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Nicolaus Copernicus' Mental Path Toward the Scientific Truth About the Integration of the Universe

ABSTRACT

This study is devoted to Nicolaus Copernicus (Mikołaj Kopernik, 1473–1543), who lived in the late Middle Ages and the early Renaissance. More precisely, our interest lies in his mental path toward the scientific truth about the structure and integration of the Universe. To this end, we will try to trace his academic biography together with the studies he pursued, the professional work he undertook, and the official roles he carried out under specific historical and socio-political conditions. Accordingly, we pose two questions: (1) How did Nicolaus Copernicus, as a canon of the Warmian Chapter, use his medical, legal, economic, and mathematical-astronomical competencies while living in Warmia? and (2) What were the successive stages in Copernicus's construction of a mental path to the structure of the heavens, in which the planets orbiting the Sun participate in an integrated and harmonized way? We will also try to identify the factors that played a part in building this path of his mental integration – the path that led to the adoption of the heliocentric system in European civilization, against the sensory illusions entrenched over centuries.

KEYWORDS: Renaissance mentality; genius of science; Ptolemy's error; paradigm of the natural sciences; social integration; stages of the mental integration of Copernicus's heliocentric system

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COPERNICUS'S STAY IN ROME AS A RENAISSANCE HUMANIST DURING THE JUBILEE YEAR OF 1500

In any discussion of Polish Renaissance philosophy, Nicolaus Copernicus deserves special distinction, for his philosophical views significantly shaped his brilliant astronomical observations and the trigonometric analyses of their results (Biela, 2019, pp. 79–83). For Copernicus as a Renaissance humanist, the earliest mentions of the Earth's motion were of great importance – first those he read in Cicero, and later in Pseudo-Plutarch. In his picture of the world, he wished to see the fulfillment of the Platonic principle of harmony. From the oldest biography of Copernicus, written in 1588 by the Italian humanist B. Baldi, we learn that in Bologna Copernicus was not an ordinary student but rather an assistant to Professor Novara, who held his mathematical and astronomical abilities in very high regard (Biliński, 1973; Borzyszkowski, 1973).

In turn, the *Narratio prima* – published in 1540 by Georg Joachim Rheticus (Jerzy Joachim Retyk), a pupil of Copernicus, and devoted to the heliocentric system of his master Nicolaus – indicates that during the Jubilee Year of 1500 he gave a lecture on mathematics and astronomy in Rome.[1] Among his listeners he names numerous students, Roman dignitaries, and specialists in the mathematical and astronomical sciences, as well as artists and architects such as Donato Bramante and Michelangelo Buonarroti. This lecture may have taken place either in the palace of Cardinal Farnese (the future Pope Paul III, 1534–1549), to whom Copernicus dedicated the dedicatory letter that served as the preface to the first edition of his astronomical work, *De revolutionibus orbium coelestium*, or at the Roman Sapienza. It is not impossible that the lecture was also attended by Pope Alexander VI himself. This very scene was depicted by the Polish painter Wojciech Gerson in his painting *Nicolaus Copernicus Lecturing on Astronomy in Rome* (see Figure 1).

[1] See the Polish translation with commentary in Retyk (2015).

Figure 1. Wojciech Gerson, *Nicolaus Copernicus Lecturing on Astronomy in Rome*

A remarkable surprise awaits the Polish reader in the biographical and psychological sketch of Michelangelo presented by Giovanni Papini, the Italian pioneer of pragmatist philosophy, who in chapter 35 of his monumental work attempts hypothetically to link, in space and time, two brilliant personalities: the discoverer of the heliocentric system, Nicolaus Copernicus, and the creator of the *Last Judgment* in the Sistine Chapel, Michelangelo. Copernicus did in fact arrive in Rome on 19 April 1500 (at Easter, during the Jubilee Year then under way) and remained there until the end of that year. Some time after his arrival, Copernicus began to give lectures on mathematics and astronomy for those who – though not students – wished to learn more about the subject. Tradition holds – as Giovanni Papini points out – that these lectures were also attended by Cardinal Alessandro Farnese, the future Pope Paul III, as well as by Michelangelo. Papini (1959, p. 77), citing Donato's *Dialogues*, stated that Michelangelo had an astonishingly broad knowledge of astronomy. Papini closes the chapter *Copernicus's Lessons* with the following reflection: "We like to imagine – even if there is no conclusive proof of it – a meeting in the Jubilee year between two young men of genius, destined for worldwide fame: the young Copernicus from Toruń, who was to give humanity a broader conception of the world, and the young sculptor and painter from Florence, who in the Sistine Chapel depicted the beginning and the end of humankind."

