a state of transcendence, beyond time. The mathematical connotation is further emphasised by the immediately succeeding reference to deduction.

Einstein drew heavily on the work of the Göttingen mathematicians in his construction of a new space-time continuum, and in this poem, the most obvious Göttingen mathematical reference is of course the ‘group’. Group theory is central to modern algebra, and it is a central concept in ad lived in New York, since it represents precisely the combination of elements (or images) that come together and interact together, leaving some features invariant, such as transcendence, purity and a second reality. It also alludes to the images of water since reflections are a strong feature of group theory, and likewise the various opposites, as symmetry is central to group theory. Barbu uses this concept in several of his poems, not least in the eponymous “Grup”:

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⁶⁵⁸ This juxtaposition of height and depth has been noted in Barbu’s poetry since Vianu’s first monograph in 1935 (see note 478). In the chapter “Perspectivă” (Perspectives), for example, Vianu remarks that in striving ‘for the peace of the non-created being or for the incipient, innocent life’, Barbu moves from the ‘summits of conception’ to the ‘depths of its most hidden meanings’. (*Pacea ființei necreate sau către viața începătoare și nevinovată [...] Înălțimile concepției [...] adâncimea sensurilor ei mai ascunse*, Vianu, *Ion Barbu*, 85–89. English translation from Vianu, “Ion Barbu’s Poetry: The Degrees of the Vision,” 67–68.)

⁶⁵⁹ Barbu himself initially wanted to call his collection *Ochean* (spyglass) in place of *Joc secund*, with the idea to create a parallel, higher, world that relies on personal, transforming, metaphors: Cornis-Pope, “Ion Barbu (Dan Barbilian).” Images of sight, light, and of the sea (a spyglass is used in particular in the nautical context) are prevalent in the poems themselves.

GRUP

E temnița în ars, nedemn pământ.
De ziuă, fânul razelor înșală ;
Dar capetele noastre, dacă sunt,
Ovaluri stau, de var, ca a greșeală.

Atâtea clăile de fire stângi !
Găsi-vor gest închis, să le rezume,
Să nege, dreaptă, linia ce frângi :
Ochi în virgin triunghi tăiat spre lume ? ⁶⁶⁰

This poem describes Barbilian's reflections on group theory, as a method which attempts to depict the 'highest states' of being. For Barbilian the mathematician and mathematical humanist, it should theoretically be possible to do this through mathematics, and in particular group theory, but as he has described in his prose work, and across *Joc secund* this attempt is frustrating and ultimately unsuccessful. "Grup" is a static poem that draws on mathematical imagery to represent an image of creative promise and suggestion that is ultimately stultified. The mathematical images are those that suggest the promise – the ideal

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⁶⁶⁰ First published in 1927 in *Sburătorul*. Barbu, *Poezii*, 156.

GROUP

It is a prison on burned, unworthy earth.
In the day, the sheaf of rays deceives;
But our heads, if they be,
Ovals remain, of lime, like an error.

Many stacks of lefthand threads!
Will they discover a closed gesture, to summarise,
To deny, straight line that brakes :
Eyes in a virgin triangle cut towards the world?

This translation draws, with modifications, from translations by Paul Doru Mugur and George Băjenaru in respectively Boskoff, Dao, and Suceavă, "From Felix Klein's Erlangen Program to Secondary Game," 20; Băjenaru, "Ion Barbu or the Revelation of the Sublime," 192.

See also Constantin Froisin's translation into French in Barbu, *Poeme / Poèmes*, 31.:

GROUPE

Un vrai cachot, cette terre brûlée, indigne.
À l'aurore, la gerbe des rayons illusionne.
Pourtant, nos têtes, au cas où elles s'alignent,
S'érigent en ovales de chaux, presque une maldonne.

Si nombreuses les tignasses à cheveux gauches.
Trouveront-elles ce geste ferme pour la réduction,
Pour le déni de la ligne droite qu'on fauche :
Cet œil en vierge triangle taillé pour la création ?

towards which Barbu is struggling – but, as he said of his poetry as a whole, ultimately he failed to reach his ideal.

In this regard, the group, as far as Barbilian conceives of it, is a prison in the sense that it is a concept that traps, rather than illuminates; on the burned unworthy earth are found the earlier foundations of mathematics that have to some extent been discredited, but not yet adequately replaced. These mistakes and misrepresentations are evident in ‘deceives’ and ‘error’ (itself a mathematical term). The rays and threads are potentially hopeful, but their innate propensity for confusion – i.e. “left-handedness”, or cackhandedness – suggests failure. The aim is to find a ‘closed gesture’ in the sense of a neat and tidy theorem, or a unified grand theory,⁶⁶¹ that will give the lie to the straight-lined Euclidean view of geometry, in favour of a possibly more accurate triangular concept. In hyperbolic, or non-Euclidean space, the angles of a triangle sum to less than the standard one hundred and eighty degrees. The ‘eyes’ may be the angles in this case.⁶⁶² Moreover, closed-ness is a property of groups and their operation.

For Barbilian in the 1920s group theory was a new and exciting field, with many as yet unexplored future possibilities. Group theory was central to developments in modern algebra, it was drawn heavily upon in the development of non-Euclidean and projective geometries, and as a field in itself held out the promise of bringing the kind of unity to disparate fields of mathematics sought after by Hilbert and others.

Of any of the poems that are analysed for their mathematical content, “Grup” is the one most consistently chosen by interested critics, perhaps because of its overtly mathematical title, given Barbu’s known interest in group theory. Gyorgy Mandics describes “Grup” as about finding a universal and analytical system of knowledge by revealing alternative possibilities of being.⁶⁶³ Basarab Nicolescu views “Grup” as somewhat of an exemplar, arguing that *Joc secund*

⁶⁶¹ Nicolescu argues that the *gest închis* refers to Hilbertian unifying theories of geometry; Boskoff and Suceavă agree that the *gest închis* refers to unifying human thought, and a complete description of existence, similar in nature to the completeness of a tightly-defined and proven theorem. See Boskoff, Dao, and Suceavă, “From Felix Klein’s Erlangen Program to Secondary Game,” 21,29.

⁶⁶² See the depiction of a Poincaré disc in note 506, where the usual small curves drawn in the vertices of the triangle look like eyes:

<http://dgd.service.tu-berlin.de/wordpress/geometryws12/category/hyperbolic-geometry/>

⁶⁶³ Mandics, *Ion Barbu “Gest închis,”* 269. See note 614

in its entirety refers to a transformation from reality into abstraction; in other words real concepts are examined through abstract group theory.⁶⁶⁴

References to sun and light rays are common to the entire collection and underline the repeated image of sight, vision, and the struggle to understand and represent, as well as their underlying essence as the “lines” of geometry (including in non-Euclidean geometry). (It should also be noted that ‘light’ in Romanian, *lumina*, is very close to the final word of “Grup”, world, *lumea*.) For Nicolescu the ‘fânul razelor’ (most literally, hay of beams) is a geometric term, particularly in optics. In my translation of *fânul razelor* I have chosen to draw on Frosin’s interesting French translation of *fânul* as *gerbe* (sheaf [of hay/wheat]), because *gerbe* is also a term used in homological algebra, associated with the francophone and former Bourbakian Alexander Grothendieck who later extended sheaf theory into his later work on category theory.⁶⁶⁵ The wheat sheaf also allows for the image of germination and new life, reinforced by Frosin’s translation of “day” as the *aurora*, and his translation of ‘fringi’ as ‘fauche’ (reap), and introduction of the term ‘creation’ in the last line.

Returning to geometric lines, ‘fire stîngi’, are also geometric, and can be interpreted to include the bent or non-parallel lines of non-Euclidean geometries. The ‘*ovaluri de var*’ for heads suggests for Nicolescu a monochrome existence, with the ovals suggesting something unstable and human.⁶⁶⁶

The poem “Grup” thus encompasses a number of familiar geometric images such as ovals, left and right, line, and triangle, and it touches on more modern developments within geometry. Interestingly, these images are both geometric, as well as algebraic as suggested so obviously in the title. This is an evocative and succinct way to unify algebra and geometry within one short poem.

ÎNECATUL

Fulger străin, desparte această piatră-adîncă ;
Văi agere, tăiați-mi o zi ca un ochian !
Atlanticei sunt robul vibrat spre un mărgean,
Încununat cu alge, clădit din praf de stîncă,

Un trunchi cu prăpădite crăci vechi, ce stau să pice,
Din care alte ramuri, armate în șerpi lemnoși,
Bat apele, din baia albastră să despice
Limbi verzi, șuierătoare, prin dinții veninoși. ⁶⁶⁷

⁶⁶⁴ Cornis-Pope, “Ion Barbu (Dan Barbilian),” 53, citing Nicolescu.

⁶⁶⁵ See note 498.

⁶⁶⁶ Nicolescu, *Ion Barbu*, Termeni științifice și sugestii poetice.

⁶⁶⁷ Composed in 1929 using earlier material of 1920. First published in *Joc secund* (1930), Barbu, *Poezii*, 157.

