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INTRODUCTION

Today, there exists an unsolved controversy as to the origin, development and significance of the heliocentric idea and its role in shaping modern scientific thought, in the evolution of contemporary natural sciences, and in its applicability to astronomical inquiries into the structure of the universe. Historians of science, as well as scientists themselves hesitate in defining the real source of the Copernican revolution. As far as the achievements of Copernicus are concerned, scholars throughout history voice conflicting opinions, at times taking radical positions [1].

Without going into particular description of the origin and historical analysis of the significance of Copernican revolution in modern science, the author would like to concentrate on the question, how could Copernicus, in resolving the obvious existing discrepancies in astronomy of his time, avoid the accusation of a double truth doctrine in his heliocentric system?

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[1] The first followers of Copernicanism came from professional mathematicians, astronomers and philosophers, and among the strongest opponents were humanists and theologians. For a general historical development and reception of heliocentricism in modern science, see Barbara Bieńkowska: *Kopernik i heliocentryzm w polskiej kulturze umysłowej do końca XVIII wieku*, Wrocław, 1971; Stanisław Cynarski: *Reception of the Copernican theory in Poland in the seventeenth and eighteenth centuries*, Warszawa—Kraków, 1973; Dorothy Stimson: *The gradual acceptance of the Copernican theory of the universe*, New York, 1917; René Taton: *Histoire générale des sciences*, Paris, 1958, vol. i, pp. 67—75.

I. EPISTEMOLOGICAL FOUNDATIONS OF COPERNICAN HELIOCENTRICISM

In ancient and medieval times there were two interpretations of the physical world, namely, the „quantitative" interpretation based on Platonic tradition of natural philosophy (e.g. Robert Grosseteste and Roger Bacon), and the „qualitative" interpretation which is strongly connected with the Peripatetic orientation of natural philosophy (St. Albert and St. Thomas). The „quantitative" interpretation explains reality in terms of mathematical principles, but the „qualitative" interpretation bases its explanation of natural events on the Aristotelian notion of nature [2].

Copernicus knew both of these current interpretations in natural sciences and in his heliocentric system of the world has used both methods of explanation of natural phenomena. Although rejecting the Aristotelian geocentric system of the world and his philosophy of nature, Copernicus duly appreciated the Peripatetic empiricism and used the Aristotelian principles and method of argumentation in natural sciences [3]. This preserved him from the danger of Pythagorean speculations and allowed him to purify the heliocentric concept of the world from that of neoplatonic ideas of the „Somnium Scipionis", and that of Marsilio Ficino [4], the emanation theory

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[2] Cf. St. Thomas, S.th., I, 7, 3c. Consult also Aleksander Birkenmajer: *Witelo, najdawniejszy uczony śląski*, Katowice, 1936, p. 19.

[3] About the studies of Aristotelian philosophy of nature and the logical treatises by Copernicus, see Ludwik Antoni Birkenmajer: *Stromata Copernicana*, Kraków, 1924, chap. 2. Cf. also Aleksander Birkenmajer: *Kopernik jako filozof*, „Studia i materiały z dziejów nauki polskiej", seria C, Warszawa, 1963, pp. 31—61.

[4] For the contrary view, see Ludwik A. Birkenmajer: *Filozoficzne podłoże odkrycia Kopernika*, „Archiwum Komisji do Badań nad Historią Filozofii", vol. 1. 1917, pp. 265—266; Jocob Bronowski: *Copernicus as a humanist*, „The nature of scientific discovery", Washington, 1975, p. 177f. A more moderate evaluation of the influence of Ficino on Copernicus was expressed by some of the participants of the Copernican Session at the Catholic University of Lublin, among others by Leszek Kuc and Bogdan Suchodolski, cf. *Mikołaj Kopernik*, Lublin, 1973; cf. also Marian Rechowicz: *Mikołaj Kopernik a platonizm teologiczny Marsilia Ficina*, in: „Z zagadnień kultury chrześcijańskiej", Lublin, 1973. It is the contention of the author that although the influence of Ficino is to some extent evident in Copernicus' „De Revolutionibus", it is nevertheless eclectic in character as included in the dedication-letter to pope Paul III, a great humanist, who was most probably, under the influence of neoplatonism in Italian Renaissance.

