

Consonances I: Mathematics, Language, and the Moral Sense of Nature.

Maynooth University, Ireland, August 30th – September 1st, 2023. Report for the International Commission on the History of Mathematics (ICHM).

This multidisciplinary conference drew upon the Maynooth alumnus and Irish philosopher of science Ernan McMullin's idea of consonance (1981)¹. It explored the interplay between mathematized logic, language, morality, and understandings of nature in premodern and modern eras from Western and Global perspectives. Acknowledging, though independent from, McMullin's theological imperative, Consonances had 17 presentations from historians of mathematics, science, philosophy, and theology which 'retain[ed] the autonomy of each discipline [...] in ways which do not fall into conflict' (Hess & Allen, 2008, pp. 134-137)². In addition to the presentations, titles and abstracts below, the two-and-a-half-day conference had a tour of the [Russell Library](#) and poster exhibitions of research conducted by undergraduate students on McMullin's Maynooth bequest.

The conference was organised by [Susan Gottlöber](#), [Ciarán Mac an Bhaird](#), and [Kevin Tracey](#).

Opening Address

Sophie Roux, École Normale Supérieure, Paris. 'History and philosophy of science at its best. A belated tribute to Ernan McMullin'

I became familiar with Ernan McMullin's writings while I was working on my PhD on mechanical philosophy nearly thirty years ago. Because of the quality of their information, the clarity of their exposition, and the vigor of their theses, they were very helpful to me. In first approximation, I found there a philosophy of science loaded with history of science and a history of science motivated by philosophical questions to which my education in France had accustomed me. In my paper, I will take a little distance from these first readings, to analyse the specific form that Ernan McMullin gave to the confrontation of the philosophy of science and the history of science. I will put this confrontation into its historical context and answer explore two questions. 1/ Why should a good philosophy of science take seriously the historicity of science? 2/ How can a good philosophy of science take seriously the history of science without disfiguring it?

Keynote Addresses

David C. Albertson, University of Southern California. 'Geometry Hot and Cold: Cusanus beyond the Metric Binary'

Despite advances made by gender studies and deconstruction, the study of medieval Christian mysticism remains bound up with early modern accounts of religion. To us it seems that the soul and God alone are unmeasurable; the world can only be measured. But this metric binary did not universally hold before the seventeenth century (Husserl). How might the history of scientific measures inform our understanding of mystical texts and mystical spaces? What lines, dimensions, or topologies in the geometrical imagination express divine presence or absence? By turning to the Boethian quadrivium, especially geometry, Nicholas of Cusa (d. 1464) explored how mystical theology could function as a mode of world-measurement or general "topology" (Certeau). Yet the Cusan geometrization of mystical space is best grasped as a secondary moment, one following a primary instance that is usually relegated to eroticism. I call these two moments hot and cold

¹ McMullin, Ernan, 'How Should Cosmology Relate to Theology?', in Arthur Peacocke, ed., *The Sciences and Theology in the Twentieth Century* (Notre Dame, IN: University of Notre Dame Press, 1981), pp. 17-57.

² Hess, Peter M.J., and Paul L. Allen, *Catholicism and Science*, Westport, CT: Greenwood Press 2008.

geometry, a double figure opposed to the opposition between *matheme* and *poeme* (Badiou). I outline two tasks for the study of Christian mystical texts beyond the metric binary and then identify three strategies latent in the Cusan corpus, "cold" but still legible.