“Încatul” is another poem about frustration and frustrated theories of mathematical representation. The ‘deep stone’ is heavy, and resists light. On a high, and somewhat liminal level, it again depicts the effort to find an illuminating theorem. The poet is asking for an external source of inspiration and clarification – lightning – to come in and cut through the confusion that he is feeling. The confusion is represented by the natural forms facing him – the bifurcating possibilities in the branches and twigs – which are turning into something rotting, obscure and menacing – the fertile but at times poisonous algae, and then the apparently lifeless branches which turn into truly menacing snakes. These snakes recall the medusas of “Din ceas dedus...” Again some kind of struggle is being required, this time against water, perhaps in the search for a lost Atlantis. The imagery of marred expression is violent: the opening lightning flashes, tongues are cleaved, ending in the forked tongues of serpents. *șuierătoare* (whistling), in addition to reminders of the sound of wind in trees, all carry with them connotations of a flailing madness. The poet is again submerged in the depths, struggling to see and express himself.

Barbu’s early title for this poem was *Copacul înecat*, (drowned tree). Petrescu observes that the poem is an image of decaying organic and vegetable matter, referring to metamorphosis more generally.⁶⁶⁸ The sea is clearly a strong image in “Încatul”, with its references to drowning, the Atlantic, coral, algae and water. As for *ochian* (or *ocean*, meaning spyglass, particularly maritime telescopes), this is a sign of vision, and was in fact the original title Barbu chose and preferred for his principal collection, *Joc Secund*.

Compared with other poems, direct mathematical images are few: bifurcation is a strong one, which is an equally significant theme in mathematics (and in relativistic views of time) and the sense of alternatives and options is present in the overall concept of the collection’s title, “Second game”. The *trunchi* might also refer to the frustum of a cone or prism, in which case any concentration or alternatively diffraction of light is going to be impaired,

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THE DROWNED

Foreign lightning, separate this deep stone;
 Sharp valleys, cut for me a day like a spyglass!
 I am a slave to the Atlantics, vibrating towards a coral,
 Wreathed in algae, built of rock dust,

A trunk with old ruined branches, on the point of collapse,
 From which other twigs, armed with wooden serpents,
 Beat the waters, from a blue bath to cleave
 Green tongues, whistling, through venomous teeth.

⁶⁶⁸ Petrescu, *Ion Barbu și poezia postmodernismului*, 158.

which would be in keeping with Barbu's work as a whole. However, viewed from within the collection, and with a corresponding sense of how the repeated images here refer elsewhere more directly to mathematics, "Inecatul" does much to illuminate Barbu's overall poetic style and themes.

MOD

Te smulgi cu zugrăviții, scris în zid,
La gama turelor acelor locuri,
Întreci orașul pietrei, limpezit
De roua harului arzând pe blocuri.

O, ceasuri verticale, frunți târzii !
Cer simplu, timpul. Dimensiunea, două ;
Iar sufletul impur, în calorii,
Și ochiul, unghi și lumea-aceasta - nouă.

- Înaltă în vint te frângi, să mă aștern
O, iarba mea din toate mai frumoasă.
Noroasa pata-aceasta de infern !
Dar ceasul - sus ; trec valea răcoroasă ⁶⁶⁹

This poem conjures up images of upset dimensions – peaks and valleys, spires and depths. At first the poet seems to see everything with an intense clarity – the purity in the stones, the measurable heat and two-dimensional and straightforward time. But it turns out that his soul and his sight are after all on an angle, so (like modern geometry) more complex, and suddenly he comes to a halt, and fresh grass is present in the hitherto inhospitable and extreme environment. He feels cool and refreshed; his ardour has eased, and finally he seems content.

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⁶⁶⁹ First published in 1926 in *Contimporanul*. Barbu, *Poezii*, 166.

MODE

You erupt with the graffiti, written on the wall,
The scale of the spires of those places,
Enter the city of stone, purified
By the dew of grace burning in blocks.

O, vertical hours, late brows!
Simple sky, time. Dimension, two;
Yet impure soul, in calories,
And the eye, angled and this world - new.

- High in the wind you brake, that I lay
O, my grass most beautiful of all.
This cloudy blot from hell!
But the hour - up; I cross the cool valley.

The word *mod* in Romanian can refer to a ‘way’ or ‘method’ of doing something. This poem then can be read as ‘method’ in mathematics, or method in mathematical humanism; in other words, how to go fundamentally about something and everything. This is an essential concept of this thesis, as it relates to the idea of process and method in mathematics, which was central to modern algebra. An earlier title for “Mod” was “În Plan”⁶⁷⁰, suggesting an open spread of pages from a book. On one level, the poem is about writing, and the struggle to write, a frequent preoccupation of the Symbolist poets. The act of writing appears in the first line, with the choice of archaic terminology in *zugrăviții*, referring to painting or writing, particularly on large external surfaces such as the frescoes of the very old painted monasteries in northern Romania.⁶⁷¹ The word *zid* too, for a wall that is large and solid, is a deliberate choice, compared with the standard Latinate, and less harsh, term, *perete*. A more oblique reference to writing lies in *aștern*: while most literally it refers to laying down, the term can also be used for creative compositions, as in the old French/middle English ‘lay’⁶⁷².

The *frunți* in line 5 (singular *fruntea* in the next poem, “Dioptrie”) literally refers to foreheads. But the figurative meaning includes ideas of best, distinctive, out in front, and hence by extension, intellect.⁶⁷³ Perhaps their being late in “Mod” is suggestive of a late flowering of creative output.

“Mod”, the title as it stands, also has a connotation in writing, as in grammatical modes. There is, in addition, the mathematical sense of permutations, suggesting that this poem is one permutation, or page, of many. Like ‘group’, ‘mode’ is also a form of permutation. Many of the images in “Grup” reappear in “Mod”: indeed the last line in the middle stanza of “Mod” (line 8) closely resembles the final line of “Grup”, with references in both to eye, angle/triangle, and the world. Shapes are common to other poems: the cut triangle recalls the *trunchi* (trunk, or frustum) of “Inecatul”, as well as the prisms and cones in the later “Dioptrie”, and similarly the stacks (by association, of hay), in “Grup” itself. (In Romania haystacks are conical.) The braking, or coming up against, (*fringi*) is also in “Mod”, as is the hay/dry grass (the sheaves), compared with the fertile grass of “Mod”. The day appears also in “Dioptrie”, as do lime (in the form of coral and rock dust) in “Inecatul”. In Romanian ecclesiastical architecture the spire (*turlă*) is often cylindrical with a pointed top, or an exact prism. It can also refer to a church tower.

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⁶⁷⁰ See Vulpescu’s editorial notes in *Ibid.*

⁶⁷¹ The Italian-derived term *graffito*, from ‘scratch’ is similarly used for ancient etchings such as on the walls in Pompeii.

⁶⁷² A short lyrical or narrative poem.

⁶⁷³ Mandics is certain that *fruntea* in Barbu refers to the intellect. Mandics, *Ion Barbu “Gest închis.”*

Along with the title, the stanza with perhaps the richest allusions to mathematics (and physics) is the middle one. The peculiar reference to time standing vertically is expressed in two dimensions, perhaps suggesting a conscious rejection of relativistic four-dimensional space-time. The soul is measured, with the classical scientific measure of heat (calories), and finally in this stanza come sight and vision – the eye taking on a new angle and in a new light. Returning to the two dimensions, several interpretations are possible. The poem itself slides from the second person in the opening stanza to the first person in the third, and at the same time the perspective moves from vertical to horizontal (x and y axes), from upright hours to a body lying down. These vertical pillar-like structures reappear in “Dioptrie”. The literary critic Nicolae Manolescu argues that “Mod” refers to church frescoes, that have a two-dimensional aspect to them, and that dimensions in the poem can multiply, but then reduce and hence the one dimension of time, in *ceasuri verticale*.⁶⁷⁴

The spiritual or religious cannot be ignored. The opening line immediately conjures up the image of painted saints, the towers like domes and spires on church roofs, and the unyielding stone city, possibly of Jerusalem (*petrus*), and more generally the suggestion of death. The fertile grass of line 10, suggestive of a grave, paradise or an Elysian field, is juxtaposed with a cloudy image of hell. (The reference to grass reappears in other poems under discussion, but in those cases the grass is hay.) One’s hour being up and crossing a cool valley is also suggestive of death.⁶⁷⁵

Overall the image from “Mod” is one of the mathematician poet being pulled, or pulling himself, back upright and into normal, vertical time, temporarily succeeding in escaping from some kind of non-creative abyss or, in modern terms, a black hole.

DIOPTRIE

Înalt în orga prismeî cântăresc
Un saturat de semn, poros infoliu.
Ca fruntea vinului cotoarele roşesc,
Dar soarele pe muchii curs - de doliu.

Aproape. Ochiî împietresc cruciş
Din fila vibratoare ca o tobă,
Coroana literei, măraciniş,
Jos în lumină tunsă, grea, de sobă.

Odaie, îndoie în slabul vis !
- Deretecată trece, de-o mătuşă -

⁶⁷⁴ Cited in Petrescu, *Ion Barbu şi poetica postmodernismului*, 139. Manolescu is not ordinarily an enthusiast of Barbu; see note 594.

⁶⁷⁵ In a biblical tradition this is represented most evidently in Psalm 23 “The Lord is my Shepherd...”