Copernicus's extended stay in Rome during the Jubilee Year of 1500 bore fruit in many ways. As a canon of the Warmian Chapter, he was one of the pilgrims who came to the Eternal City from all over the world to visit the capital of Christendom and to obtain the jubilee indulgence. During his stay in Rome at this time, he managed to establish excellent contacts with circles of people who could interest him and for whom he – a young assistant to the renowned Bolognese professor of astronomy, Novara – offered an opportunity to exchange views and to draw upon new ideas and theories in mathematics and astronomy. It was thanks to these circumstances that he could also present his own views and astronomical theories and put forward convincing arguments for their truth. This he did in full measure, winning the recognition of his interlocutors and listeners.

The only monument to Nicolaus Copernicus erected outside Poland – commemorating the Jubilee Year in Rome in which our great master of astronomy once took part – was carved to mark the 400th anniversary of the astronomer's birth. The sculpture depicting Nicolaus Copernicus, which stands in the courtyard of the General House of the Congregation of the Resurrection in Rome, was made by a Polish sculptor from Volhynia – a participant in the November Uprising of 1830 – who from 1848 until the end of his life, that is, until 1886, remained in Rome. The monument was made in 1873, using Carrara marble.

This monument, measuring 210 × 95 × 70 cm, is signed. Three inscriptions can be read on it: one on the front face of the base: NICOLAVS COPERNICVS POLONVS / NATVS AN.

Figure 2. Monument of Nicolaus Copernicus, by Mikołaj Sosnowski, standing in the courtyard of the Church of the Resurrectionist Fathers in Rome, via S. Sebastianello 11

MCCCCLXXIII TORVNI CASIMIRO IV JAGELLONIDE REGNANTE OBIIT AN. MDXLIII; a second on the book resting on the pillar: DE REVOLVTIONIBVS ORBITVM COELESTIVM 1543; and a third on the scroll hanging from the pillar: SOL STAT TERRA MOVETVR. This third inscription expresses the essence of Copernicus's system.

As we know from the later pages of Copernicus's life, his stay in Rome during the Jubilee Year of 1500 bore abundant fruit not only for himself but also for all of humanity, for whom he opened a broad perspective on the existing world as an integration and harmony established by the Creator.

HOW DID NICOLAUS COPERNICUS, AS A CANON OF THE WARMIAN CHAPTER, USE HIS MATHEMATICAL-ASTRONOMICAL, MEDICAL, LEGAL, AND ECONOMIC COMPETENCIES?

In 1503 Nicolaus Copernicus returned to his Warmian Chapter as a master of astronomy – or, more precisely, as its precursor – who, through observational methods and mathematical analyses, demonstrated the truth about the motions of the celestial bodies. Moreover, he returned as a qualified physician ready to serve the sick, and as a lawyer-economist[2] capable of managing the economic estates of the Warmian Chapter – working for the people employed on those estates and looking after the national wealth of Poland (among other things, by protecting the Polish currency in circulation). Let us see, then, how our Renaissance scholar was able to use his innate competencies and those acquired during his studies to meet the tasks and expectations of those he served.

In November 1510, Nicolaus Copernicus was appointed to the responsible office of chancellor, to which was attached the function of visitor of the Warmian Chapter's estates. His duties included the systematic visitation of all the bailiwicks belonging to the Chapter. While caring for the Chapter's economic interests, he also looked after, as a physician, the health of the workers and their families employed in these estate districts, taking no remuneration for his medical services. Living in Olsztyn at the time, Copernicus also saw to the effective military defense of the chapter castle, bringing in defensive howitzers from Elbląg to protect the town walls against the besieging invaders.

[2] The diploma Copernicus obtained from the University of Ferrara describes him as a doctor of decrees, that is, of canon law. In contemporary academic terms, given the range of activities he carried out for the Warmian Chapter and for the macroeconomy of the Polish Crown, his education could be described as economics and business administration.

We may also say of Copernicus that, while performing important administrative functions in Olsztyn, he was a keen observer of the social and economic life unfolding in the town. One of his initiatives recorded in history is the introduction of the so-called Olsztyn bread tariff (Kopernik, 2007, pp. 141–145). From his own observation of the inhabitants' lives, he noticed that one of the causes of their families' impoverishment was the rising cost of bread in the town bakeries. He therefore carried out his own analysis of the bakeries' production costs for the daily baking of bread, and on that basis set an official rate for the bakeries in the town of Olsztyn. As administrator of Olsztyn, he gathered all the town's bakers and announced to them his new official ordinance on bread prices (Wasiutyński, 2007, pp. 263–265). Foreseeing that his proposal would not please the bakers, he solemnly promised them that they would soon be very satisfied with the change, since far more inhabitants of Olsztyn would then want to buy their bread (cf. Biskup, 1971.

