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EDITORIAL

Scientific Interests and Technological Innovation in Byzantium: Interdisciplinary Perspectives[1]

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Abstract: This editorial begins by surveying the status of Byzantine science and technology as a field integral to the history of science as an academic discipline. After addressing the marginalization of Byzantine science and technology until quite recently, the editorial then proceeds to show that the origins of this field are not recent. Building on the trailblazers of the early twentieth century, a plethora of scholars have already contributed to the emergence of the field as a respectable and consequential pursuit. Much more should be done, however, and the articles here summarised inaugurate further avenues of research that, hopefully, will contribute to the recognition of this field by historians of science and scholars of Byzantium alike.
Keywords: Byzantine science and techology; Byzantine studies; history of science; interdisciplinary approaches.

ES Editorial: Intereses científicos e innovación tecnológica en Bizancio: perspectivas interdisciplinarias

Resumen: Este editorial comienza examinando el status de la ciencia y la tecnología bizantinas como un campo integral de la historia de la ciencia como disciplina académica. Después de abordar la marginación de la ciencia y la tecnología bizantinas hasta hace muy poco, el editorial pasa a mostrar que los orígenes de este campo no son recientes. Sobre la base de los pioneros de principios del siglo XX, una gran cantidad de académicos ya han contribuido al surgimiento de este campo como una actividad respetable y trascendental. Sin embargo, queda mucho por hacer, y los artículos aquí resumidos inauguran nuevas vías de investigación que, con suerte, contribuirán al reconocimiento de este campo tanto por parte de los historiadores de la ciencia como de los estudiosos de Bizancio.
Palabras clave: Ciencia y tecnología bizantinas; estudios bizantinos; historia de la ciencia; enfoques interdisciplinarios.

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The study of Byzantine science and technology is neither an academic newcomer nor a peculiar interest of isolated scholars. It is integral to the history of science, which, until quite recently, focused on the most obvious factors (at least to the Western mind) that led to the rise of modern science.[2] As a rule, Western historiography began the narrative with Greek antiquity, from the Ionians to Aristotle, then went straight to scholasticism and the Renaissance as stepping-stones for the scientific revolution. Ideologically motivated historians were even more reductionist, skipping a couple of millennia of development from

[1] Writing this editorial and the curation of this collection of articles were integral to the author's commitments as the Selby Old Fellow in Religious History of the Orthodox Christian Faith at the University of Sydney Library (2023-2024).

[2] The trailblazing efforts of Alistair Cameron Crombie, while crucial for the development of the discipline, illustrate a narrow Western European idea of science history. In short, Crombie focused on Western (Latin) Late Antiquity and the Middle Ages as paving the way for modern science. See his *Science from Augustine to Galileo: The History of Science*, two vols (London: Falcon Press and Mercury Books, 1952); *Robert Grosseteste and the Origins of Experimental Science 1100-1700* (Oxford: Clarendon Press, 1953); *Medieval and Early Modern Science*, two vols (Garden City, NY: Doubleday, 1959); *Science, Art and Nature in Medieval and Modern Thought* (London and Rio Grande: Hambledon Press, 1996). For a more recent contextualisation of this kind, see John Gribbin, *Science: A History 1543-2001* (London: Penguin Books, 2002).

the Greeks to Galileo. In time, the historians' scope broadened to encompass the roots of ancient Greek science, such as Babylonian and Egyptian, then medieval influences, such as Arab, Jewish, and Persian. Meanwhile, Byzantine science received almost no mention from Western scholars. When they were referred to, more or less incidentally, the Byzantines were portrayed as scribes of manuscripts and translators of works of other cultures, ancient and contemporary alike, but not as contributors.[3] Historians then turned to the great Chinese and Indian traditions, whose direct impact upon modern Western science, however, was limited.[4] Even more recently—and this is an exciting development—the history of science came to be further broadened, to include the natural philosophy, the discoveries, and the practices of many other and much older traditions around the world, indigenous to areas untouched by Western ideas, at least until the modern age.[5]

It is against this backdrop that the study of Byzantine science has become a burgeoning field, part and parcel of this global effort of retrieving the many strands of human ingenuity expressed in the form of scientific enquiry and technological innovation, broadly conceived. And while currently Byzantine science constitutes a distinct branch of the history of science, attracting the interest of Byzantinists and non-Byzantinists alike, it is by no means an emerging field.