Gunoilul tras in conuri, lagăr scris,
Adeverire zilei- prin cenuşa. ⁶⁷⁶

As in the preceding poems, “Dioptrie” suggests an imperfect attempt at creating a unifying mathematical theorem, and frustration at the failure to represent an ideal, a common theme in Symbolist poetry. The poet is faced with a plethora of signs and prisms, suggesting purity and the many possibilities of refracted light. These are already in a book (infoliated), so written down in some way, but the result is heavy, made up only of sweepings from the floor, and at best, cones (which suggest a more monochrome, not refracted, light), not the prisms of “Grup”. The writing process itself becomes a stultifying prison, in *lagăr scris*. Images of writing – folios, a leaf (page), letters, and finally the unambiguous reference to writing in *scris* (written) – occur throughout. The ‘unfolding’ is reminiscent of Mallarmé (and similarly Derrida) with their interest in discovery within folds, and Mallarmé’s (along with that of Erdős) overall preoccupation with ‘the Book’ (*Livre*) of ultimate expression and meaning. It is also in contrast to the open book of “Mod”.⁶⁷⁷

Light is a prevailing theme, with the suggestion that perception is imperfect. The colour of vines approaches the first colour in the visible spectrum – red, but the illuminating sun slips away on the edge. Eyes are crossed, not seeing properly, leaving the page to vibrate like a drum, which in turn suggests the ear, so sight gives way to faint hearing. In this middle stanza the light becomes shaved and heavy. Eventually, the sun that has been rising from the first stanza indeed rises, but through ashes.

The poet uses in part images from physics. In contrast with “Mod”, this is a very three-dimensional poem – prism, cone, stove, room, prison – except for the vibrating drum. The opening line depicts a prism (possibly of light), high and like an organ (with the suggestion of

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⁶⁷⁶ First published in 1928 in *Tipăritura Literară*. Barbu, *Poezii*, 171.

DIOPTER

High in the organ of prisms I weigh
A saturation of signs, porous infoliated.
As the wine’s brow the stalks redden,
But the sun flows on the edges - of grief.

Almost. Eyes crossed petrify
From the vibrating page like a drum,
Lettered crown, enthorned,
Down in shaved light, heavy, like in an old stove.

Chamber, folded in that faint dream!
- It passes tidied up, by an old woman -
Sweepings drawn into cones, a cell written,
Risen is the day - through ash.

⁶⁷⁷ The term “Book” can also be associated quite clearly with religious books, such as the Bible in Barbu’s case.

rows of cylindrical shapes, echoing the scale of spires and vertical hours in “Mod”) and ends with cones, of dust and ashes, taken from the ground. Light through a prism indeed reflects the range and colours of the spectrum; but cones of light are more restricted and unitary.

A diopter is an ancient tool of angle measurement, and it is also a unit of measure in optical lenses. The choice of a very old instrument, dioptré, is also of interest in that it matches the use of archaic terminology in *sobă* (stove) and *odaie* (an old, countryside or peasant-style room), along with the elderly woman (*mătușă*) herself. All this perhaps suggests a struggle to formulate a modern and unobscured vision.

This poem continues the theme of sight and vision, and as in “Din ceas...” and the spyglass in “Mod”, the struggle to see and realise a transcendent state. Compared with “Din ceas...” however, it is more pessimistic, and the references to light even more liminal: the sun for example approaches only on the margins and is grieving, the light is heavy and red, and ultimately obscured by ashes. The hope offered to human senses by an array of prisms and cylinders (the organ) is furthermore reduced to a far less refractive and monochrome cone, made up of sweepings from the floor.

The attempts to write are explicitly represented by the signs, the folded page, the vibrating drum and crown of letters, recalling the ‘wreath’ of algae in “Inecatul”.

Again evident in this particular poem is the religious imagery. The organ in the opening line immediately conjures up images of churches, and this is followed by a crown of thorns, blood-red wine and finally the reference to the risen day, with its strong liturgical connections to Easter and the crucifixion. The day is welcomed with *Adeverire*, the term used in the liturgical Easter dialogue – Christ has Risen, He has Risen *Indeed* – and in eastern Orthodox countries, as a standard form of greeting during the Easter season. Thus the sun has risen, but beyond the early lofty organ, and setting in a homely country room, chamber or cabin (*odaie*).

For Barbilian, the transcendental and spiritual nature of perfect and idealised mathematics was critical, as discussed earlier in this chapter most explicitly in the references to spiritualism in geometry. As can be seen from a letter in the next section, for Barbilian, ultimate and pure knowledge was ‘salvation’. These features are incorporated in the type and nature of mathematics that was important for Barbilian. He was not writing about mechanical formulae, but about concepts central to the modern mathematical projects of geometric algebra: a unity of vision, a building up of images and logical suggestion from axioms, coherence of sets and groups, and the final transcendence of concise, precise and beautiful mathematical thinking.

PARALEL ROMANTIC

Numisem nunții noastre-un burg,
 Slăvit cu ape-abia de curg -
 Ca un dulău trântit pe-o labă,
 - Vechi burg de-amurg, în țara șvabă,

Scări, unghiuri, porți ! În prag de ușă,
 O troli domoli, o troli cu gușă,
 La ce vărsări, ca de venin,
 Vis crud striviți și gând cretin !

Stângi cuburi șubrede, intrate,
 De case roșii, zaharate ;
 Verzi investiții, prin câte-un gang,
 Sub ceasuri largi - balang, balang ! ⁶⁷⁸

With its trolls and salivating dogs, “Paralel romantic” is far from romantic. But then for Barbilian the mathematician, the concept of parallelism was complex and somewhat twisted; certainly not straightforward. Parallels also appeared in the organs of “Dioptric” and vertical hours of “Mod”, but for a modern mathematician there are inherent ambiguities in the term parallel.⁶⁷⁹ Continuing with the overtly mathematical images, in the opening line, *numisem* (named) in Romanian has evident associations with *numitor* (denominator).⁶⁸⁰ In that sense, it is a solid, base-level image, contrasting with the heights and zeniths aspired to by Barbu, and indeed the entire poem is heavy, grounded and far from light-filled. In line 5 *unghiuri*, nooks or corners, are also more literally ‘angles’ as in mathematics (as was also the case in “Mod”). Again like “Mod”, clocks and time for a modern, relativistic mathematician, are strongly suggestive. Then in line 9, the peculiar, lefthand cubes are mentioned, recalling – again – the

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⁶⁷⁸ Written April 1924. Barbu, *Poeme / Poèmes*, 70.

ROMANTIC PARALLEL

I named for our wedding a village,
 Glorified with a faint trickle of water -
 Like a big dog slouched on a paw,
 - An old village at dusk, in Swabian lands,

Stairs, corners, doors! On the doorstep,
 O gentle trolls, o goitrous trolls,
 What pourings, as of venom,
 Raw dream crushed and idiot thought!

Lefthand ramshackle cubes, entered,
 From red, sugared houses,
 Covered in green, through some passage,
 Under great clocks - ding-dong!

⁶⁷⁹ See the discussion on non-Euclidean geometry in chapter 1, and Herbert’s and Miłosz’s engagement with parallelism in chapters 3 and 4.

⁶⁸⁰ These two words in fact come from separate Latin roots: *nomen* (name) and *numerus*, (number).

lefthandedness in “Grup”. These cubes are in a sense imperfect building blocks, possibly of the house, but perhaps also of the poem, and so the suggestion is of a dulled and stupefied, or held back, axiomatic approach.

The image of building blocks is sustained in the composition of the poem itself. As has been noted at length earlier in this chapter, Barbu shaped his poems as a stark fitting together or juxtaposition of terms, with relatively limited grammatical filler terms. This is certainly the case in “Paralel romantic”, where some words, and certainly images, are stacked up against one another, leaving much for the reader to interpret. Or, as the algebraic-minded poet might put it, presenting the exact bare essentials. Like many of Barbu’s poems it has a very regular rhythm and rhyme, in keeping with his regular, axiomatic approach to both poetic and mathematical construction.

The poem opens with a German fairytale-like image, with the old village at dusk in Swabia⁶⁸¹, trolls, ramshackle sugared houses and clocks, alongside the overall slightly unnerving and unpleasant images of salivating dogs, deformities and clumsiness (*stînga* in Romanian as well as meaning ‘left’ carries connotations of gaucheness or awkwardness, or ‘cack-handed’ as in the *fire stîngi* “Grup”), and its pervading otherworldly tone recalls the little old woman sweeping a small house in “Dioptric”.

Continuing the fairytale atmosphere, the word *cretin* can refer to alpine dwarves, but it is also related to ‘Christian’. As in the previous poems, religious imagery is suggested in the baptismal or holy water in line 2, and invoking the heavily Catholic Swabia (an important region of the Holy Roman Empire) and Garden of Eden’s archetypal snake or serpent present in “Înecatul” and “Din ceas dedus...”.