In 1517, Copernicus wrote his first treatise on monetary reform, entitled *Rozmyślania* (*Meditations*), which dealt with the deliberate debasement of the circulating coin in Prussia by the Teutonic Order. This was a concrete, historically documented example of the economic and political integration of the lands of Royal Prussia with the Polish Crown. It was then that Copernicus formulated – as the first in the history of economic science – his famous economic principle that coin of lower metal content (gold or silver) drives good coin out of circulation (Wasiutyński, 2007, pp. 299–305). Living in the Warmian land as administrator of the estates of the Chapter of which he was a canon, Copernicus showed much kindness and compassion toward the families of the tenant farmers who worked on those estates. During his routine visitations he also paid attention to the health of his peasants' family members and treated them when they were in need – again charging nothing for these services.

In *Nicolaus Copernicus: Complete Works* (2007, vol. 3, pp. 153–174), one can find a scholarly study of the *Prescriptions* once written out by Copernicus the physician for his patients. The author of this study is Małgorzata Golińska-Gierych (2007, pp. 156–159). Her analysis shows, among other things, that the prescriptions written by Copernicus are marked by exceptional care and neatness, by attention to the aesthetic arrangement of the page, and to the keeping of even margins. His handwriting on the prescriptions bears a striking resemblance to the notes at the bottom of certain pages of the autograph manuscript of *De revolutionibus orbium coelestium*.

Despite the war begun by the Teutonic Order, Copernicus decided to return quickly to Olsztyn, where, as he noted, on 19 February 1520 he was already observing the motions of the planet Jupiter. Copernicus spent that entire year in Olsztyn, where he continued his observation of the planets. Both his observation points and the equipment he needed had been in place in the castle building since his previous stay in the town. On the northern wall facing the courtyard, on the first floor of the cloister of Olsztyn Castle, there survive diagrams for astronomical research made by Copernicus himself. In November of that year he again became administrator of the chapter estates (Górny, 2010, pp. 50–51).

The Teutonic forces approached the walls of Olsztyn as early as 15 January 1521. Their commander, Wilhelm von Schaumburg, having captured Dobre Miasto, set out toward Olsztyn. A lack of ladders, however, led the knights of the Teutonic Order to abandon any further assault on the castle and to pitch their camp beside it. After a few days of observation, Copernicus summoned the military commander of the town's defense and briefly acquainted him with Gideon's strategy in the fight against the Midianites, described in the Book of Judges.[3] It was based on surprise, psychological pressure on the enemy, and a radical

[3] See the Book of Judges (chapters 6–8).

reduction of one's own forces – meant to underscore divine intervention. Instead of a classic military confrontation, Gideon employed the tactics of psychological warfare and nighttime diversion. It was precisely this strategy that the military commander of Olsztyn's defense applied, at Copernicus's urging. Around midnight, when the Teutonic camp had sunk into sleep, the young commander and his soldiers opened the town gate and moved silently up to the Teutonic camp; they deployed according to a designed plan encompassing the whole camp and, at their commander's agreed signal, simultaneously gave out sound signals and prearranged words of command toward the Teutonic knights, who – taken completely by surprise – soon became their prisoners of war. After laying down their arms, they were allowed to dress and to depart freely from beneath the walls of Olsztyn. The Grand Master of the Teutonic Order did not venture another attack on the towns under the administration and jurisdiction of the Bishop of Warmia. Despite the many duties attached to the offices entrusted to him, Nicolaus Copernicus worked continuously – though with interruptions – on his astronomical work (Biskup, 1971; Grzybowski, 1973).

Copernicus rigorously divided his occupations and all his work into two parts: (1) daytime and (2) nighttime. To his daytime work he assigned all labor and service for people, institutions, and organizations – ecclesiastical, economic, social, and political. These included his service as a physician, canon, administrator, diplomat, scholar, philosopher, archivist, military strategist, lawyer, economist, and mediator. His evening and night work, in turn, he devoted to astronomical observations, mathematical analyses, the synthesis of his assumptions and observations, and religious and philosophical meditation. In all these labors and activities his genius revealed itself – human genius, religious genius, scientific genius, and the genius of seeking truth and loving one's neighbor. Copernicus called his daytime work "work for people," and his nighttime work "work for God and the heavens."

COPERNICUS'S MENTAL INTEGRATION TOWARD THE DISCOVERY OF THE HELIOCENTRIC SYSTEM

In this part of the article we will try to identify the mental stages of Copernicus's work leading to the discovery of the heliocentric system. By "Copernicus' mental integration," we shall mean the mental stages of his intellectual journey toward the discovery of the heliocentric system. More specifically, this concept will denote the dynamic integration of the motion of planets orbiting the sun. This integration takes place according to the pattern established by God, the Creator of the Universe. Copernicus expressed this truth as early as in Book 1 of his monumental astronomical work, *De revolutionibus orbium coelestium*.

The starting point of our analysis will be the observations of Ludwik Antoni Birkenmajer (2004)[4] concerning the genesis and course of this momentous act of Copernican creativity, which placed him among the most profound thinkers in human history. This author clearly distinguished two stages of intellectual work, covering the Kraków period (1491–1495) and the Bologna period (1496–spring 1500).