We already know that the Byzantines—not being obsessed with either things transcendent or the glories of ages past, rhetorical protestations of reverence and regard for these zones notwithstanding—were curious to know and to understand reality, as well as industrious in transforming the space they inhabited. Albeit not specialising in the history of science and technology, older generation scholars such as Panagiotes Chrestou[6] and Basil Tatakis[7] had told us this much. The Byzantines theorised, experimented, and innovated. They developed new mathematics and applied them to practical issues, innovated in chemistry, improved on medical science and practice, innovated in architecture, and perfected astronomical instruments and other mechanical devices—to mention only their most obvious feats of inventiveness. No wonder the great polymath Nikephoros Gregoras (d. 1360), to give an example from almost the end of their world, could ridicule his Western colleagues for adhering to Aristotle's division between theoretical and applied sciences, while his compatriots had advanced beyond that point.[8] It is this wealth of knowledge, ingenuity, and prowess that the Byzantine refugees from the Ottoman invasion of the East—of whom most established themselves as scholars in Italy and contributed to the dawn of Renaissance—brought with them. We know this much from a distinguished academic of even older a generation, Nicolae Iorga.[9] But our understanding of Byzantine science and technology dramatically improved in the last few decades.

The works of Paul Magdalino[10] and Efthymios Nicolaidis[11] were instrumental towards this revival of the field. As part of the developing interest in Byzantine science, recent research brought to light Byzantines' consuming interest in both "canonical" and "occult" sciences—from astronomy, mathematics, architecture, and medical research to alchemy and astrology—as well as their technological ingenuity and skills. An important landmark of this development is the imposing 2020 volume, *A Companion to Byzantine Science* (including fourteen chapters, flanked by the introduction and conclusions), edited by Stavros Lazaris,[12] which examines the many areas where the Byzantines contributed, scientifically and technologically. The volume also pays tribute to the trailblazers of the field, which justifies my conviction that the study of Byzantine science is not a newcomer. Thankfully, the field continues to expand with the years passing. This monographic issue of *De Medio Aevo* hopes to further our understanding of Byzantine science and technology by addressing little discussed matters and by reconsidering known topics from unexpected new angles.

These new avenues for research relate to the diverse expertise of the contributors to this interdisciplinary project—Eva Anagnostou-Laoutides (Macquarie University, Australia) is a classicist with an interest in the intersection of cultural and civilisational trends in Late Antiquity and the Byzantine era; Vladimir Cvetković (Institute of Philosophy and Social Theory of the University of Belgrade, Serbia) is a philosopher and theologian who works at the crossing

3 See Crombie, *Medieval and Early Modern Science*, 1: 188, 209; Otto Neugebauer, *A History of Ancient Mathematical Astronomy*, Studies in the History of Mathematics and Physical Sciences 1 (New York: Springer, 1975), 9-12.

4 An early illustration of this trend is the collection of essays edited by A. C. Crombie, *Scientific Change: Historical studies in the intellectual, social and technical conditions for scientific discovery and technical invention, from antiquity to the present* (London: Heinemann, 1964).

5 See, for example, the impressive *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin (Springer Dordrecht, 2016). See also David C. Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, Prehistory to A.D. 1450*, 2nd edn (Chicago and London: The University of Chicago Press, 2007). The assessment of Indigenous knowledge and its place in the history of science, including science education, is not easy, however. See, for example, O. Ripeka Mercier and Beth Ginondidoy Leonard, "Indigenous Knowledge(s) and the Sciences in Global Contexts: Bringing Worlds Together," in *Handbook of Indigenous Education*, ed. Elizabeth Ann McKinley and Linda Tuhiwai Smith (Singapore: Springer, 2019), 1213-1242.