The poem draws contrasts between the rounded hills suggested by a sleeping dog and its paw, the sharp angles of the stairs, corners and doors, then the ramshackle cubes that they descend into. It also suggests possibilities of inspiration, through glorification (baptism, holy water), but the water is weak and trickling, and eventually unnerving as it becomes the saliva of trolls. The venom here (that has appeared in previous poems) is associated with stupidity, or for Barbu, lack of inspiration. The ringing bells of time suggest stupefaction and stunned

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⁶⁸¹ Swabia is an area more or less equal to modern-day Baden-Wurtemberg, which was the origin of a number of agricultural people who subsequently spread over Eastern and South-Eastern Europe including to modern-day German-speaking Transylvania in western Romania. Towards the end of and immediately following the Second World War these people were systematically expelled in a process of ethnic cleansing, on account of their Germanic roots. Colloquially, the term ‘Swabians’ in Eastern Europe can refer to Germans in general and is pejorative and discriminatory. The Brothers Grimm fairytale, “The Seven Swabians” (*Die sieben Schwaben*) depicts Swabians as stingy, prudish simpletons: Barszczewska and Peti, *Integrating Minorities*; Minahan, *One Europe, Many Nations*.

oblivion. Whether he means a loss of poetic or mathematical inspiration is not clear – the poem was written the year he finally abandoned his studies and returned to Romania.

In 1922 Barbu sent a postcard from Göttingen, describing the town as old and sleepy:
e un oraș vechi și somnoros, pe care l-am îndrăgit de pe acum.⁶⁸²

In “Paralel romantic” perhaps the romance lies in Barbu’s complicated feelings towards Göttingen.

UT ALGEBRA POESIS

[Ninei Cassian]

La anii-mi încă tineri, în târgul Göttingen,
Cum Gauss, altădată, sub curba lui alee
- Boltirea geometriei astrale să încheie -
Încovoiam poemul spre ultimul catren.

Uitasem docta muză pentru-un facil Eden
Când, deslegată serii, căinței glas să dee,
Adusă, coroiată, o desfoiată fee
Își șchiopăta spre mine mult-încurcatul gen.

N-am priceput că Geniul, el trece. Grea mi-e vina...
Dar la Venirea Două stau mult mai treaz și viu.
Întorc vrăjitei chiveri cucuiul străveziu

Și algebrista Emmy, sordida și divină,
Al cărei steag și preot abia să fiu,
Se mută-m nefireasca - nespun de albă ! - Nina.⁶⁸³

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⁶⁸² Mandics, *Ion Barbu “Gest închis,”* 341.

It is a sleepy old town, with which right now I have fallen in love.

⁶⁸³ First published in *România literară* in 1969, and not included in Barbu’s collected editions during his lifetime. According to Nina Cassian the poem was written to her at some point in 1947 or 1948: Barbu, *Poezii*, 93–95, Vulpescu notes.

An English translation by JoAnne Growney and Romanian-born Jewish-American Sarah Glaz appeared in a 2006 issue of *The American Mathematical Monthly*: Barbu, Glaz, and Growney, “Ut Algebra Poesis (As Algebra, So Poetry),” 793.

AS ALGEBRA, SO POETRY

[For Nina Cassian]

In my young days I strolled the lanes of Göttingen -
Where Gauss, beneath arched canopies of leaves,
Sealed once for all the vaults of higher geometries -
And curved a poem towards its last quatrain.

For easy Eden I scorned the learned muse
And nights without restraint unraveled me
As they drew forth a hook-nosed, exposed Eve
With hobbling gait and writing style abstruse.

I failed to see the transience of genius. The guilt is mine...

The last poem I examine is “Ut algebra poesis”, written around 1947 to the poet Nina Cassian, but unpublished during Barbilian’s lifetime.⁶⁸⁴ Compared with the poems in *Joc secund*, this piece is strongly biographical, more direct and less abstract.⁶⁸⁵ It alludes to Barbu’s regret at having abandoned his studies in Göttingen, his missed mathematical opportunities, and an awareness of those whom he later fully appreciated to be great mathematicians: Noether, in person; and Gauss, who lived a century before Barbilian, but left a deep legacy at Göttingen.⁶⁸⁶

The reference to Gauss and ‘sealing the vaults’ of geometry refers to his status as a founder of modern geometry, and the ‘curving’ of the poem to the last quatrain points to the

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But for the Second Coming I watch and am prepared
To turn the magic helmet against my fevered head.

And algebraist Emmy, both common and divine,
Whose priest and standard-bearer I would dare emerge,
Surpasses Nina – transcendental and indescribably fair!

I provide here a less elegant but more literal version:

UT ALGEBRA POESIS

In my still youthful years, in the township of Göttingen,
As Gauss, formerly, under the curve of his pathways
- closed the astral vaults of geometry -
I bent a poem towards its last quatrain.

I forgot the learned muse for an easy Eden
When, released into the serried evening, to give voice to remorse,
Brought forth, hunched, a de-petaled fairy
She hobbled towards me with a much-entangled style.

I didn’t grasp that Genius passes. Great is my fault...
But for the Second Coming I stand much more awakened and alive.
I turn away the bewitched, lump in hooded disguise

And the algebraist Emmy, made sordid and divine,
For whom I would be both standard-bearer and priest,
Changes into the unnatural – unspeakably white! - Nina.

⁶⁸⁴ Nina Cassian (1924-2014) was a Romanian poet and translator, who lived in New York after 1985, when she was granted political asylum from socialist Romania. Barbu wrote the 1947-48 verse “Ut Algebra Poesis” to her, and while she went on to find her own voice, her style is described as having been ‘truly revolutionised’ by Barbu. (Ibid., xv–xxiv.) Some of Cassian’s own work includes elementary mathematical references, see in particular “Planul Înclinat”/“The Inclined Plane”, first published in 1967 in Cassian, *Destinele paralele*, 30–39. An English translation of part of that poem can be found in the collection of mathematical poetry, Glaz and Grownney, *Strange Attractors*. However Cassian herself claimed in a personal conversation with me that while Barbu is one of Romania’s two greatest poets (along with the Romantic Mihai Eminescu) and he certainly profoundly influenced her, her own writing is not mathematical in any particular respect: Cassian, *Conversation with Nina Cassian*. See also notes 592 and 693.

⁶⁸⁵ The poem was almost certainly intended only as an ephemeral ditty for Nina Cassian. Writing a poem describing so obviously his own personal situation goes counter to Barbilian’s preference for a ‘dehumanised’ mathematical poetics.

⁶⁸⁶ See note 497.

legacy that Gauss could be considered to have passed on to the equally great, modern algebraist, Noether. That is, early modern geometry leads into very modern algebra. The ‘curve’ in this context may also refer to the non-linear aspect of modern geometry, with which Gauss was associated.

The title echoes Horace’s *ut pictura poesis*, in which he suggested that poetry merits the same attention as art, both in detail and viewed as a whole.⁶⁸⁷ In Barbu’s case, he is suggesting that poetry might be dealt with in the same way as mathematics; a clear echo of the views expressed in his prose writings on the value of a mathematical ‘humanist’ education. He is also referring indirectly to the Erlangen approach to mathematics; i.e. both local and global.

The poem is misogynistic, with its suggestions of temptation in the form of a hunch-backed witch and (by implication) Eve in the Garden of Eden.⁶⁸⁸ These references to temptation shed a new light on the images of serpents and snakes in previous poems. Barbu’s expectation of a (Christian) second coming also suggests a further interpretation of his title *Joc secund*, viz. that the other, ideal reality he is seeking is somehow divinely ordained. The ‘sealing’ (*incheie*) of geometry’s vaults suggests that Gauss in his geometry had achieved ultimate perfection. *Incheie* is a term used also in “Grup”, where the ‘closed gesture’ (*gest inchis*) was somewhat elusive; but used as it is in “Ut algebra poesis”, the suggestion is of the attainment of ideal perfection.

The poem draws also on a number of Symbolist pre-occupations: the imperfect poem that fails to reach the ideal is suggested by the de-petalled fairy (as unflowering is a common Symbolist image for a ruined poem). Similarly, a Parnassian white, almost unnatural (*nefireasca*) appears to represent the ideal, which in this case is Noether, and equally, Nina.⁶⁸⁹ (The white (limed) ovals in “Grup” thus acquire this same interpretation of Parnassian perfection, but interestingly they are not perfect circles, but the slightly more complicated mathematical ovals or ellipses.) It is not clear what Barbu meant by ‘sordid’ in relation to Noether, unless possibly a reference to her struggles, as a woman, throughout her career to be recognised, and her later effective expulsion from Germany on account of her Jewishness.⁶⁹⁰

The tangled poem (*incurvat*, line 8) resembles the poet’s frustration in “Grup” with the stacks of left-handed threads – an image that can also in the original Romanian suggest tangled

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⁶⁸⁷ See Barbu, *Poezii*, 94, Note 2. Also Turner, “Ut Pictura Poesis.”

⁶⁸⁸ This could explain why neither this nor any other poem by Barbu was included in Graz and Growney’s 2008 anthology of mathematical poetry: Glaz and Growney, *Strange Attractors*.)

⁶⁸⁹ In this last line in particular I would question Glaz’s translation.