Robert Goulding, University of Notre Dame. "If the image never lies": Ramist Optics and Snell's Measure of Refraction'

Towards the end of his life, Petrus Ramus began to prepare a textbook on optics, working with Friedrich Risner. Ramus died before the work was completed, a task that Risner took on while holding the posthumous "Ramus chair" in mathematics at the Collège Royal. It is a fascinating, and little-studied text, which I will consider in the context of Ramus's other mathematical works, especially his *Geometry* and *Arithmetic*. Although the *Optics* was a work of no great originality, it found a careful reader in Willebrord Snell, professor of mathematics at Leiden---an avowed Ramist, and one of the pioneers of modern optics. Snell used his copy of the Ramus-Risner *Optics* (now in Leiden University Library) as a notebook to record his optical thoughts and experiments over more than a decade, thickly annotating almost every page and sewing in extra blank leaves on which he wrote substantial optical essays, inspired by the text. In the paper, I examine Snell's use of this volume (again, in the context of his mathematical and astronomical studies in the second decade of the seventeenth century), and its role in helping him think his way to a measure (or "law") of refraction.

Accepted Papers (* denotes Invited Speaker)

Ovanes Akopyan, Villa I Tatti and Ca' Foscari University, Venice. 'Tides: Thinking on Water Motion in Early Modernity'

This paper focuses on pre-modern engagement with the relatively neglected yet highly problematic and significant natural phenomenon of tides. It might seem that in the shifting world of pre-modern science and natural philosophy, the search for a reliable explanation of tidal motion was a marginal issue or, at least, was not prioritized. This paper argues, however, that the flow and ebb effect was an essential component of cosmological discussions in pre-modern Europe and attracted the attention of all key scholars whom we currently associate with the so-called Scientific Revolution. The competition among the prominent thinkers involved in the study of natural philosophy, astronomy and mathematics left its mark on a considerable number of works on tides. At the same time, the contesting solutions were believed to constitute a valid argument in favour of their respective cosmological theories. This implies that the issue of determining the flow and ebb of water formed part of a larger discourse that went beyond strict mathematization of natural knowledge in the early modern period but reflected, on a more general level, a peculiar understanding of the cosmos and all it contains. Thus, by looking at a selection of early modern texts that discussed the origin of tidal motion, and ranged from purely natural philosophical and mathematical tracts to political treatises and humanist reflections on the inundation of the Nile, this paper aims to unveil a significant episode in the history of early modern knowledge.

Maria Amuchastegui, York University (CAN): 'The Theological Binary in Leibniz and Caramuel'

When the seventeenth-century Spanish philosopher Juan Caramuel Lobkowitz and the German Enlightenment philosopher Leibniz are mentioned in the same breath, it is generally in the context of the priority dispute over the discovery of binary numbers. Nevertheless Caramuel and Leibniz had other things in common, such as a shared interest in China and in the development of a universal language. One little discussed commonality is their similar theological take on binary numbers. This commonality merits further study, not least because it may shed light on the claim---made by partisans of Caramuel---that Leibniz plagiarized Caramuel.

Caramuel is mostly known nowadays for his role, during the Counter-Reformation, as the foremost proponent of the philosophy of probabilism. Probabilism is usually understood as a moral philosophy--the notion that moral decision-making should be subject to probabilistic computation--but for Caramuel probabilism was applicable to all natural phenomena. Just as Caramuel applied mathematical reasoning to morality, so too did he imbue his mathematical insights with theological meaning. Caramuel's most famous mathematical work was the preface to his 1670 encyclopedia of mathematical knowledge, *Mathesis biceps*. In the preface, entitled "Meditatio Proemialis," Caramuel set forth a theorization of how numbering systems work, a theorization that included the first account of binary numbers and that was fraught with theological overtones. Similarly, when Leibniz privately announced his discovery of binary to his employer, the Duke of Hanover, he did so in theological terms that mirrored those of Caramuel. However, when Leibniz later publicly announced his discovery of binary to the Académie Royale des Sciences, he omitted all theological allusions, thereby obscuring his debt to Caramuel.