6 See his *Greek Orthodox Patrology: An Introduction to the Study of the Church Fathers*, trans. George Dion. Dragas, Orthodox Theological Library 4 (Rollinsford, NH: Orthodox Research Institute, 2005; original Greek edn 1976).

7 See his *Christian Philosophy in the Patristic and Byzantine Tradition*, trans. George Dion. Dragas, Orthodox Theological Library 2 (Rollinsford, NH: Orthodox Research Institute, 2007; original Greek edn 1952).

8 See the discussion in Tatakis, *Christian Philosophy*, 156-157.

9 See his *Byzance après Byzance* (Bucharest: The Institute of Byzantine Studies, 1935).

10 See his *L'Orthodoxie des astrologues: La science entre le dogme et la divination à Byzance (VIIe-XIVe siècle)*, Réalités Byzantines 12 (Paris: Lethielleux, 2006); see also Paul Magdalino and Maria Mavroudi (eds), *The Occult Sciences in Byzantium* (Geneva: La Pomme d'or, 2006).

11 See his *Science and Eastern Orthodoxy: From the Greek Fathers to the Age of Globalization*, trans. Susan Emanuel (Baltimore: The Johns Hopkins University Press, 2011).

12 See *A Companion to Byzantine Science*, ed. Stavros Lazaris, Brill Companions to the Byzantine World 6 (Leiden and Boston: Brill, 2020).

of Byzantine studies and patristics, having an interest in modern Orthodox theology and ecumenism; Richard de Grijs (Macquarie University, Australia, and the International Space Science Institute, China) is an astrophysicist with an interest in the history of science, especially the nexus of astronomy, geography, and seafaring; Stavros Lazaris (French National Centre for Scientific Research, France) is an expert in Byzantine civilisation who researches manuscripts relevant to the history of science and technology and the history of texts and images; Gerasimos Marianos (Institute for Historical Research at the National Hellenic Research Foundation, Greece) is a philosopher and historian of science who specialises in Byzantine alchemy at the crossing a several fields, including the history of economics. As for me (The University of Sydney and the Sydney College of Divinity, Australia), I am a theologian with an interest in Christianity and culture in Late Antiquity and the Byzantine era, specialising in science-engaged theology and studies in religion. On this note, let's take a tour of the articles gathered here.

The contribution of Gerasimos Merianos, "Innovation and Byzantine Alchemy in Context: The Constantinian *Solidus* and the Chrysopoetic Goal," opens this collection by considering alchemic theory and practice against a complex backdrop, including innovativeness, as we learn right from the title. This contribution draws upon historiographical and social study approaches. It shows that, together with appropriating classical and medieval antecedents, Byzantine alchemy emerged due to factors inherent to the Byzantine setting. One such factor, never before discussed by scholars, is a matter of happenstance, namely, the issue of Emperor Constantine I's *solidus*, a golden coin that became the epitome of the Byzantine obsession with gold. If alchemy was overall suspected as an occult art, the golden *solidus* catalysed a lasting interest across various walks of life, with many people seeking to acquire it and all things made of that metal. To justify this "gold rush," as it were, Byzantine Christians considered possession of the precious metal a proleptic sign of future glory. This *theological* assumption legitimised the acquisition of golden items, foremost in the form of currency, in large quantities. No wonder the flurry of ways of obtaining and trading gold. This included the impetus of alchemy, which promised to produce the metal through *chrysopoeia* ("gold-making") for people with little access to the usual ways of procuring it. Deftly, Merianos discusses examples (from the Byzantine alchemists Pelagios, Christianos, and the Anonymous Philosopher) of deliberate interpretation of gold as denoting eschatological glory—and of *chrysopoeia* as a theologically endowed art, or science, that made possible its acquisition. It is against this backdrop that the author discusses the rise of Byzantine alchemy at the nexus of ancient traditions and new social and cultural realities. Very relevant to this collection of studies are the author's remarks about innovation in Byzantium. Specifically, while the Byzantines' indebtedness to the broader alchemic tradition is indisputable—and the same goes for other sciences—contemporary scholars should moderate their quest for "originality" when it comes to Byzantium and, indeed, other medieval and ancient cultures. Byzantine innovativeness is not about radical creation out of nothing; it emerges out of existing theory and practice, which it refashions and develops in new ways. The evidence in relation to alchemy, as presented in this article, is compelling, and the same angle—Merianos suggests—should be adopted by researchers of other dimensions of scientific and technological development in the Byzantine world.