THE KRAKÓW PERIOD (1491–1495)

According to Birkenmajer (2004, pp. xxv–xxvi), in the Kraków period the leading role was played by rational and logical arguments, whose consequence was first deep astonishment, then disbelief, followed by a gradual loss of confidence in the truth of Ptolemy's system, until at last it grew into complete incredulity and a denial of its truth. Copernicus experienced these intellectual

[4] See chapter 3 of L. A. Birkenmajer's preface, "The History of the Discovery of the True Structure of the World – the Concealment of the Discovery," in Mikołaj Kopernik (2004)

dilemmas on his own, as a student of the Kraków *Alma Mater*, and could not resolve them. Yet he bore no grudge against the professors who taught the current state of mathematical or astronomical knowledge. On the contrary, he held many of them in high esteem. For example, he was greatly fascinated by the mathematics lectures of Professor Wojciech of Brudzewo, whose mathematical fame was then widespread throughout Europe. Copernicus counted heavily on being able, thanks to geometric – and more precisely trigonometric – knowledge, to carry out exact astronomical observations in the future. Fairly soon, however, he realized that, given the current state of trigonometry, he would not be able to do so. From then on, he harbored the intention of developing trigonometry himself in the future, so that it could be used in astronomical observations. As for the state of astronomical knowledge, when he left Kraków in the summer of 1495, Copernicus was convinced that "[…] the astronomy taught in the schools is only a caricature of the truth."

THE BOLOGNA PERIOD (1496–1500)

In the Bologna period, Copernicus, together with his collaborators (Professor Domenico Maria Novara and Marco Beneventano of the Bolognese Celestine order), sought to establish whether the facts perceived by the senses in the sky would also confirm these contradictions. An example of such observations was their observation of the occultation of the star α Tauri by the Moon on 9 March 1497. It was then that Copernicus's period of criticism and rejection of Ptolemy's system came to an end, and the mental process of seeking the foundations of the heliocentric system began.

What did Ptolemy's error consist of? The geocentric system assumed that in nature there exist only uniform motions, occurring exclusively along a circle. At the same time, fictitious circles called equants were introduced into the mechanism of the world, along whose circumference motion took place that was supposedly uniform but in reality was non-uniform. This contradiction between premises and conclusions was detected by Copernicus himself. He was aware that, with such novel views, he in fact stood alone against everyone.

THE PERIOD OF SEEKING THE FOUNDATIONS OF THE HELIOCENTRIC SYSTEM IN ANCIENT AUTHORS (1501–1504)

The third period of Copernicus's mental work on the heliocentric system may be described as the search for the foundations of that system in ancient authors. Birkenmajer (2004, pp. xxviii–xxxii) points out that Copernicus drew mainly on Greek authors of the Pythagorean circle, such as Hicetas, Ecphantus, and also Plutarch, who held that the Earth moves. Copernicus also found mentions of the Earth's motions in authors such as Pliny, Martianus Capella, Vitruvius, and especially Pseudo-Plutarch. Reading these authors had a creative influence on Copernicus's intellectual work on his sketch of the heliocentric structure of the world, which he called the *divina Optimi Maximi fabrica*. By May 1504 this sketch was sufficiently complete that the theoretical apparatus it contained allowed Copernicus to calculate the positions of the planets for the first time according to heliocentric conceptions.

THE FOURTH PERIOD OF THE DEVELOPMENT OF HELIOCENTRISM IN COPERNICUS (1505–1535)

The fourth period of the development of Copernicus's heliocentric system covers the years 1505–1535, resulting in his writing of the *Outline of the New Mechanism of the World*, known briefly as the *Commentariolus*. It is a concise outline of the heliocentric mechanism of the world, altered in many details by the author himself.

Birkenmajer (2004, p. xxxiii) called this event Copernicus's release of a scout-dove, like Noah from his ark. At this time Copernicus was working very intensively on his books, *De revolutionibus orbium coelestium*. Yet this giant of the spirit was held back by the fear of revealing publicly and openly the work of his life – a work that was changing the mental horizons of his contemporaries. He did, however, have the great support of friends such as Wawrzyniec Korwin, Bishop Tiedemann Giese (a fellow canon of the Warmian Chapter), and Bishop Jan Dantyszek, who urged him strongly to publish his mature scholarly work as soon as possible.

According to Birkenmajer (2004, p. xxxv), despite Copernicus's rather careful concealment of his astronomical doctrine, its quality of novelty and authenticity broke through the walls of his fear of wider dissemination. By 1514 at the latest, Copernicus's teaching was already known in Kraków, Wrocław, Wittenberg, and Basel. By 1533 the news had even reached Rome, where in the summer the well-known orientalist Johann Albrecht Widmanstetter[5] explained the essence of Copernicus's teaching to Pope Clement VII and to Cardinals Orsini and Salviati during a walk together through the Vatican gardens.