of Averroes, and the pantheistic interpretation of Stoics [5]. At the bases of Copernicus' theory of scietific knowledge lies the realistic theory and view of reality [6]. In the opening paragraph of the „Revolutions" Copernicus praises astronomy as a science which „deals with the godlike circular movements of the world and the course of the stars, their magnitudes, distances, risings and settings, and the causes of the other appearances in the heavens; and finally explicate the whole form" [7].

1. THE HISTORICAL BACKGROUND OF COPERNICAN DEBATE

In Copernicus' mind there was no doubt that not only „the world is spherical" but „the earth is spherical too" [8]. In this respect Copernicus was in agreement with Ptolomy and medieval astronomers. Copernicus agrees also with Plato and Aristotle that the movements of celestial bodies are both regular and circular. In argumentation for the sphericity of the world and the circular motion of the celestial bodies Copernicus almost verbatim repeated Aristotelian reasoning. The departure from the Aristotelian physics lies in the new evaluation of the concept of the motion of the earth, both around its own axis and its yearly movements around the sun.

Now, in the time of Copernicus, the theory of Earth's move-

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[5] In Bogusław Leśnodorski, *Założenia poznawcze Kopernika*, „Odrodzenie w Polsce", Warszawa, 1956, vol. II, part 2, p. 82, after quoting sentence of Cicero from *De natura deorum*, II, 14, 29: „Est autem nihil mundo perfectius, nihil virtute melius", the author tries to apply the Stoic understanding of Copernican view on the perfection of the world and God. For a reply to B. Leśnodorski's interpretation of Stoic influence on Copernicus see A. Birkenmajer: loc. cit, p. 56.

[6] Cf. Józef Witkowski: *The reform of Copernicus*, „Sesja Kopernikowska, 15—16 IX, 1953", Warszawa, 1955, p. 80.

[7] „Nicolai Copernici Thorunensis *De revolutionibus orbium caelestium* libri VI", Thoruni, 1873, p. 9.

[8] On the meaning of spheres in Copernican *De Revolutionibus*, Edward Rosen summerizes in the following way: „As we have seen, Copernicus accepted the doctrine of the spheres, ignoring the question whether they were imaginary or real. In referring to them he used the terms sphaera, orbis, and even circulus, for at times he regarded them as three-dimensional bodies, but more frequently as two-dimensional circles. When he dealt with planetary theory, he used orbis to mean the 'great circle' in the case of the earth, and the deferent in the cases of the other planets. Seldom or never did he employ orbis in the sense of 'planet'; his words for 'planet' were chiefly sidus, sidus errans, planeta, stella errans, and corpus"; *Three Copernican treatises*, New York, 1971, p. 21.

ment was not a novelty, and as such was tolerated as useful hypothesis, especially for mathematical computation and astronomical tabulation. Once, however, accepting the postulate of the earth's movement, both around its own axis and around the sun, not as a pure hypothesis but as ontologically true description of the world, Copernicus of necessity had to provoke not only the professional astronomers and philosophers, but especially those who were the followers of a double truth doctrine, and those who claimed that the truth about reality can be obtained either by faith or reason alone.