Somehow corroborating and to and extent challenging the above conclusions—but indirectly, of course—Eva Anagnostou-Laoutides discusses another aspect of Byzantine technological prowess, that is, mechanics. Her contribution, "Miracles of Technology and Art: Ancient Religious Aesthetics and Byzantine Iconoclasm," focuses upon the historical circumstances that led the Byzantines to oppose the use of machinery for religious purposes and to encourage inventiveness and the application of technological devices elsewhere. The author begins with a detailed survey of the use of machines, especially automata, in antiquity, from Ptolemaic Egypt to imperial Rome to the beginnings of the Byzantine era. Obviously, the Byzantines both inherited engineering and mechanical skills, and contributed to their development. The survey continues with further historical moments, such as the genial contributions of Hero of Alexandria, whose inventions and relevant treatises represent a bridge between ancient and medieval machine technology. His works, we learn, were known to Oriental cultures, such as Arab and Persian, primarily through the diligences of Byzantine scholars who preserved and improved upon his ideas. And it is these cultures, Arab, Byzantine, and Persian, who progressed beyond Hero and his sources in terms of developing machine technology, especially automata. Anagnostou-Laoutides describes at length the building of partially mechanised palaces, as well as the staging of religious and theatrical representations, which caused awe, delight, and fascination to onlookers—from whole paradisal sceneries of automatic trees, chirping birds, and flowing waters to hydraulically moving statues and "levitating" thrones to mechanic orchestras able to perform with utmost fidelity the music of the respective times and places. Nevertheless, Byzantine educated believers voiced concerns about the fake mechanical miracles meant to stir religious fervour during religious processions and to substantiate the claims of numerous charlatans, who asserted their "holiness," rather their engineering skills. No wonder the religious use of automata fell in disuse. This turn of events echoed much earlier worries, expressed in Late Antiquity by a plethora of authors who rejected the use of mechanical devices for religious purposes as "pagan," therefore contrary to the spirit of Christianity. It should not come as surprise that the iconoclast Emperor Theophilos, a sponsor of innovators for civil undertakings, outlawed the employment of automata in religious settings. And so, Byzantium's Christian culture both supported and staved off the development of mechanics—depending on what aspects of this complex world one considers.

The article of Stavros Lazaris, "Preliminary Considerations on the Columns and Framings of the Nicetas Codex (Laur. Plut. 74.7)," discusses the significance of aspects pertaining to the illuminations of the tenth-century manuscript mentioned in the title,