According to Jan Jerzy Górny (2010), Copernicus's so-called Lidzbark years saw the first elaboration of the new theory of the world, already conceived intellectually in Bologna. It was called the *Little Commentary on the Hypotheses of the Motions of the Celestial Bodies*.[6]

In it Copernicus laid down, for the first time, his outline of the heliocentric system. It was not, however, intended for print,

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[5] For which the Pope gave him, in thanks, a precious Greek manuscript. This fact clearly indicates what great scientific authority Nicolaus Copernicus enjoyed among the ecclesiastical elites even during his lifetime.

[6] The original Latin title of this work is: *Nicolai Copernici de hypothesibus motuum caelestium a se constitutis commentariolus*. In our article we relied on its Polish translation by Jerzy Drewnowski in *Mikołaj Kopernik, Zarys podstaw astronomii*, in Mikołaj Kopernik (2007, pp. 19–29).

but circulated in numerous copies that the author sent to his acquaintances. Copernicus did not include detailed mathematical arguments in it. Its content was captured in the following postulates (Kopernik, 2007, p. 20):

1. There is no single center of all the celestial spheres.
2. The center of the Earth is not the center of the world, but only the center of gravity and of the lunar sphere.
3. All the spheres revolve about the Sun as their midpoint, and therefore the center of the world lies near the Sun.
4. The ratio of the Sun's distance from the Earth to the height of the firmament is so much smaller than the ratio of the Earth's radius to its distance from the Sun that this distance is imperceptible in comparison with the size of the firmament.
5. Whatever motion appears in the firmament is caused not by any motion of the firmament itself, but by the motion of the Earth. The Earth, then, together with the elements surrounding it, performs a complete daily rotation about its fixed poles, while the firmament and the highest heaven remain motionless.
6. Whatever we perceive as motion of the Sun is not its own motion, but a result of the motion of the Earth and of our sphere, with which we revolve around the Sun like any other planet; the Earth thus performs several motions.
7. What appears in the planets as retrograde or forward motion arises not from them but from the Earth. Its motion alone, therefore, suffices to explain so many of the irregularities observed in the sky.

As can be seen, Copernicus very much counted on receiving critical comments on his astronomical visions concerning the revolutions of the celestial bodies. What mattered to him was that these visions were grounded in astronomical observations, which he carried out not only alone but also jointly with other scientific authorities.

According to Górny (2010), around 1523 Copernicus set about thoroughly reworking the version of his principal astronomical work that he had written between 1516 and 1519 in Olsztyn. Even after completing the whole work – that is, after 1532 – Copernicus still kept making certain changes as his own conception of the world, so different from the one commonly accepted at the time, took firmer root in his mind. Even so, the fame of his observations and their discoveries spread through all the scholarly circles of Europe. An example is the reform of the Gregorian calendar planned by the Roman Curia at the beginning of the sixteenth century. Responsible for this reform was the Bishop of Fossombrone, Paul of Middelburg, who in 1513 turned to Copernicus for help in drawing up the plan of the reform. Copernicus sent his proposal for the calendar reform to Fossombrone, which was clearly noted in Bishop Paul's treatise. The calendar reform itself was carried out only in 1582, that is, after Copernicus's own death.

THE FIFTH PERIOD OF THE DEVELOPMENT OF COPERNICUS'S HELIOCENTRIC SYSTEM (1536–1542)

Of great psychological importance to Copernicus was a letter from Rome, received by him in 1536, from the Italian astronomer Cardinal Nikolaus von Schönberg, a Dominican and Archbishop of Capua. In this letter its sender, extolling the greatness of our astronomer's doctrine and his new ideas about the structure of the Universe, begged him to provide more detailed information on the subject. This was the historic letter of Cardinal Nikolaus von Schönberg to Nicolaus Copernicus, sent from Rome and dated 1 November 1536, on All Saints' Day. In the history of astronomy this document may be regarded as one of the key events that directly influenced the decision of the Master of Frombork to publish his groundbreaking astronomical work, *De revolutionibus orbium coelestium*. The content of this letter is clear and unambiguous, and its significance enormous: (a) a cardinal of the Catholic Church expresses enormous appreciation for Copernicus's knowledge and achievements in mathematics and astronomy, together with assurances of his support; (b) the cardinal from Rome makes an ardent request, urging the Frombork astronomer to prepare and make his heliocentric theory available to the scholarly world as soon as possible.[7]

The second turning point in Copernicus's mental attitude toward his scholarly achievement should be taken to be the arrival in Frombork, in the autumn of 1539, of the young professor of astronomy at the University of Wittenberg, Georg Joachim Rheticus, who – having heard of new and remarkable principles in astronomy that were to heal its ailing body – resolved to seek instruction from the master himself in Frombork about the essence of his sensational ideas.