Copernicus himself foresaw the controversy and the ideological conflict with theologians; first those from the Reformed Church, and later those from the Catholic Church [9]. In his letter to pope Paul III, to whom he dedicated his book „De Revolutionobus", Copernicus writes: „It may fall out, too, that idle babblers, ignorant of mathematics, may claim a right to pronounce a judgment on my work, by reason of a certain passage of Scripture basely twisted to suit their purpose" [10]. Being well aware of the possible danger of inflaming the contemporary minds, Copernicus sought advise from many of his friends, among whom he also counted Andreas Osiander. The latter, in a letter to Copernicus written on April 20, 1541, in a desire to defend heliocentricism from the accusations already raised by the leaders of the Reformed Church, states: „Regarding hypotheses, I was always of the conviction, that they do not represent precepts of faith, but are basic mathematical computations, and thus, even should they be erroneous, it does not matter, as long as they accurately portray the phenomena of movements" [11]. Osiander also advised Co-

[9] For the reaction of the Protestant Church authorities see Hans Blumenberg: *Melancthons Einspruch gegen Kopernikus*, „Studium Generale", 13, 1960, pp. 174—182; Donald Fleming: *The judgment upon Copernicus in Puritan England*, „Mèlanges Alexandre Koyré", Paris, 1964, II, pp. 160—175; Konrad Müller, *Ph. Melanchthon und das kopernikanische Weltsystem*, „Centaurus", 9, 1963, pp. 16—28; Wilhelm Norlind, *Copernicus and Luther*, „Isis", 44, 1953, pp. 173—176. For the attitude of the Catholic hierarchy towards Copernicanism see Pierre Badoux: *Copernic et l'église*, „Ciel et terre", 70, 1954, pp. 318—320; Carlo Giacon, *Intorno alla condanna di Copernico*, „Vita e pensiero", 34, 1943, pp. 182—187; and especially Pierre Conway; *Aristotle, Copernicus, Galileo*, „New Scholasticism", 23, 1949, pp. 38—61, 129—146.

[10] *De Revolutionibus*, Ad S.D. Paulum III.

[11] „De hypothesibus ego sic senso semper, non esse articulos fidei, sed fundamenta calsuli, ita ut etiamsi falsae sint modo motuum phainomena exacte exhibeant, nihil referat": quoted after Joannis Kepleri:

pernicus that „it would be praiseworthy should you mention this in the preface, in order to appease the Peripatetics and theologians, whose objections you misgivingly anticipate" [12].

It is a historical fact, that Copernicus rejected Osiander's advice, convinced of the truth contained in the heliocentric idea. He refused to consider heliocentricism as hypothetical only and claimed that his system of the world is superior to that of Ptolomy [13]. Both in his letter of dedication and in his „Introduction" to the „De Revolutionibus", Copernicus stresses the apodicticity of the presented truth [14]. However, taking advantage of the fact that Rheticus was unable to edit the manuscript of Copernicus' „De Revolutionibus" due to his new teaching appointment at the University of Leipzig, Osiander arbitrarily preceded the work of Copernicus with an anonymous Preface, presenting the author's theory not only as hypothetical but improbable one at that, proving himself unloyal to the author.

2. OSIANDER'S ATTEMPT FOR DOCTRINAL FALSIFICATION OF SCIENTIFIC TRUTH

In order to properly evaluate the postulate of hypotheticality of Copernican heliocentricism, insinuated by Osiander in his Preface to „De Revolutionibus" (nota bene, a preface which has been called by Johannes Broscius as „stultissima Praefacio") a twofold mode of understanding a scientific hypothesis, namely as a methodological device in scientific investigations and as an epistemological evaluation of the truth

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„Opera omnia", ed. Ch. Frisch, Francofurti a M. et Erlangae, 1858, vol. i, p. 246.

[12] Ibidem: „Quare plausibile fore videretur, si hac de re in praefatione nonnihil attingeres. Sic enim placidiores redderes peripatheticos et theologos, quos contradicturos metuis".

[13] Cf. Paul Couderc: *Les Étapes de l'Astronomie*, Paris, 1955; Harold S. Jones: *Copernicus and the De revolutionibus*, „Polish Science and Learning", 3, 1943, pp. 11—24. For contrary views cf. Edwin Burtt: *The metaphysical foundations of modern physical science*, London, 1956; Thomas Greenwood: *Les hypothèses de Copernic*, „Revue trimestrielle canadienne", 30, 1944, pp. 240—249.