which comprises sixteen medical treatises. Some of these treatises are copied in full, but from others only fragments are included here. The article focuses upon Apollonius of Citium's *On Joints*, with thirty whole-page miniatures, examining the illuminations that are framed by two columns and an arch. Lazaris points out the custom of framing images within manuscripts, showing that as a rule this occurs when the scribes wished to emphasise the importance of something, whether a person or an event. But this is not the case of a medical treatise, whose imagery is usually functional, not ornamental. To find out the nature of the lavish ornamentation of the treatise, Lazaris undertakes a fascinating analysis of three similarly illuminated manuscripts (the table framings of the Eusebian canon tables of the Etchmiadzin, Garima, and Yerevan Gospels), pointing out differences and similarities between the Nicetas Codex and these other codices. He then discusses the various explanations put forward by scholars in regard to the ornamentation of Apollonius' *On Joints*, dismissing the possibility that it is merely a matter of filling the empty spaces inevitably left by the exact copy of scroll illuminations into the codex format. Lazaris also argues against the authors who assert that the arches present in these illuminations indicate a misunderstanding of architectural principles, in turn showing that the details iterate preexisting models, such as the mosaics of Basilica of Sant'Apollinare in Classe, Ravenna. After clearing away several misinterpretations of the manuscript's illuminations and after discussing the impact of these images upon later medical treatises, the author turns to the crux of his argument—the nature and function of the codex' rich ornamentation. As with the frames of the Eusebian tables in Gospel manuscripts, whose purpose was to draw attention to their content and to facilitate use, the Nicetas Codex' frames constitute a mnemonic visual device. In short, their function is to draw attention to medical procedures and to ease memorisation, as well as to help the practitioners to locate—as "mental bookmarks"—the relevant information before applying a procedure. This shows an awareness, on the part of the Byzantine scribes and artists, of the importance of visual means for learning and remembering.

Vladimir Cvetković's article focuses on (primarily) Slavonic manuscripts from the end of the Byzantine era and on the geometry of cosmic symbolism in manuscript illuminations. The title of his contribution, "The Medieval Slavonic Reception of Maximus the Confessor's Circle-Center-Radii Analogy," is to an extent misleading. The article, truly, treats primarily the theological worldview of Maximus, whose seventh-century complex thinking marked the theological developments of later centuries in fundamental ways. That said, Maximus' ideas feature here in the company of two sixth-century monastic authors, Dionysius the Areopagite and Dorotheus of Gaza. What brings these authors together is the interest they showed in the geometrical analogy of the circle, by which they illustrated the relationship between God and the creation—especially the thinking creation or, as Cvetković clarifies at some point, the saintly representatives of intelligent races. The theological motif of an ideal, or saintly, creation orbiting the divine centre of reality draws on the second-century thinking of Clement of Alexandria—whose Platonic and Pythagorean background is known—and on the third-century thinking of Origen of Alexandria, of course. Given the ongoing disputes around Origen's legacy, the author avoids mentioning him. What matters for Cvetković is that, towards the end of the fourteenth century, many patristic manuscripts copied throughout the Balkans (especially in Serbia) of works by Dionysius, Dorotheus, and Maximus include geometrical visualisations. Relevant are a series of concentric circles whose centre represents God, with the radii standing for individual created beings and with the circumference denoting the ontological limitations of the creations that depend on God to exist and to flourish. The fact that the title of this article singles out the name of Maximus has to do with the fact that Cvetković undertakes to explain and interpret the meaning of these circles against the backdrop of known Maximian tropes. As such, the article brings to light both the cosmological cast of mind of the Byzantines, Maximus' foremost, and the geometrical skills of Serbian scribes who illuminated patristic manuscripts with figures that echo the great Greek mathematical tradition, ancient and medieval alike.

Richard de Grijs's contribution, "All Roads Lead to (New) Rome: Byzantine Astronomy and Geography in a Rapidly Changing World," undertakes to examine the significance of Byzantium as the point of intersection of many cultures for a whole millennium—which was largely coextensive with the Western spiral of decline of learning after the collapse of the Old Rome from the end of Late Antiquity and for the next five centuries, or so. Being relatively more stable for most of this span of history (but de Grijs shows that things did not go happily uneventful, not on an ongoing basis anyway), the Byzantine world, orbiting Constantinople, the New Rome, represented a point of convergence for many cultures—including geographically—from the past as well as contemporary to itself. This made possible important advances, whereby the centre of scientific and technological progress moved from Alexandria to Constantinople. Aptly, the author brings to the fore the assiduous work of many Byzantine scholars from the beginning to the end of that world, who engaged, more or les critically, both ancient science and the progress of contemporary Arab, Jewish, Persian, and then Western scholars. Especially in the last centuries of their era, the Byzantines themselves contributed to areas such as astronomy and geography (the author mentions the efforts of Gregory Chioniades, John Chortasmenos, Demetrios Chrysoloras, George Lapithes, Maximus Planoudes, etc.), beyond safeguarding ancient knowledge and borrowing from others. In so doing, the Byzantines impacted contemporary cultures as much as were influenced by them. That said, while their advancement was unquestionable in various areas, de Grijs points out, on a long run the shift of focus from natural philosophy to theology in early Byzantium stifled the development of theoretical sciences. Most affected were precisely the fields of astronomy and geography. No wonder Byzantine scholars perpetuated mistakes that originated with Ptolemy of Alexandria, whose authority went largely unquestioned throughout the Byzantine era, with exceptions. This situation transpires through the case