Among scholars who study Copernicus there is a conviction that the turning point in finalizing work on the manuscript of his synthetic work was precisely Rheticus's arrival in Frombork. His youthful enthusiasm and zeal became for Copernicus a new impulse to prepare the manuscript of his fundamental astronomical work for print. Also helpful in this work were the newly published astronomical books that Rheticus brought with him, including the *Almagest* (published in Greek in Basel in 1538), to which Copernicus, in Frombork, could have had no access. As a result of the final revisions, Copernicus himself arranged his principal work into six books.

Rheticus, received most warmly by Copernicus, was able through his personality and his passion for astronomy to win

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[7] In this letter its author asks that materials on the motion of the celestial bodies be sent to him, in order to disseminate them in ecclesiastical and academic circles. Unfortunately, shortly after the letter reached Frombork, its author died, and Copernicus could no longer use this avenue for spreading his vision of the world.

the master's liking and trust. He extended his stay in Warmia and, together with the Bishop of Chełmno, Giese, persuaded the still-reluctant Copernicus to publish his by-then-completed astronomical work, *De revolutionibus orbium coelestium*. It was agreed, however, that in order to prepare minds – especially those of conservative scholars – to accept so innovative a doctrine, the publication of Copernicus's main work would be preceded by the printing of a short summary of it. The composition of its content, as well as responsibility for printing and distributing it, was entrusted to Rheticus, who promptly fulfilled his mission. Having drawn up this summary (*De libris Revolutionum D. Doctoris Nicolai Copernici, Narratio prima*) in the autumn of 1539 and had it printed at Franz Rhode's press in Gdańsk, Rheticus was able, in the first months of the following year, to send numerous copies to contemporary scholars, together with elements of the biography of his master Copernicus.

Rheticus treated his master of astronomy and mathematics – and canon of Warmia – with great respect. He proved a most helpful assistant to Copernicus, thanks to whom the master regained the driving force to dot the "i's" and cross the "t's" in his astronomical-mathematical and methodological syntheses. After studying the final version of the manuscript of *De revolutionibus orbium coelestium*, Rheticus prepared an extensive summary of it, called the *Narratio prima*, and printed it in Gdańsk in the form of a letter to Johann Schöner, the well-known Nuremberg astronomer (Retyk, 2015). It was the first printed scholarly work announcing the emergence of the heliocentric structure of the astral world. It aroused great interest, but also much opposition and indignation.

When Rheticus left Frombork in 1541, he carried with him to Nuremberg the precious manuscript entitled *De revolutionibus orbium coelestium, libri sex*, which – together with the famous dedication to Pope Paul III later added by Copernicus (in June

1542) – was promptly handed over to the printing house in Nuremberg (Retyk, 2015).

It turned out that Copernicus's theory met the greatest opposition in Lutheran circles. Yet although the leading figures of the German Reformation – Martin Luther and Philipp Melanchthon, in June 1539 – treated Copernicus's heliocentric theory with disdain (Górny, 2010; Włodarczyk, 2015), both in Ducal Prussia itself and in many centers of the Reformation in the West, Copernicus and his works were regarded so favorably that it was in Nuremberg that a Lutheran first published the text of his principal work. Duke Albrecht Hohenzollern (the first secular Lutheran ruler in history), in turn, personally wrote a letter of recommendation regarding the publication of the work, with Copernicus's assistant Rheticus acting as intermediary.

Górny (2010) points out that in the summer of 1540 Copernicus yielded to the urging of his best friend from the Warmian Chapter, then Bishop of Chełmno, Tiedemann Giese, and finally agreed to send his entire astronomical work to print in Nuremberg. He maintains that it must be assumed that Rheticus, during his second stay in Frombork (from spring 1540 to autumn 1541), made a copy of the whole work and in the autumn took it to Germany to hand it over for printing at the press owned by Johannes Petreius in Nuremberg. It is worth emphasizing that, besides the Author's Preface and the six successive books, the original of this work also contained Copernicus's dedicatory letter to Pope Paul III (Kopernik, 2004, pp. 23–30).

To His Holiness, Pope Paul III

NICOLAUS COPERNICUS'S
PREFACE

to the books on the revolutions of the heavenly spheres

In this letter Copernicus clearly set out the methodological and philosophical foundations, and his deep conviction that the proposed new system of the world – and the thesis that the Earth is endowed with motion around the Sun, which is the center of the motion of all the planets – gives a true picture of the essence of the planetary system. It should be emphasized that Copernicus wrote his dedicatory letter to Pope Paul III in June 1542, that is, less than a year before his death.