Álvaro J. C. Bo, University College Dublin, 'The role of Proclus' *communis mathematica* in Alessandro Piccolomini's *De certitudine mathematicarum*'

As studied by Crapulli and Rabouin, Proclus' *In Euclidem* is one of the main sources of the modern concept of a *mathesis universalis*. The first remarkable chapter in the Latin reception of Proclus' notion of a *ὅλη μαθηματική* was that of Alessandro Piccolomini in his work *De certitudine mathematicarum*. Indeed, in interpreting and adapting Proclus' mathematical ontology and epistemology to his own theoretical ends, Piccolomini also introduced the notion of a *communis mathematica*. Nevertheless, Piccolomini's common mathematical science has been understood as ahistorically relevant, yet doctrinally idle notion. Indeed, its central role and purpose in the whole of Piccolomini's philosophy of mathematics has remained unclear. In my talk, I shall deal with this episode in the history of philosophical and mathematical ideas. I shall show firstly (1) the debts and variations of Piccolomini on Proclus' *ὅλη μαθηματική*, and (2) how the notion of this overarching meta-mathematical science must be necessarily supposed for the sake and coherence of Piccolomini's argumentation. To put the problem in short: Alessandro Piccolomini makes exclusive use of geometrical arguments all through in his exposition in *De certitudine*, whereas the conclusions drawn are generally applied to every actual (and possible) mathematical science. How is this possible? The answer lies in the backing concept of a *communis mathematica* which allows him to draw conclusions on the common nature of mathematics (unspecified quantity) through specific mathematical examples.

Francesco Bossoletti, McGill University. 'Number Theory and Mathematics as Epistemology: Nicholas of Cusa's Thought and the Concept of Nature'

Despite an undoubted relationship, the immediate equation of Cusanus' philosophical thought to the process of "mathematization" of the universe by which the transition from the Middle Ages to Modernity has been interpreted betrays a failure to explore both sides of this association. Indeed, the very notion of "mathematization" requires an explanation of the status of mathematics in Cusanus' thought, which is what we do in this paper through an analysis of the "constructionist" ontology of mathematical entities on which he sets his gnoseology. This philosophical approach, which in its anti-innatism even seems anti-platonic, highlights the innovative structure of Cusanus' mathematical framework and Christian theology, which manages to hold together Aristotelian-scholastic (ultimately Boethian) instances with a Platonic and neo-Pythagorean doctrine of number, founded on the metaphysical categories of identity (oddness) and difference (evenness). Indeed, he finds through the notion of *magnitude* and the related category of quantity a first fundamental distinction between the mathematics of the *discrete* (arithmetic and music) and the mathematics of the *continuous* (geometry and astronomy) in fact distinguishing arithmetic and geometry. These are, however, held together and grounded through recourse to a metaphysics of number that

distinguishes between a *rational* mathematics, based on the concept of quantity, and an *intellectual* mathematics, which grounds the former through the neo-Pythagorean concept of unity. This discourse, embedded in the broader Cusa's epistemological discourse and based on the equation between knowledge and measure, modifies our understanding of the term "mathematization": if this is made equivalent in Cusanus to the term *quantification*, we must therefore understand it as the process of *rational arithmetization* and *rational geometrization* by which we measure the Real and not as a transfer of mathematical properties to Nature.

Paolo Celi, Villa I Tatti and the University of Pisa. 'What we talk about when we talk about mathematics. Piccolomini, Varchi and Speroni, and the quest for a scientific language' Online

In 1540, three members of the Accademia degli Infiammati in Padua, Alessandro Piccolomini, Benedetto Varchi and Sperone Speroni simultaneously composed their works on mathematics, a discipline they considered a testing ground for a radical reform of Aristotelianism. The matter was made urgent by the publication of Proclus' *Commentary* on the first book of Euclid's *Elements* (Grynaeus 1533).

The philosophical discussion was first and foremost a question of language. If the reform was to be radical, it had to start with the redefinition of terminology itself. Latin came with its own history, and the very same words had been used over the centuries with many different meanings. Therefore, some Infiammati went so far as to suggest abandoning Latin in favour of the vernacular, while others took a more conservative stance. Even within the same side of the vernacular supporters, there were those who advocated for a more pragmatic approach and those who envisioned a literary linguistic ideal, cautiously open to everyday speech.