study central to this article, that is, the determination of geographical positions for Constantinople and other places around the Mediterranean basin, which remained imprecise, regardless of the efforts of cartographers towards improving the calculations. And while the input of the Byzantines to the development of science deserves recognition, a more important contribution, de Grijs concludes, is their facilitation of the "cross-cultural communication" that made possible the rise of the modern world.

My own article, "Astral Iconography and the Byzantine Study of the Heavens," concludes this collection by returning to Byzantine science, especially in the form of astronomy and astrology, through the lens of astral and zodiacal iconography. More specifically, here, I consider the connections between diverse aspects of Byzantine culture—a theology open to natural philosophy and encouraging of scientific research; a rigorous and assiduous scientific study of the starry skies, entailing the critical and creative engagement of ancient and medieval sources; the innovative use of mathematics for theoretical and practical purposes; the growing interest across most walks of life in all things cosmic, including astral divination; and the constant fascination with the heavens illustrated by the sacred arts and church architecture. What prompted this line of investigation is my realisation that while scholars are not unaware of the presence of Byzantine zodiacal iconography in sacred settings, usually they treat it outside the broader context of early Christian and medieval developments in astral imagery, that is, in separation from traditional theology and the development of astronomy and astrology. In short, scholars examine zodiacal iconography as symptomatic of an increasing interest in occult matters, with the zodiac being used for mantic practices, including horoscopes (despite the reservation of many early Christian and Byzantine believers who associated astrology with pagan practices). What scholars usually intimate is precisely that, namely, zodiacal iconography signifies the resurfacing of ancient worldviews and practices, amounting to a crack in the Christian narrative. The nexus between the various aspects of Byzantine culture outlined above denotes a different motivation behind the rise of this iconography. What I am proposing in this article—the growing popularity of astral divination notwithstanding—is that what facilitated both the rise of practical astrology and zodiacal iconography is the impetus of Byzantine science, foremost in terms of studying the starry sky. Furthermore, I show that this impetus was largely fuelled by a theology that traditionally accommodated enquiry and consistently engaged natural philosophy, the scientific culture of that age. And so, given this theological and scientific background, also the Byzantine fascination with the heavens, zodiacal iconography, albeit a more recent iteration of ancient and in fact prehistoric stances, is part and parcel of an historical process of Christianisation of cultural trends and ideas, not a matter of succumbing to such trends and ideas.

In the light of the above, especially the surprising outcomes of using new methodological and interdisciplinary lenses, it emerges that much more needs to be done to uncover the cultural, civilisational, and social ramifications of Byzantine contributions to science and technology. It is my hope that the research presented here, which furthers our understanding of the Byzantine world in several directions, will also inspire new avenues of study.

At the end of this editorial, it would be remiss of me not to express my utmost gratitude to Professor José María Salvador González, the editor of *DMAE*, for the kind invitation he extended to me several years ago, to curate this special issue of the journal, and for accommodating the topic I proposed. I am also grateful to the anonymous reviewers, whose input led to the improvement of the articles gathered here, and to the authors who joined this venture and thus contributed to the progress of the field. More colleagues began this journey during the pandemic, a few of us stayed the course—heroically, dare I say. I hope that our efforts will not go unnoticed. Above all, I hope that the field of Byzantine science and technology will elicit increasingly more interest, both from the historians of science and from the scholars of Byzantine studies.

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