The Protestant theologian Andreas Osiander was authorized by Rheticus, Copernicus's assistant, to oversee the printing of the text, part of which was the preface written by Copernicus himself. In the event, the printing of the first edition of Copernicus's principal astronomical work took a more dramatic turn than might have been expected. Copernicus's dedicatory letter, intended by him as a methodological introduction to the entire astronomical monograph, was meant to dispose the reader to seek the truth about the structure of the planetary motion of the world. This truth had its empirical confirmation in the astronomical observations carried out and in the mathematical analyses of their results. The second path of seeking the truth about existing reality is, for Copernicus, the truths revealed in the Bible. These two paths are not contradictory but constitute complementary ways of knowing the world and humanity created by God.

Copernicus's dedicatory letter (addressed to Pope Paul III), in the form of a preface to his astronomical work, was indeed printed in Nuremberg, but Andreas Osiander removed – without Copernicus's knowledge or consent – the original introduction to Book I and put in its place his own, unsigned preface to the monograph. In this introduction he stated that Copernicus's work was a set of hypotheses, not necessarily true and rather improbable. Copernicus very precisely distinguished the concept of a hypothesis from that of a proposition as the basis for building an astronomical theory. He wrote about this explicitly in the introduction to his astronomical monograph. It was difficult, however, for the old and already ailing Copernicus, from distant Frombork, to have any influence over the publisher's abuses in Nuremberg during the printing of his monograph (Sierotowicz, 2001, pp. 39–42).

Figure 3. Aleksander Lesser, *The Last Moments of Nicolaus Copernicus*

Figure 3 shows the dramatic, historic moment in May 1543 when the dying astronomer receives, from the hands of his collaborators and pupils, the first printed copy of his epochal work, *De revolutionibus orbium coelestium*. From 1540 – as Górny (2010, pp. 68–69) points out – Copernicus's strength was failing, and by the end of 1542 he was already stricken with illness and unable to rise from his bed unaided. He was cared for by two Warmian canons: Jerzy Donner and Fabian Emmerich (both present in the painting). Copernicus also lost his memory and clarity of mind. Hence, although during his long illness the first printed copies of

De revolutionibus orbium coelestium reached Frombork, their author was no longer able even to read any part of them, or to open any of them by himself.

Legend has it that Copernicus, with his cooling fingers, still managed to touch the fruit of his many years' labor, and so gave thanks to God the Creator for the gifts through which he had discovered, for his brethren, the truth about the heliocentric system. This scene is portrayed by Aleksander Lesser in his painting *The Death of Nicolaus Copernicus*, painted around 1873. Nicolaus Copernicus died of a cerebral hemorrhage and paralysis of his right side in Frombork on 24 May 1543. The body of the great astronomer, canon of the Warmian Chapter, was buried, in accordance with custom, in the cathedral of Frombork near the altar of the Holy Cross, which he himself had tended during his life as a canon.

As Górny (2010, p. 70) puts it: "Today we know with full certainty that it was the altar of the Holy Cross, and there a part of his mortal remains was found. After his death it was long not realized how great a discovery this modest and unassuming Warmian canon had made."[8] The renewed, solemn burial of Nicolaus Copernicus's remains in Frombork Cathedral took place on 22 May 2010. The astronomer's remains were laid to rest again in Frombork Archcathedral, near the altar of the Holy Cross, where he had originally been buried in 1543. This was made possible by the discovery of the grave and the definitive identification of Copernicus's remains by Polish scholars, together with DNA testing.

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[8] The author of this statement – Rev. Dr. Jan Jerzy Górny, a mitred prelate (infułat) – is currently the successor of Nicolaus Copernicus as a canon of the Warmian Chapter. It was on his initiative and with his private funds that an international team's work on locating the grave and identifying Copernicus's remains was undertaken. It lasted from August 2004 to December 2009 and ended in complete success. On this basis the astronomer's reburial took place in Frombork Cathedral.

The text placed on his gravestone reads:

Here lies
Nicolaus Copernicus
b. 19 Feb 1473 in Toruń
d. 24 May 1543 in Frombork
astronomer
creator of the heliocentric theory
canon of Warmia
"Christ is the Author of our salvation" (N. Copernicus)

CONCLUSION

De revolutionibus orbium coelestium is the most famous work of Nicolaus Copernicus. Its first edition appeared in 1543 in Nuremberg (Copernicus, 1543). The printing was to be supervised by the Lutheran theologian Andreas Osiander, who, unfortunately without the author's knowledge, inserted his own anonymous preface presenting Copernicus's theory as a hypothesis. This falsification provoked the indignation of the astronomer's friend, the Bishop of Chełmno Tiedemann Giese, and of Georg Rheticus, but their attempts to restore the original wording of Copernicus's work ended in failure. Despite the strong opposition of some Protestant theologians, the Frombork astronomer's treatise continued to arouse enormous interest, as evidenced by the printing of further editions in Basel (Copernicus, 1566) and Amsterdam (Copernicus, 1617). It was only the placing of the work on the Index of Forbidden Books in 1616 that halted the reception of Copernicus's thought in Catholic circles for over two centuries. In the Protestant intellectual world, meanwhile, the truth of the heliocentric theory continued to be disputed until the triumph of Isaac Newton's law of universal gravitation.