Numerous themes entered the debate at the Accademia degli Infiammati, being the Accademia a less formal environment than university: the "questione della lingua", the issue of imitation, the principle of authority and the controversy over the audience of science—all of which will have a considerable influence on the future development of Italian as a language of culture. In this paper, I will examine the attempt to reform Aristotelianism through mathematics and language from the perspectives of Piccolomini, Varchi and Speroni.

Isobel Falconer, University of St. Andrews, and David Horowitz, Golden West College (Emeritus). 'MacLaurin and Morality'

Scottish mathematician Colin MacLaurin (1698-1746) is best known for his *A Treatise of Fluxions* (1742), *An Account of Sir Isaac Newton's Philosophical Discoveries* (1748), and the appellation for a type of power series. However, it is hardly known that in 1714 at the age of sixteen MacLaurin penned a short manuscript wherein he tried to apply Newtonian principles to morality, in an approach to mathematization that suggests strong continuities with earlier centuries. *De viribus mentium bonipetis* (*On the good-seeking forces of minds*) remained unpublished and hidden in the papers of the Colin Campbell Collection at the University of Edinburgh for over 250 years; it was only uncovered at the end of the twentieth century. *De viribus* provides a remarkable glimpse into how the young MacLaurin dealt with early Newtonianism, the tenets of the Church of Scotland, and the nascent interface between science and religion just prior to the dawn of the Scottish Enlightenment.

Perhaps the most intriguing aspect of *De viribus* is the personal snippets related to Scottish Presbyterian morality that MacLaurin interjects throughout his mathematical discussion. These are often vague and oblique, and one must look to his mathematics, his contemporaries, and the social fabric of his surroundings to understand them. In the process, one gains insight into MacLaurin's family background, education, and personal religious thought.

John Gallagher, University of St. Andrews. 'The Six Ages of the World and Temporal Theology in the Early Medieval Latin West'

Time, the calendar, and conceptions of history became increasingly regimented and systematised during the early medieval period in the Latin West (c.AD 700–1000). Through the endeavours of computational scholars like the Venerable Bede (c.673–735), the assorted difficulties of temporal reckoning and the correct ordering of the time were modernised and rationalised according to innovative technical methods. Notwithstanding these developments, time, history, and their trajectories remained inextricably linked with biblical notions of cosmology (the beginning of the world), eschatology (the end), and the grand scheme of salvation history. Time, in the Christian sense, is ordered by God and the blueprint for its patterns, which are detectable in nature, are furnished by the biblical text. The shift in the calendar era to *Annus Domini* allowed for a universalised conception of world history, but it did not stifle interest in the *Annus Mundi* system, which measured time from the biblical Creation. This method of quantifying the world's age, by implication, invited apocalyptic calculations of how much time remained. At least three different systems for dating the age of the world coexisted in the early medieval Latin West and even more theories about the end. By focusing on the enduring historiographical model of the six ages of the world, this paper explores the tensions inherent in early medieval prophetic conceptions of time and the problems of mathematical and temporal theologies. Overall, this paper will present fresh insights into how conceptions of time and history intersect with biblical literature and thought.

E. A. Hunter, University of Chicago. 'Understanding Nature through Hymns and Math: Proclus' De Sacrificio and his Commentary on Euclid'

The hymns of Proclus have been neglected in scholarship due to their confusing narrative and seemingly lack of metaphysical content. Although Meunier (1935) and Beierwaltes (1965) have identified an anagogic theme in each hymn and Van den Berg's illuminating commentary (2001) has provided their theurgic context, the narrative structure is still confounding. Even to the extent that there is no agreement about the addressees of some of the hymns, like whether the sixth hymn honors two or three gods, or which Aphrodite is celebrated in her two hymns. This problem becomes resolved, however, once we consider the epistemological role of mathematics in Proclus' theology and how his mathematized ontology is reflected in the language of the hymns.