⁶⁹⁰ Barbilian’s political stance is discussed in the conclusion, see note 697. His views on twentieth-century Jewish persecution in Romania are not clear. As it turned out, Nina Cassian too, was later expelled from Romania (in the 1980s) for her remarks against socialism.

head of hair (haystack) – and the old woman in “Dioptrie” who tidies up the tangled mess of the cabin. Barbu appears to be seeking clarity and clear (but not straight) directions, which is reflected in the neat curve of this poem from Gauss to Noether. In Romanian *serii* (to the evening), is very similar to the mathematical series (*serie*), i.e. the progressive sums of the terms in a sequence. This is, unfortunately, lost in translation.

This is not one of Barbu’s best poems, but it stands here as a poetic illustration of a rare personal and less obscure reflection, written some fifteen years after publishing *Joc secund*, when he was established in his career as a mathematician at Bucharest University. While regretful, it is a clear recognition of his esteem for the Göttingen mathematicians, and the modern algebraist and group theorist Emmy Noether in particular.

The selected poems from *Joc secund* put into practice much of Barbilian’s theory of mathematical poetics. They are all rich in mathematical allusion, drawing in particular on themes from his preferred fields, modern algebra and geometry. They are exemplars of his interest in minimalist style, with maximum implication and inference, and they operate as a unified whole. They are furthermore markedly abstract in nature, and they draw on images of spirituality and religiosity, that Barbu found particularly evident in modern geometry. Put together, they operate as an algebraic poetic ‘group’, being a collection of images coming together in a tightly structured syntax, perhaps fittingly – from the perspective of poetry – marginal and oblique.⁶⁹¹

Conclusions: Barbilian’s highly depersonalised ideal

Barbilian did not simultaneously pursue a career as both poet and mathematician: he stopped publishing poetry once he took up his professional lecturing position in mathematics. Did he then, abandon poetry for mathematics, finding the two together to be mutually incompatible? His biographer Alexandre Cioranescu asserts that it was never possible for Barbu and Barbilian to exist simultaneously, and that one person had to prevail at the expense of the other.⁶⁹²

Barbilian himself offered some explanations as to why he stopped writing poetry. In 1947 he wrote to Nina Cassian that he had relinquished poetry, saying that he would not have done so if he could have written it in a ‘mathematical’ way, and constructed a ‘perfect’ theory

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⁶⁹¹ As in previous sections, the following English translations are, unless otherwise noted, my own in consultation with Alina Savin.

⁶⁹² Cioranescu, *Ion Barbu*. See also Cornis-Pope, “Ion Barbu (Dan Barbilian),” 52.

of verse. Immediately then, this raises the idea that Barbilian felt that such perfect poetry might be possible; and it was merely that he himself was unsuccessful in realising it. He added that his own path to knowledge was not through poetry, but through science:

Nu crezi, iubite poete, că poezia inventivă, în care un anumit Ion Barbu a căutat să se instaleze, este totuși o poezie impură : că dacă pe atunci ar fi făcut matematică (cum face acum) poezia lui ar fi câștigat în curăție ; că și-ar fi pus invențiunea în teoreme și perfecțiunea în versuri [...] Toate preferințele mele merg către formularea clară și melodioasă, către construcția solidă a clasicilor. [...] Sunt cel mai demodat poet [...] Cariera mea poetică sfârșește logic la cartea lui Vianu despre mine. Orice vers mai mult e o pierdere de vreme. [...] Pot ajunge la cunoașterea mântuitoare nu pe calea poeziei, interzisă mie și alor mei, dar pe calea rampantă a științei, pentru care mă simt în adevăr făcut. [...] Numai matematicile mă fericesc. Poezia mă declasează.⁶⁹³

The references to invention are important, because in determining that this should be avoided in his poetics, Barbilian is indicating a Platonist view of mathematics, where an external existence is waiting to be discovered and reached for transcendently, rather than invented.⁶⁹⁴ He felt that he had reached as far as he could in his quest to implement fully a ‘pure’ mathematical method in poetry, but as a mathematician Barbilian did not entirely disengage from literary activities and writing: the letter to Cassian is after all written some 17 years after his last poetic publication, *Joc secund*, and he continued to take part in literary salons and to contribute to literary reviews. Many of his prose pieces in which he sets out and elaborates on his theory of mathematics and poetry were composed in the 1940s and 1950s.⁶⁹⁵ Thus, as far as giving serious thought to the theoretical links between poetry and mathematics, Barbilian, continued this until his death.

In all likelihood Barbilian stopped writing and publishing poetry because he felt that he had taken his ideal of poetics as far it could go.⁶⁹⁶ There is, however, an additional

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⁶⁹³ Letter to Nina Cassian, July 1947, first published in *Gazetă literară*, 31 August 1967, see Barbu, *Pagini de proză*, 57–59.

Do you not think, dear poet, that inventive poetry, in which a certain Ion Barbu tried to establish himself, is after all impure poetry: for had he done mathematics then (as he does now) his poetry would have gained in clarity; and would have put inventiveness into theorems and perfection into verse [...] All my preferences tend towards clear and melodious formulation, and towards the solid construction of the classics. [...] I am the most unfashionable poet [...] My poetic career came to a logical end with the book that Vianu wrote about me. Any further verse is a waste of time. [...] I can reach the knowledge of salvation not through the path of poetry, denied to me and to mine, but through the rampant path of science, in which I truly feel made. [...] Only mathematics makes me happy. Poetry leaves me outclassed.

Nina Cassian is discussed in note 684. The Vianu biography is referenced in note 478.

⁶⁹⁴ See also note 554.

⁶⁹⁵ Dinu Pillat makes this explicit point in his introduction to Barbu, *Pagini de proză*, xv.

⁶⁹⁶ It is a common preoccupation of poets that they may have taken their poetry as far as they can, see for example Steiner, Heaney or Dante, but of interest here is Barbilian’s particular vision as it applies to a mathematical method.

consideration, and that is the political dimension. Mathematician and theoretical linguist, Solomon Marcus writes:

After the Second World war, the political (dictatorship) power in Romania did not like Barbu's poetry, considered against humanism [sic]. So, Barbu marginalized his poetry and claimed that he is a mathematician and only a mathematician. But his way to look at math [sic] and his everyday speech were deeply impregnated with poetry, so it was impossible for him to hide his poetic existence. However, [sic] no explicit reference to his poetry in the last decades of his life.⁶⁹⁷

Barbilian may well have felt that the political environment, with its oppressive censorship, would hinder his free poetic expression, and therefore he chose to withdraw entirely. 'Humanism' in this context refers to the Marxist appropriation of literature, which insists that it be socially relevant. Whether or not to politicise one's writing is not just a pre-occupation of those dealing with totalitarian censorship, and the question of whether or not to write 'for' the state is for some an ethical issue concerning the very purpose of writing. If Barbu did abandon poetry on account of political pressure, this is in stark contrast to the approach taken by the two Polish poets, Miłosz and Herbert, towards the socialist regime. They saw their role as precisely to write against that regime, that is, as a necessary political act.

For Miłosz and Herbert, their reaction to the contemporary history of Poland was the need to write and object, and to explore human ethics. Barbilian appears to have taken a very different approach, considering that the role of literature should have no relation to politics, and should in fact operate above it.⁶⁹⁸ His mathematics too, operates in an ideal world beyond that of the human being. Such an explanation is sustained by the fact that his work had a particular resurgence after the Second World War, which Cornis-Pope argues can be explained in part by characteristics perceived as an antidote to socialist realism.⁶⁹⁹ That is, Barbilian's poetry has an a-politicism that Miłosz and Herbert do not share.

In 2007 writer, literary critic and Professor of Literature at Bucharest University, Mihai Zamfir, wrote a short piece for the national literary journal *România literară*, commenting on recently discovered apparent paradoxes in Barbu's political and ethical stance.⁷⁰⁰ Zamfir's article was prompted by the recent unearthing of a hitherto little-known fact: that around the time of the outbreak of the Second World War, Barbilian had written a short ditty extolling Hitler (he compares him to Alexander the Great, who is traditionally admired in Romanian Roman-era history). Zamfir argues in support of Barbilian, observing that for the very large

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⁶⁹⁷ Marcus to Kempthorne, "Continuare Marcus."

⁶⁹⁸ This latter view is discussed in detail recently by Nobel laureate, Gao Xingjian. See Gao, *Aesthetics and Creation*.

⁶⁹⁹ Cornis-Pope, "Ion Barbu (Dan Barbilian)."

⁷⁰⁰ Zamfir, "Căderea poetului." In common with a number of 'intellectuals', Zamfir himself served as a government Minister in the first post-socialist government in Romania, and has taken up postings abroad as Romanian Ambassador on several occasions.

part, Barbilian avoided political engagement in his society. He explains that Barbilian had briefly aligned himself with the Fascist Iron Guard movement during the war, apparently in the hope that the Iron Guard would soon win power over the Nazis and that his association with them would help win him a professorship at the university.⁷⁰¹ Zamfir remarks that this support of the Iron Guard should be seen in the context of Barbu's wariness towards the current regime.⁷⁰² In 1948 he wrote another short poem rejoicing at the overthrow of King Mihai of Romania, and, by inference, celebrating the emergence of the socialist Republic. Zamfir remarks that this poem was written on the urging of Barbu's friend Alexandru Rosetti⁷⁰³; but it was in the event never published, and unlike many other Romanian poets, Barbilian resisted compromise – Zamfir terms it 'prostitution' (*prostituarea*) – with the pro-Soviet regime, and for the rest of his life wrote no poetry for the state.