[14] Cf. Gino Cecchino, *Il cielo*, Turin, 1952. The claim that Copernicus regarded his heliocentric doctrine as hypothetical one can see in Bertrand Russell: „A history of Western Philosophy", 1945, p. 916. An ambiguous view in regard to the veracity of the heliocentric system in Copernicus see Jerome R. Ravetz, *Traditional and innovatory elements in the cosmology of Nicolas Copernicus*, „Organon", 2, 1965, pp. 49—59.

attained, have to be taken under consideration. Hypothesis, in a methodological sense consists in a tentative assumption for the purposes of investigation of certain facts. Hypothesis so understood is a practical device and means by which scientific truth can be reached, and as such is known as a working hypothesis; Copernicus himself used this particular meaning of hypothesis, as evidenced in the title of his first book: „Nicolai Copernici De Hypothesibus Motuum Caelestium A Se Constitutis Commentariolus" [15]. On the other hand, the epistemological understanding of hypothesis implies that any assumed presupposition cannot be considered as a categorical and apodectic truth, even should it be in agreement with conducted observations of facts, or proven by mathematical computations. All what can be reached by scientific procedure is not an absolute, but a relative truth.

Now, Osiander claimed that Copernican heliocentricism is hypothetical, both in methodological and epistemological sense. Osiander, as an epigone and a follower of medieval tradition was convinced that Copernican heliocentricism was not only hypothetical, in both methodological and epistemological sense, but he also attempted to prove that many of the postulated by Copernicus views, are erroneous and improbable, or even false. Without giving any ontological value for his heliocentric idea, Osiander nevertheless was convinced that those erroneous pre-suppositions of heliocentricism could, for the practical reason be applied in astronomy, e.g. astronomical tabulations of stars and in a proposed reform of the calendar. Consequently, according to Osiander, every scientific truth, not being pre-speculated by theological principles, does not have any objective foundation in reality, and as such, has only relative value. The only authority, for Osiander, were Scriptures, and the Scriptures seemingly contradicted the idea of heliocentricism, becoming the decisive argument for Osiander [16]. Following Averroes and Maimonides, Osiander

[15] In this connection Edward Rosen rightly observed that Copernicus used the terms „principium, assumptio, and hypothesis without any distinction", op. cit., p. 29.

[16] Scientific truth about the universe can be obtained, according to Osiander only from divine revelation: „Sunt et alia in hac disciplina non minus absurda, quae in praesentiarum excutere nihil est necesse. Satis enim patet, apparentium inaequalium motuum causas, hac artem penitus et simpliciter ignorare. Et si quas fingendo excogitat, ut certe quamplurimas excogitat, nequaquam tamen in hoc excogitat, ut ita esse cuiquam perusadeat, sed tantum, ut calculum recte

claimed that scientific truth cannot be reached by reason alone, as Martin Luther described it, is „the Devil's bride, the beautiful harlot for reason is the highest whore the Devil has" [17].

II. EMPIRICAL REALISM OF COPERNICANISM

For St. Thomas Aquinas any scientific theory can be true either being in agreement with the philosophical principles of nature, or with the observed facts and mathematical computation [18]. The dominant opinion among medieval thinkers was that truth about the universe consists in finding the philosophical principles of a given scientific theory rather than in proving it as being in agreement with observed facts alone. The claim to estimate the truth according to the philosophical principles rather than scientific observation of a given planetary system consists in the fact, as Averroes puts it, that „the observed results are known but the principles themselves are unknown, for the principles cannot be logically derived from the results" [19]. If there were many possible hypothesis about the natural phenomena, the decisive prove therefore of their validity belongs to the philosophers or theologians, and not to the scientists, as Moses Maimonides has expressed: „Man knows only these poor mathematical theories about the heaven, and only God knows the real motion of the heaven and their causes" [20]. Consequently scientific theory can be true only insofar as it satisfies the philosophical criterion of truth.