The first Polish translation, *On the Revolutions of the Heavenly Spheres*, did not appear until 1854 in Warsaw, and it already contained the text of Copernicus's authentic preface, found in the autograph manuscript of *De revolutionibus orbium coelestium* that had just then been discovered in Prague. This priceless manuscript was handed over to the Polish nation by the government of then-Czechoslovakia in 1956. The manuscript is now kept in the Jagiellonian Library in Kraków.

In Poland, Copernicus studied mathematics at the Jagiellonian University Library in Kraków (1491–1495), where the professor was the Europe-wide celebrated Wojciech of Brudzewo, who took a critical view of the eccentrics and epicycles in Ptolemy's theory of planetary motion. Copernicus was especially fascinated by Euclid's geometry, yet he noticed that it was insufficient for him to apply in his astronomical observations. His studies must have been good, since they soon bore fruit in Copernicus's formulation of new trigonometric formulas: the *secant* and the *cosecant*. These were the first two formulas deduced axiomatically since the time of Euclid, and it was Copernicus who accomplished this. His assistant and friend Georg Rheticus published his master Copernicus's trigonometric treatise, *De lateribus et angulis triangulorum*, in Wittenberg in 1542 – that is, still during Copernicus's lifetime (Copernicus, 1542). In this way Copernicus prepared the methodological and mathematical ground for a new discipline – astronomy – which he himself created and set out in *De revolutionibus orbium coelestium*. He presented its essence already in Book I of his momentous monograph (Kopernik, 2004). From that time astronomy acquired the status of an academic discipline, and Nicolaus Copernicus is its unquestioned – founding father.

Many anniversaries have already passed commemorating the person of Nicolaus Copernicus and his works for science and civilization on a universal, human scale. In the mid-1950s, the American professor of physics, historian, and philosopher of science from Harvard, Thomas Kuhn (1922–1996), published a book devoted to the significance of Nicolaus Copernicus in astronomy, under the telling title *The Copernican Revolution*. In it he creatively introduced the concept of the *scientific paradigm* and argued that the work accomplished by Nicolaus Copernicus in astronomy meets all the defining features of the *first scientific paradigm in the history of the natural sciences*! Besides the empirical verification of observed phenomena, Kuhn (1957) counted among the defining features of a paradigm a psychosocial one: Copernicus's confronting of centuries-old optical illusions concerning the phenomena of the external world; it was also necessary to have the courage to articulate, in the name of the truth about the universe, credible arguments showing that it is "the Earth that turns around the Sun, and not the Sun around the Earth."

In concluding our closing reflections on the development of Nicolaus Copernicus's mental integration concerning his vision of the solar system, we should recall the remarks made on this subject by Michał Heller – cosmologist, philosopher, and theologian – in the *Introduction* to his book entitled *The Theory of Relativity of Nicolaus Copernicus*, published in Kraków by Copernicus Center Press (Heller, 2023).[9] This author seeks to view Copernicus's achievement as an element in the sequence of Great Discoveries, within which it holds a place of honor. He begins his survey of the great discoveries in the third century BC, when Eratosthenes of Cyrene proved that the Earth is not flat and, in doing so, calculated the size of our planet.

Over the course of the development of science, in Heller's view, the idea of relativity was simply the guiding idea – something we can perceive only from today's perspective, when we are equipped with the appropriate knowledge and analytical tools. Copernicus did not, to be sure, create the theory of relativity himself, but he performed a mental transformation of the reference

[9] Prof. Michał Heller is a co-founder of the Copernicus Center for Interdisciplinary Studies at the Jagiellonian University in Kraków.

frame tied to the Earth into a reference frame tied to the Sun. It must be stressed, however, that this mental transformation gained its empirical foundation through the astronomical observations that Copernicus personally carried out and mathematically analyzed their results.

For the physicists and astronomers who followed Copernicus – such as Tycho Brahe, Johannes Kepler, Isaac Newton, and Albert Einstein – it was already easier to develop science by following his mental footsteps toward the discovery of the entire solar system. Copernicus's achievements were an indispensable logical link in the chain of scientific accomplishments in astronomy and physics – right up to and including the twentieth century. Hence Heller ultimately justifies the title of his book on Copernicus thus: "[…] and since the unifying idea was the idea of relativity, I have the right to call this sequence the *theory of relativity of Nicolaus Copernicus*." For people engaged in science around the world, Copernicus became an unquestioned authority who sought – both in the Universe and among the people with whom and for whom he worked (as physician, business adviser, mediator, and scholar of the highest class) – integration, harmony, and order in social, political, and religious relations. He did not lead the life of a recluse, but involved himself in meeting the needs of the people around him.

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