These brief accounts add another dimension to Barbilian's move in such an extreme manner from poetry to mathematics, but the bulk of this chapter has been devoted largely to his articulation of an abstract theory relating mathematics with poetry. Barbilian was deeply attracted to particular areas of mathematics: abstract modern algebra and geometry. Indeed, he was attracted to these almost as to an aesthetic movement. The influence of 1920s mathematicians in Göttingen was profound, and their work influenced not only his, but the direction of much modern mathematics in the twentieth century. This includes Gauss, Riemann and Klein's work in extending the nature of geometry from an empirical description of a single, anthropocentric world, to multiple geometries that bear little evident relation to the one in which we perceive we live. It also encompasses the work of Noether in systematising new types of abstract algebra, and it centres on the work of Hilbert and of all his colleagues in addressing a fundamental move to unify mathematics into an integrated whole, through a formalist, axiomatic approach.

The poet Ion Barbu strove to realise many of these same characteristics. His poems are formed by putting together discrete, yet repeated, images, in a way similar to the building up of theorems from axioms. In style, they draw on mathematical brevity and concision, and their resulting 'purity' lies in the elimination of redundant expressions. As a collection, the poems come together as a unified whole, describing a vision of an absolute and abstract ideal, to be shared by the writer and reader, with the ultimate goal of attaining an almost spiritual transcendence. As such, the poems are removed from any day-to-day formulaic and analytical approach to mathematics. The translation of mathematics into poetry is impressionistic, with

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⁷⁰¹ As it turned out, Barbilian achieved his professorship regardless, in 1942. See note 525.

⁷⁰² In fact a number of major Romanian writers initially supported the Iron Guard, notably Cioran and Eminescu.

⁷⁰³ The same Rosetti who in 1966 edited the then definitive edition of *Joc secund*: Barbu, *Joc secund*.

its objective being to remove the particular and individual, while seeking to reach a pre-existing and ideal ‘essence’ of intellect.

Yet the poems themselves consistently describe a failure fully to perceive and to capture the ineffable, to the point that Barbu the poet eventually succumbed to Barbilian. As it turned out, the great unifying mathematical project also fell short of its aim, not least because of the discoveries of Gödel, and evidenced in the petering out of Hilbertian-inspired projects such as Bourbaki. As a practising mathematician, Barbilian too felt he had failed to reach an absolute: the later poem “Ut Algebra Poesis”, where he describes his own inadequacies at Göttingen, is a testament to this. However he continued to find inspiration in mathematics’ ability to embrace and represent deep complexity, and he continued to reflect on theories of poetics, describing in his prose work much of what he had been trying to achieve, and where he had gone wrong.

While Barbilian argued that the individual and human element should be largely absent from poetry, he paradoxically constructed a new theory of holistic education, ‘mathematical humanism’, based on mathematics, with the objective that students should first learn an objective and out-of-self approach to perceiving the world, and only then encounter more personal and traditionally literary or ‘humanistic’ approaches to education.

Barbilian has bequeathed a rich and ambitious attempt to weld the traditionally disparate elements of mathematics and poetry. If, in his own analysis, he fell short in achieving his poetic-geometric ideal, he nonetheless created a unique body of work that still resonates today. Scholars of the elusive and subjective interdisciplinary field of mathematics and poetry will benefit from paying close attention to the work of Dan Barbilian.

Professor of Mathematics at Bucharest, Dan Barbilian
(<http://www.scoaladanbarbilianconstanta.ro/biografie-dan-barbilian>)

A 1981 edition of Barbilian's writings, published under the editorship of his wife, Gerda Barbilian.
(<http://www.coltulcolectionarului.ro/pagini-inedite-dan-barbilian-p-88141.html>)

CONCLUSION

‘Creative transposition’⁷⁰⁴

PROPOZYCJA DRUGA

Utwór
skończony
trzeba złamać
a kiedy się zrośnie
jeszcze raz łamać
w miejscach gdzie styka się z rzeczywistością
[...]
rozbija
przekształca

i sam ulega
przekształceniu

Tadeusz Różewicz ⁷⁰⁵

A contemporary of Miłosz and Herbert, Tadeusz Różewicz (1921-2014) lived through the Nazi occupation of Poland and, in the years following, maintained a committed stance against Socialist totalitarianism.⁷⁰⁶ Różewicz was one of several poets who felt a moral

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⁷⁰⁴ This term is attributable to Roman Jakobson, see note 713.

⁷⁰⁵ First published in 1961. English translation by Adam Czerniawski in Różewicz, *Poezje wybrane/Selected Poems*, 90–91.

PROPOSITION THE SECOND

The poem
is finished
now to break it
and when it grows together again
break it once more
at places where it meets reality
[...]
splitting
and transforming it

and itself undergoing
a transformation

⁷⁰⁶ During the wartime occupation, Różewicz was a member of the Polish underground armed resistance group, the Home Army (*Armia Krajowa*). His brother was killed by the Gestapo in 1944. Różewicz was also engaged in

obligation to continue to write poetry, but of necessity re-examining and reconstructing its form, in a bid to give voice to what was in many respects inexpressible horror.⁷⁰⁷ Describing the process of creative writing, but also of a fundamental human response, “Propozycja druga” exemplifies the mathematical poems discussed in this thesis. In an axiomatic and foundational approach, the poem is meticulously built up from bare essentials; assumptions and conventions are removed and repeatedly re-examined, the result ‘broken’ whenever it ‘meets reality’, this reassessment leading to an iterative transformation. In its title, the poem honours the style of written exposition laid out by Euclid two millennia earlier.⁷⁰⁸ It also echoes the more philosophical proposition of a second, or alternative, reality variously articulated in Barbu’s 1930 *Joc secund*.

When I began this thesis I hoped to identify, or elaborate, a single model which would describe the relationship between mathematics and poetry. But what transpired was an elusive case-by-case set of individual scenarios, in which some common threads can be discerned, but – like the puzzling and twisted threads depicted in diverse forms in Barbu’s “Grup”, “Dioptrie” and “Ut Algebra Poesis” – each one is also differentiated, and very much tangled. The result is far from a single framework or model, and is instead a collection of indications of where the relations might lie, or a ‘web’ of ‘patterns’.⁷⁰⁹

Mathematics and poetry both reach towards an ideal that, like a mathematical limit, is ultimately out of reach. They use heavily formalised languages that are characteristically concise and precise, and draw heavily on established codes and conventions, while all the time questioning these norms. They lend themselves to intense abstraction, and are also deeply metaphorical. In the case of poetry, metaphor emphasises the intuitive and imaginative, whereas metaphor within mathematics depends on previously established rules and methods, drawing on the insights of predecessors. On inspection, these perspectives apply – if not equally, then in some transformed way – to the other: the uncertainty that arose in modern

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literary resistance and protest against censorship under the Socialist regime. Under consideration for a Nobel Prize in Literature during the period that it was eventually given to Miłosz, Różewicz was awarded the European Prize for Literature in 2007.

⁷⁰⁷ Influential in this context in Europe is Theodor Adorno’s oft-cited reflection in 1949 that to write poetry after Auschwitz must be barbaric: Adorno, *Prisms*, 37.

⁷⁰⁸ In the *Elements*, Euclid’s second proposition describes the construction of a straight line of given length from a given point.

⁷⁰⁹ The concept of ‘webs’ or ‘patterns’ has been touched upon several times in this thesis, from the *OED* definitions of both mathematics and poetry (as ‘arrangements’), to the discussions by both Glaz and Birken and Coon, to the ‘web of allusions’ in Herbert’s “Revelation”. It is also a notable concept in the poetry of the Russian novelist Vladimir Nabokov who, tellingly, was also a serious lepidopterist, deeply attracted to the patterns and precision on butterfly wings. In “Pale Fire”, for example, Nabokov plays a literary game (like Barbu’s *Joc secund*) of a story within a story, and at one point writes, ‘not text, but texture [...] / But topsy-turvy coincidence / Not flimsy nonsense, but a web of sense [...] / some kind of a correlated patter in the game [...]’: Boyd, *Vladimir Nabokov*, 441.

mathematics about the nature of our and of other constructed realities is a metaphor; and an acknowledgement of foundational existing constraints and axioms is a central feature of poetics. Suggestiveness, inference and implication abound in both mathematics and poetry, and they create an evocative tension between creating and discovering knowledge that is both deductive and inductive, leading to a re-examination of truth and meaning.

Is there an existing theory or model that can help in understanding this dialogue? Translation theory is one such possible model. There are many issues around translation in poetry that pertain to this study, including at a fundamental level the question of translation from one language to another.⁷¹⁰

One of the key elements of a relationship between mathematics and poetics that emerges strongly from the literature review is metaphor; how the ideas embedded within a metaphor are transposed between the two fields can then be framed as a question of translation. In mathematics, the term ‘translation’ most immediately brings to mind the mapping of a point or object (often a vector) from one point to another in a pure Cartesian space, with no transformation of the intrinsic properties of that object in the process. But under modern, non-uniform and relativistic models of space, the behaviour of say a vector under a mathematical translation is a deeper question, and how and in what form it arrives at its new configuration is not always straightforward. So even mathematical translation is, after all, not necessarily simple.