Now, Copernicus' interest in empirical observatios and mathematical calculations about the structure of the world and

instituant... Philosophus fortasse veri similitudinem magis requiret; neuter tamen quicquam certi comprehendet aut tradet, nisi divinitus illi revelatum fuerit", pp. 1—2. For a Marxistic „defense" of Osiander's attitude towards scientific truth see Roman S. Ingarden: *Mikołaj Kopernik i zagadnienie obiektywności praw naukowych*, „Odrodzenie w Polsce", vol. 2, part 2, pp. 7—53, Warszawa, 1956. Heiko A. Oberman evaluates Osiander's insertion of his Preface to the „De Revolutionibus" as „a nominalist platform", in scientific search for truth, in: *Reformation and Revolution*, „The nature of scientific discovery", op. cit., pp. 143ff.

[17] „Werke", Erlanden, 1826—1868, vol. XX, 2, 479ff.

[18] S.th., I, 32, 1, ad 2.

[19] Quoted after Philipp Frank, *The philosophical meaning of the Copernican Revolution*, „Proceedings of the American Philosophical Society", 87, 1944, p. 383.

[20] Ibidem.

the nature of the motions of celestial spheres or bodies [21] led him to challenge the age-old custom of thinking either/or, by paving a new order of scientific investigation. First of all, Copernicus insisted that the scientific truth must be sought in everything: „Veritatem omnibus in rebus inquirere" [22]. Secondly, in searching for the totality of scientific truth, Copernicus is convinced that both sense perception and mathematical calculation about the natural events in the universe cannot contradict each other, because otherwise our search for truth would be in vain. In the „Introduction" to the „De Revolutionibus", Copernicus writes: „Many philosophers have called the world a visible god on account of its extraordinary excellence: For the divine Psalmist surely did not say gratuiteously that he took pleasure in the working of God and rejoiced in the works of His hands, unless by means of these things as by some sort of vehicle we are transported to the contemplation of the highest Good" [23]. Now, if our senses or intellect would be unable to know the causes of „the circular movements of the world and the course of the stars, ... and the causes of the other appearances in the heavens", then the divine design of the created world would be futile for us, and as such would remain unintelligible [24]. „And since a property of all good arts is to draw the mind of man away from the vices and direct it to better things, these arts can do that more plentifully over and above the unbelievable pleasure of mind (which they furnish). For who, after applying himself to things which he sees established in the best order and directed by divine ruling, would not through diligent contemplation of them and through a certain habituation be awakened to that which is best and would not wonder at the Artificer of all things in whom is all happiness and every good?" [25] Finally, as a matter of consequence, Copernicus claims that the intelligibility of all things being created by God for man require that scientific truth is attainable with ontological certainty.

Things, however, can be known either by sense perceptions or intellectual speculations, and as such, constitute a specific

[21] For discussion of the understanding of the doctrine of spheres and celestial bodies see Edward Rosen: op. cit., pp. 11—21.
[22] *De Revolutionibus.*
[23] Ibidem.
[24] Ibidem.
[25] Ibidem, I, Intr.

order of intelligibility. For St. Thomas Aquinas there are in the order of intelligibility of things threefold *rationes* which constitute the very nature of any truth in its integrity:
— *ratio prioris et posterioris;*
— *ratio distinctionis et compositionis;*
— *ratio ordinis* [26].
Now, in Copernicus' heliocentricism *ratio prioris* is given to the principle of mathematical calculations, *ratio compositionis* to the principle of relativity of our sense perceptions, and *ratio ordinis* to principle of gravity.