I propose a new interpretation of the divine in Proclus' hymns based on the mathematical understanding of *seira* with the theurgic beliefs of later Neoplatonists. I argue using Proclus' *De Sacrificio* and his commentary on Euclid's *Elements* that the hymns are not addressed to a singular version of a deity but are addressed to their whole *seira*, hence why they seem to lack consistency and cohesion. The purpose of hymning then becomes an opportunity for the participant to reflect upon the universal *seirai* in a spiritually charged experience rather than to communicate or honor the divine. This paper concludes with considerations of how Proclus conceived the role of mathematics in theological knowledge and argues why his hymns should be considered a part of mathesis' genealogy.

**Aditya Jha, University of Canterbury, New Zealand. 'A Buddhist take on mathematical realism'.
Online**

Confirmational holism requires that ontological commitment to some of our best scientific theories necessitates extending a similar commitment to mathematical entities (models) quantifying over such theories (Quine 1980; Colyvan 2019). It is thus claimed that these models give us epistemic access to the external world in a mind-independent sense, akin to our scientific theories: call this the 'received view'.

The mind-independent notion of the received view has been challenged on various ontological grounds: one such, often discussed, objection being the Madhyamaka Buddhists' position of 'dependent origination' of all conditioned phenomena (Roy 2018, Westerhoff 2020) which stands at odds with a scientific and mathematical reformulation of the world involving independent and *sui generis* entities. This talk, however, discusses the relatively unexplored epistemic objection to the received view, from the perspective of the Madhyamakas, based on the principle of 'dependent designation'. The broader goal of the talk is to show how '*dependent designation*' weakens ontological commitment to the received view concerning mathematical entities. In doing so, the talk engages the current Philosophy of Science literature with that of Madhyamaka philosophy and shows how:

- (1) mathematical models and claims are dependently designated and thus are no more privileged than ordinary linguistic claims, when evaluated in the context in which the claims were made (Chang 2009; 2016; Elgin 2017; Potochnik 2017), since they are artificially constructed by an epistemic agent to provide contextual scientific explanations, and
- (2) using such models to make realist claims amounts to epistemic circularity, similar to the one raised in the classic Nyāya-Buddhist debate on the validity of the means of knowledge concerning a variety of epistemic foundationalism. Here I show how foundationalism concerning mathematical entities fails since the only plausible route for such a defence - the explanatory virtue of models - is blocked due to Madhyamaka's objections of epistemic circularity.

Blocking foundationalism of this sort and demonstrating that mathematical models are contextual linguistic entities weakens the commitment towards the received view and endorses humble agnosticism.

Emily Kent, University of Edinburgh. '*Music and the Order of Minims: Re-Contextualizing Marin Mersenne's Mathematics in Seventeenth-Century France*'

Although the mathematician Marin Mersenne (1588-1648) has long been an object of inquiry for historians of science and philosophy, many questions remain concerning the French polymath and the priorities driving his scholarship. Despite being a Minim monk, a member of a mendicant order with strict demands of asceticism and a distrustful attitude towards knowledge and erudition, Mersenne somehow managed a scholarly career which appeared to both flagrantly disregard the demands of his Order while also supporting its missions. Indeed, Mersenne crafted a unique approach to scholarship which reconciled Minim philosophical beliefs, practices, and initiatives with his output on music theory. The aim of this talk is to evaluate Mersenne from within this much neglected religio-institutional context. The paper will incorporate the frameworks and concerns of historians of religion to demonstrate that Mersenne's mathematical and musical scholarship worked in tandem with the spiritual imperatives demanded by the Minims. Using in particular Mersenne's 1627 *Traité de l'harmonie universelle*, an early text which prioritizes discussions of musical metaphysics over the acoustics and mechanics which dominate his later work, this talk will re-contextualize the "harmonizing" impulse of Mersenne's music theory as it related to the religious, social, and political concerns of seventeenth-century religious orders in France. Excavating the Minim spiritual and philosophical traditions evident in Mersenne's music publications reveals the lingering influence of medieval intellectual culture in a figure typically associated with the new science of the early seventeenth century.