In an essay first published in 1959, the Russian-American linguist and literary theorist Roman Jakobson classified three types of translation:

- 1) Intralingual translation or *rewording* is an interpretation of verbal signs by means of other signs of the same language.
- 2) Interlingual translation or *translation proper* is an interpretation of verbal signs by means of some other language.
- 3) Intersemiotic translation or *transmutation* is an interpretation of verbal signs by means of nonverbal sign systems.⁷¹¹

Where mathematics would fit in Jakobson’s schema (verbal or non-verbal) is debatable, and in particular what comprises intersemiotic translation is an essential concern arising from this thesis.⁷¹² Jakobson goes on to describe intersemiotic translation as transposition from

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⁷¹⁰ Plurality and transfer of meaning is a vast topic within literary translation studies, and I do not discuss it here.

⁷¹¹ Jakobson, “On Linguistic Aspects of Translation,” 261.

⁷¹² There is no universal agreement on where the line falls between semiotic and ‘non-semiotic’ translation. An interesting monograph is Goriée, *Semiotics and the Problem of Translation*. In one particular case, Nuria de Asprer Hernandez de Lorenzo makes the case for applying Jakobson’s intersemiotic translation to Mallarmé’s

one sign system to another, identifying music, painting and dance as examples, and observing that intersemiotic translation is scarcely translation at all; rather it is at best, ‘creative transposition’.⁷¹³ Interestingly, Jakobson does not mention the most obvious sign system – namely mathematical symbolism. On one level, mathematics is a quintessentially non-verbal semiotic system. It is written and, as discussed in this thesis, rarely intended to be read aloud, or even verbalised as such. But this thesis has also demonstrated that mathematics is a language, and – like any other – a unique method for describing this world. The intersemiotic model of translation is therefore not entirely applicable.

It is notable that not one of the three poets presented in this thesis uses mathematical notation directly in poetry. This is despite that fact that many consider the most obvious form of “mathematical poetry” to be that which imports such notation directly into a poem.⁷¹⁴ Barbilian would certainly have been capable of inserting mathematical symbolism in a meaningful way into his verse, and Herbert, or even Milosz, might have chosen to do so, albeit superficially. But what is significant is that none of them felt the need. This is, I believe, because to do so would obscure the essence of the relationship between the two fields, whose common intent is the expression of a transcendent meaning, or, more specifically, what is *suggested* by mathematics. The symbol or diagram itself is only a form of representation, and not to be transposed in its entirety. Mathematical symbolism is detached from the subjectivity of the personal, and any consequent affective concerns. It is an additional language that describes something that cannot be articulated in natural language. But all three poets, in their differing ways, are wanting to describe *what* is happening in mathematics, through natural language, even if it is ultimately inexpressible.

That said, Jakobson himself did not limit his thinking to a straightforward classification. In the 1910s, he took as the subject of his first major study, the work of his Russian formalist poet compatriot, Velimir Khlebnikov, thereby laying the foundations of a ‘scientific’ approach

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‘synaesthetic iconism’ (*l’iconicité synesthésique*), as amplified particularly in the influential avant-garde *Un Coup de dés*. Asprey Hernandez de Lorenzo, “Trans-forme-sens: de l’iconicité en traduction,” 228. Mallarmé is discussed in Chapter 2.

⁷¹³ Jakobson, “On Linguistic Aspects of Translation,” 267.

⁷¹⁴ See for example the pieces in Glaz and Growney, *Strange Attractors*. I would like at this point to make particular mention of the poems by New Zealander Glenn Colquhoun, a medical General Practitioner who writes that he was attracted to the mathematical equations of physics during his medical degree, while not always being able to manipulate and understand the equations as he would like. His poems, written in consultation with the physicist Tony Signal, are a very nice example of translating (and in his notes Colquhoun specifically uses the term ‘translation’) mathematical equations into a narrative poetic form. The poems form part of a project instigated by the Royal Society of New Zealand during the “International Year of Physics” in 2005, when a number of New Zealand published writers were commissioned to write short creative pieces in response to meeting New Zealand physicists. See in particular, Colquhoun, “The Yang-Mills Lagrangian for Quantum Chromodynamics.”

to linguistics and language analysis.⁷¹⁵ In poetics, the groundbreaking factor was Jakobson's approach that was in itself semiotic; as he suggested that the 'signifier' in poetry becomes more important than the 'signified'. In other words, the form of expression is more important than the ostensible external content, a tenet which is now central to linguistics. The two are necessarily interlinked:

The analysis of poetic language can profit greatly from the important information provided by contemporary linguistics about the multiform interpenetration of the word and the situation, about their mutual tension and mutual influence.⁷¹⁶

The parallels with mathematics are immediately evident, and indeed Jakobson posited a theory of *parallelism* in poetics, referring to a 'parallelism' between words and sense, which is present in several figures, including rhythm and metaphor:

There is a system of steady correspondences in composition and order of elements on many different levels: syntactic constructions, grammatical forms and grammatical categories, lexical synonyms ... and finally combinations of sounds and prosodic schemes. This system confers upon the lines connected through parallelism both clear uniformity and great diversity. Against the background of the integral matrix, the effect of variations of phonic, grammatical and lexical forms and meanings appear particularly eloquent.⁷¹⁷

This concept of parallelism is also inherent in Barbu's principle of secondariness in *Joc secund*. While it is not explicitly mathematical, Jakobson's language is redolent of mathematics, notably, of course, in his theory of parallelism, as well as his reflections concerning verbal equivalence:

Equivalence in difference is the cardinal problem of language and the pivotal concern of linguistics [...] In poetry, verbal equations become a constructive principle of the text.⁷¹⁸

In his 'scientific' theories of linguistics Jakobson also drew on the philosophical writings of the quantum physicist Niels Bohr, who, in Jakobson's words, had suggested that experimental evidence needs to be expressed in ordinary language:

in which the practical use of every word stands in complementary relation to attempts of its strict definition.⁷¹⁹

Quantum physics in its development as a field is deeply mathematical. An alluring aspect of the physics, as in poetry, is that the very act of observation itself changes the nature

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⁷¹⁵ Khlebnikov is discussed in Chapter 2.

⁷¹⁶ Jakobson, *Puskin and His Sculptural Myth*, 3.

⁷¹⁷ Roman Jakobson's *Dialogues*, 102-103, cited by Krystyna Pomorska Jakobson in Jakobson, *Language in Literature*, 6, introduction.

⁷¹⁸ Jakobson, "On Linguistic Aspects of Translation," 261-266. 'Verbal equations' are on the one hand the syntactic and morphological categories such as conjunctions, roots, affixes and phonemes, as well as relations between the signified and signifier.

⁷¹⁹ With reference to Niels Bohr's "On the Notions of Causality and Complementarity", 1948, in *Ibid.*, 263. The Danish physicist Niels Bohr (1885-1962) won the Nobel Prize in Physics in 1922 for his work in the establishment of quantum theory. Initially a close colleague of fellow quantum physicist Heisenberg, the two apparently disagreed over the development of Nazi atomic research. Heisenberg is discussed in Chapter 4.

of what is being observed. Put differently, quantum physics allows for a fundamentally anthropocentric, if not anthropocentric, scientific standpoint. By extension, the metaphysical dimension comes into play, and this is a concern for all three poets, in their different forms of engagement with mathematics in poetry, and (for Barbilian at least) in the poetics of poetry.

Czesław Miłosz did not have a deep relationship with mathematics, and on the whole evinces a rejection of it, based principally on his cultural, religious and political beliefs. He placed an emphasis on ethical standards, such as integrity, compassion and personal courage, and he was wary of any dehumanised and idealised system of knowledge creation, or discovery (however described), especially as appropriated and transformed by Fascist and Marxist theorists and practitioners. This view is reflected in Miłosz's dislike of the classically ordered and rationalist scientific systems developed and made use of by Newton and Darwin, which he sees as fundamentally opposed to an anthropocentric approach. For Miłosz, a mathematical bias – as he perceived it – was largely a hindrance to fulfilling his vision for society.

Any deeper appreciation by Miłosz of mathematics is restricted to the single case of relativity in modern (mathematical) physics, but this is an isolated and, in practice little understood, instance. For him, relativity is a metaphor for multiplicity and spiritual unknowns, it conflates the macroscopic with the microscopic, allows for individual interpretation and reinforces the centrality of the human.

In fact, his approach to mathematical metaphor is largely metonymic, that is to say mathematics exists as a concept by virtue of its association with other ideas, rather than as an analogy in itself, and it is at most a restricted metaphor, whose precise detail is not relevant. Poetry for Miłosz was the ideal medium to articulate unfettered, or unbounded, imagination and creativity, together with ethical values. But in fact many mathematicians consider that mathematics also shares this higher essence, whether it be spiritual or redolent of something transcendent, an approach grasped, even if not comprehensively, by Herbert.