1. THE ROLE OF MATHEMATICS

The existing logical and philosophical contradictions aboundant in the natural sciences were his first concern: „So I should like your Holiness to know that I was induced to think of a method of computing the motions of the spheres by nothing else than the knowledge that the Mathematicians are inconsistent in these investigations" [27]. Presenting as a young man his first outline of the world in „Commentariolus", Copernicus admits a departure from established opinions: „ratione, postea quidem sensu" [28]. In this respect Copernicus was following the medieval procedure in scientific investigation in which the emphasis was put on the rational explanation of a given system, But, giving priority to the rational explanation of natural phenomena, Copernicus insisted at the same time that our reason cannot contradict our sense perceptions,

[26] In Sent., I, 20, 1; 509.
[27] *De Revolutionibus,* Ad S.D. Paulum III.
[28] Ludwik A. Birkenmajer enumerates two of these rationes which Copernicus brought forward as an argument against the Aristotelian-Ptolomaic geocentricism: „1. according to Aristotelian-Ptolomaic understanding the most perfect movement in nature is the uniform one. Aside from this, any other movement (violentus) is an attribute of falling bodies, which, as Galileo was to discover later on, accelerate their speed in their downward motion. Velocity, on the other hand, as well as inertia of matter was then unknown. It is necessary to distinguish here between kinematic movement, in which the movement is considered independently of any causes, and dynamic movement, when the source of movement is given to as well. 2. In the deliberation of these two movements, geometry also played an important role, proclaiming the circular line to be the most perfect one. In the view of ancient philosophers the nature of celestial bodies was ideal, while earthly ones (haec inferiora) were mutable and destroyable (coorruptio)..., see: *Filozoficzne podłoże...*, loc. cit., p. 266f.

and as such it must also be in agreement with our sense observations. The principle of intelligibility is according to Copernicus not only logical but ontological one. Now, in the mind of Copernicus there was little possibility for the vast celestial bodies, including the sun to circle around the earth in the span of 24 hours. Copernicus asks himself: „Could that which encirles be movable comparing to that which is encircled?" [29]. The epicyclic movement of planets, in addition, does not centralize on the earth but on themselves. Finally, if movement is attributed to the planets, deferentials as well as complicated epicycles became unnecessary.

The first doubt as to the correctness of the world's image had entered Copernicus' mind during his studies at the Jagiellonian University in Kraków, where Wojciech of Brudzewo, referring to the epicyclic movement used the expression „circulus imaginarius". In his commentary Wojciech of Brudzewo noted among others: „Qui quidem ecentrici an veraciter existant in sphaeris planetarum, nemo mortalium novit, nisi fateamur illos (ut nonnulli aiunt), similiter et epicyclos revelatione spirituum· propalatos, sinon extunc sola imaginatione mathematicorum effictos" [30]. From his philosophy master — Jan of Głogów — Copernicus could hear that the sun is not only the first planet but the biggest among them, and as such in control of the motion of celestial bodies in the universe: „Sol est dignissimus planeta, ergo etiam eius influentia est nobilior... Ille planeta est dignior, qui omnes planetarum motus regit, dirigit et mensurat, quarum Sol est huiusmodi, quia regens est dignior recto" [31]. Independently however, from the criticism raised by the Jagiellonian scholars, earlier medieval masters already saw the insufficiency and incongruence existing between the Aristotelian physics and Ptolomaic theory of epicyclic motions of celestial bodies, which union has already been questioned by Averroes [32] and St. Thomas [33]. Attempting to correct these discrepancies, Coper-

[29] *De Revolutionibus*, I, 5.

[30] „Commentariolum super 'Theoricas novas planetarum' Georgii Purbachii in Studio Generali Cracoviensi per mag. Albertum de Brudzewo diligenter corrogatum A.D. MCCCCLXXXII. Post editionem principem Mediolanensem A. MCCCCXCV ad fidem codicum praestantissimorum denuo edendum curavit Ludovicus Antonius Birkenmajer", Cracoviae, 1900, p. 26.

[31] Quoted after L. Birkenmajer: *Stromata Copernicana*, op. cit., p. 125.

[32] *Com. in Aristotelis Metaphys.*, XII, Summa II, c. 4.

[33] *In de coelo*, I, lect. 3, no. 28.

nicus turned to mathematics. We might quote here Alexander Birkenmajer, who in his „explanations" to Copernicus' work writes: „The basic goal, which he pursued in his work, was to give the heliocentric idea such a mathematical form, which would be consistent with the phenomena observed in the sky" [34].