Richard Oosterhoff, University of Edinburgh. '*Freedom and Constraint: Mathematics and Rule in Renaissance Political Thought*' *

Our narratives of liberal modernity have made mathematical reasoning a focal point of both freedom and coercion. Classic accounts since at least Koyré considered how mathematics enables humans to

challenge finite bounds in a bid for infinite perspectives; meanwhile, influential critics point out the pernicious consequences of mapping the world, of constraining it within a numbered grid to enable the extractive, surveilling state. This talk attempts to trace an emerging sense—and dismissal—of this tension in the sixteenth century. It will use Renaissance assumptions of how to do mathematics to find a way into the tensions between coercion and freedom, and from there examine the place of mathematical reasoning in Renaissance political thought.

Daniel Rowe, University of Oxford. ‘Modal-Potentialism and the call for Consonance’

From the Seventeenth Century, mathematical descriptions of reality took centre stage, often at the expense of other perspectives. Contemporary ZFC set-theory, often viewed as a foundation of mathematics, exemplifies the trend. It views mathematics as being about agglomerated collections that are actually infinite, overturning centuries of mathematical, philosophical and theological thinking.

In a fascinating turn of events, in recent decades many philosophers of mathematics have begun to argue that the ZFC set-theoretic universe requires a notion of potential infinity at its core. One important question for the Modal-Potentialist is whether the traditional Judeo-Christian concept of Divine omniscience would make it incoherent. In an unpublished lecture Levey, Linneo and Shapiro offer an answer, that such a Being would need to fail to be fully amodal. I argue that this approach contradicts not only much of traditional theology, but also leaves deep unanswered questions about mathematics.

Ernan McMullin called for consonance and I suggest, in this spirit, a resolution that offers a new-old picture of mathematics: that it is less about agglomeration, than about the division of a oneness into many. Such a perspective could help Modal-potentialism match classical quantification (thus improve on constructivism), whilst explaining deep mathematical phenomena, such as the uniqueness and centrality of prime-numbers. Without meaning to be sensationalist, it also leaves a tantalising suggestion. What if a mathematized viewpoint is one that takes fragmentation as a given, and builds parts of parts, but masks a deeper reality; that at the core of reality is a pre-mathematized oneness?

Jeremy Thompson, Independent Scholar. ‘Reflections on Number and God out of the Margins of Boethius’

According to a commonplace in the Middle Ages, all things depend on numbers: “Take away numbers from all things, and everything perishes” (*Tolle numerum omnibus rebus, omnia pereunt*). The motto, derived from Augustine and transmitted over Isidore, appears in numerous texts and manuscripts, including the marginal glosses of the standard arithmetic textbook of the early Middle Ages, Boethius’s *De arithmetica*. There, it figures in the commentary attached to the proem of the work, a critical locus for reflection on the integration of arithmetic and the ancient mathesis in the rationale and motivation of the scientific disciplines. The considerable corpus of evidence for the reception of *De arithmetica*—the annotations present in the codices themselves—has been overwhelmingly understudied. At once, they reveal not merely didactic explications and exemplification, but learned associations intersecting with philosophical and doctrinal traditions beyond the confines of arithmetic. The theological tradition is thus alive in the margins. Not only does the motto *Tolle numerum* turn up, but also another provocative declaration: “God is called nature” (*Deus natura dicitur*). Yet if nature can—nay, must—be analyzed by numbers, what are the ramifications of the notion that God is also called nature? This presentation proposes to stage moments in the early medieval confrontation between these two ideas—nature as number and God as nature—and to examine them primarily in the reflection generated by Boethius’s *De arithmetica*. While many scholars have stressed the Chartrian contribution to this theme, this paper will conclude by considering the innovative adoption of these ideas in a Cistercian milieu.