Like Miłosz, Zbigniew Herbert explored the place of human ethics under totalitarianism, but in looking for the precise means to describe this, he sometimes turned to mathematical concepts, acknowledging in them their potential to illuminate, if not solve, the ethical problem. Although most evident towards the end of his life, and most explicitly in the *Prayers*, a closer reading of his whole oeuvre reveals an openness to the realisation of the potential of mathematics to both model and suggest.

Herbert recognises in mathematics characteristics of predictability and deterministic knowledge, and the existence of basic building blocks of knowledge, as well as qualities such as multiplicity and ‘uncertain clarity’. In the “Cogito” series, he explores how far the rationalist Mr Cogito can overcome his self-imposed constraints of rationalism, and to what extent universality and the impersonal can in fact be personally liberating.

Zbigniew Herbert was undoubtedly sensitive to the complexities and potential of mathematics, and he made an effort to bring himself and his poetry into a relationship with it. But he was also repulsed by his own early and narrow perception of what constitutes mathematics, although intrigued by modernist concepts of uncertainty. For Herbert, the dangers in applying a mathematical model to poetics are multiple. Poetry, in his view, predicates an ethical human society. As for mathematics, at one extreme, there is the application of a cold-hearted inhuman and limited counting approach that excludes any subtlety, while at the other, modern extreme, there is uncertainty and an absence of human causality.

Herbert does not concern himself with mathematical method per se, being alienated by the perceived narrowness or supposed mechanical nature of mathematical thinking, but he does demonstrate an awareness of mathematics’ more complex nature. For Herbert, a rationalist approach expanded to encompass the non-rational is tantalising, but ultimately unsatisfactory and unfulfilling, whereas Barbilian finds fulfilment in exactly that impersonal extrapolation.

Dan Barbilian (Ion Barbu) furnishes a uniquely balanced case, because he was a serious practitioner of both mathematics and poetry, and acclaimed in both fields. From the outset he saw mathematics and poetry as equally capable of holding the answer to understanding and reaching an ideal. As elaborated in his ‘mathematical humanism’, he was convinced of the basic importance of mathematics, yet at the same time he acknowledged that had he been more adept, poetry could also have offered that possibility.

Barbilian’s poetic theory accepts that restrictions on the use of mathematical metaphor are in fact liberating, as they allow for a ‘pure’ and less individual representation of inferences, a sentiment apparently shared by the Symbolist poets in their search for universal meaning, and an attraction certainly felt by Oulipo in their experiments with ‘constraints’. He takes a consciously and deliberately mathematical approach to poetry, starting with building blocks of discrete images or ideas, and juxtaposing and arranging them to create a structure of inference and interpretation. His method resembles an axiomatic, Hilbertian one, where metaphor is

abstract and in many respects impersonal. However, the interpretation required of the reader is profoundly individual, given its scant references to common shared images.

For him, the method is as important as the result itself. As well as being an essential characteristic of mathematics, method is central to “the scientific method” as discussed in the influential *Discourse on Method* of Descartes, whose philosophy was familiar to and explicitly referenced by all three poets.⁷²⁰ But what Barbilian in particular emphasises is that method is also inherent in poetics. This is evident in the standard definitions of poetry and poetics, which examine them from the perspectives of both form and creative principles⁷²¹, but Barbilian extends this writing from his personal standpoint based on a deep admiration for and submersion within the contemporary mathematical developments of abstract algebra and the foundations of mathematics.

Joc secund was published in 1930, but Barbilian published much of his theoretical writings only after the Second World War, in the 1940s and 1950s. One mathematical field developed in this period was category theory, first introduced in 1945 by Samuel Eilenberg and Saunders Mac Lane as a new description and organising system of abstract mathematical structures and systems of structures.⁷²² Historically deriving from algebraic topology and group theory, category theory has become a separate model, sometimes described as phenomenological, within the “foundations of mathematics”, in the sense that it is very abstract, and does not depend to a great extent on other fields of mathematics. A *category* is a collection of *objects* together with *morphisms*, where the morphisms can be viewed as maps, or defined relations (often depicted as arrows), between the objects. Almost any mathematical structure can be used to build a category, for example sets as objects, with structure-preserving

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⁷²⁰ The development of a ‘scientific method’ is discussed in particular detail in chapter 2, both from the perspective of Descartes and also Novalis.

⁷²¹ See the discussion in Chapter 2, and the *OED* definition of poetics:

The creative principles informing any literary, social or cultural construction, or the theoretical study of these; a theory of form.

⁷²² See note 155 in chapter 5. Samuel Eilenberg and Saunders Mac Lane first collaborated on category theory in 1945 at Michigan. Eilenberg was a Polish Jew who took his doctorate at Warsaw in topology, leaving for the US in 1939. He was a member of Bourbaki for fifteen years, and later combined his Columbia professorship in mathematics, with a successful parallel career as one of New York’s most celebrated collectors and dealers in Indian art. Eilenberg reputedly at first tried to devise an ‘axiomatic method’ for his art dealing, but eventually gave that up, preferring to keep his two interests separate. At Warsaw he was supervised by the well-known Polish mathematician and mathematical historian Kazimierz Kuratowski (see chapter 1), and it has been claimed that category theory very clearly derives from developments in the Polish topological school (see Marquis, “Category Theory.”). Saunders Mac Lane was an American who in the early 1930s worked at Göttingen under David Hilbert and (briefly) Emmy Noether, before returning, this time to Harvard, as the rise of Nazism intensified. As Mac Lane describes it, the various departures from Göttingen in the Nazi era led to the demise of Göttingen as a centre of mathematics. See North Dakota State University and American Mathematical Society, “Samuel Eilenberg”; Bass, Hyman et al., “Samuel Eilenberg (1913-1998)”; Albers, Alexanderson, and Reid, *More Mathematical People*, 206–207. For a short mathematical introduction to category theory, see Gowers, Barrow-Green, and Leader, *The Princeton Companion to Mathematics*, 165–167. Also Mac Lane, *Categories for the Working Mathematician*.

functions as morphisms; or alternatively vector spaces as objects, and linear maps as morphisms (that ‘translate’ from one vector space to another).

What is of particular interest in category theory is not the make-up of the objects themselves, but rather their morphisms and how the structure of the category is understood by these morphisms. In other words, it is the *relations*, and their qualities of preservation, that are significant. In this regard, category theory provides a rich framework for situating further study of the relationship between mathematics and poetry; and indeed a much deeper analysis of other specific mathematical fields provides rich potential ground for further research. Barbu’s *Joc secund*, for example, immediately lends itself to a category theoretical analysis, with its repeated elements within and across the poem, layered structure, and permuted images that are both preserved and altered from one poem to another.

However, an internalisation of poetry, or focus on itself and its syntax as much as semantics and an outside world, is in many respects anathema to the two Polish poets, and to Miłosz in particular. I set out to explore the confluence of mathematics and poetry, and to investigate frameworks for what is occurring. In considering these three case studies, the essential substance of the evocative similarity between mathematics and poetics is the underlying question. Herbert and Miłosz have taken metonyms of mathematics – what the concepts suggest to them – and considered in their poetry the consequences for their ethical philosophies. Barbilian instead takes an opposite approach, relying on mathematical method. Clearly there is not a uniform pattern or theory. But the specificity of the case studies are enlightening, and the stronger the mathematician or poet, the greater the opportunities.

There are many avenues open to further research, some of which have been indicated in the separate concluding discussions at the end of each chapter of this thesis. The genre of mathematical poetry which is deeply reliant on overt mathematical symbolism offers one such path.⁷²³ In contrast, an embryonic mathematical idea may initially be encountered in poetry, and so offer a generative starting point for mathematicians. For this reason, a deeper analysis of what mathematicians see in poetry holds fascinating potential.⁷²⁴

What emerges from this thesis is that the relationship between poetics and mathematics is a shared building up and layering of ideas and connotation, where both attempt to make sense of the human condition, be it through the humanist ethics of Miłosz and

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⁷²³ One possible example is the set of poems each based on a mathematical figure, mentioned in chapter 2: Guillevic, *Euclidiennes*. Yet Guillevic was not himself a trained mathematician, and his poems do not successfully integrate mathematical symbolism in any holistic manner.

⁷²⁴ This is touched on in the Scottish project described in Dillon, “What Scientists Read | How Does Literature Influence Scientific Thought and Practice?”

Herbert, or the intellectual striving of Herbert and Barbilian. Both are the creative approaches towards the (asymptotic) solving of a puzzling conundrum. Mathematics uses specific methods of building up knowledge and ideas in order to suggest something, and that comparable layering of ideas within a tight structure, together with reliance on inference and metaphor is also integral to poetics.

Limits in mathematics are by definition not reached, but expressed asymptotically. This understanding is clearly manifested and understood by Barbilian, and partially and gradually realised by the non-mathematicians Miłosz and Herbert. Mathematics and poetry do indeed ‘meet in a spiritual highpoint’ (to cite Barbilian), but that fulfilment is dependent on consideration of their buried implications and inferences, and the precise methods with which these are evinced.

$$d(a, b) = \max_{p, q \in K} \ln \left[\left(\frac{pa}{pb} \right) \left(\frac{qb}{qa} \right) \right]$$

Dan Barbilian ⁷²⁵

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⁷²⁵ The distance metric defined by the Romanian mathematician Dan Barbilian. See chapter 5.

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