Now, stressing the validity of mathematics in scientific explanation of natural phenomena, Copernicus challenged the medieval masters who gave the priority to the theological or philosophical truth over and against the empirical and mathematical ones. Moreover, giving the priority in scientific investigations to mathematics, Copernicus claimed that his heliocentricism is also true empirically. Although he was not the first to employ mathematics in astronomy, Copernicus built his mathematical system as upon the earth's motion [35]. The thesis concerning the movement of the earth was also not brought up for the first time by Copernicus alone. To different degrees it was forwarded also by Johannes Buridanus [36] and Nicholas Oresme [37]. Copernicus himself mentions certain ancient thinkers who favored heliocentricism in order to explain the phenomena of sunrise and sunset. Calling upon Cicero and Plutarch, Copernicus quotes the following philosophers: Philolaus of Crotona, Ecphantes, Heraclides of Pontus and Nicetas of Syracuse as forerunners of heliocentri-

[34] Warsaw edition of „De Revolutionibus", p. 95. Cf. also Stanisław Turski: *Znaczenie odkrycia Kopernika dla rozwoju myśli matematycznej*, „Studia i Materiały z dziejów nauki polskiej", 2, 1954, pp. 93—101.

[35] Thomas Kuhn: *The Copernican Revolution*, Cambridge, 1971, p. 143.

[36] On the influence of Buridanus on Copernicus see Roman S. Ingarden: *Buridan i Kopernik: dwie koncepcje nauki*, „Studia i materiały z dziejów nauki Polskiej, I, 1953, pp. 51—63. Cf. also Mieczysław Markowski: *Burydanizm w Polsce w okresie przedkopernikańskim*, „Studia Copernicana", vol. 2, Wrocław, 1971; idem: *Stanowisko Jana Burydana, Mikołaja z Kuzy i Mikołaja Kopernika wobec niektórych tez starożytnych teorii średniowiecznych*, „Materiały i studia Zakładu Historii Filozofii Starożytnej i Średniowiecznej", vol. IX, Wrocław, 1968, pp. 76—84.

[37] About the influence of Nicolas Oresme on Copernicus see Pierre Duhem: *Un précurseur francais de Copernic: Nicole Oresme*, „Revue Générale des Sciences Pures at Appliqueés", 20, 1909, pp. 866—873. P. Duhem evaluates the influence of Oresme to the extent that he calls him the precursor of Copernicus; for critical evaluation of this position see Roman S. Ingarden, op. cit., Cf. also Marian Kurdziałek: *Rola tradycji chrześcijańskiej w przewrocie kopernikańskim*, „Zeszyty Naukowe KUL", 16, 1973, no. 1.

cism [38]. Moreover, the heliocentric idea was taught not exclusively by philosophers, but has also been proclaimed by some astronomers such as Aristarchus of Samos [39].

The novelty of his theory then consisted not only in the earth's movement around its own axis, but also its yearly movements around the sun [40]. And although he was familiar with the Pythagorean theory of the movement of all celestial bodies, (including the sun), around Hestia, a central fire, our astronomer not only freed heliocentricism from the speculative and hypothetical idea of a central fire, but placed the sun in the center of the universe, claiming it to be in possession of its own light (contrary to the view of Philolaus who saw the sun's light as a reflection only) [41]. Thus, although inspired by the ancient thinkers, Copernicus gave heliocentricism its realistic form [42].

2. THE PRINCIPLE OF RELATIVITY

Intelligibility of all things in the world requires then that any scientific truth is attainable in its totality. However, things are revealing themselves differently in various cognitive faculties of man, and as such constitute a specific order of intelligibility. Now, in the order of intelligibility, there are two modes of attaining scientific truth, namely, the truth of sense perception and the truth of intellectual speculations.

The order of the scientific truth of the empirical sense observations Copernicus bases on the principle of relativity of perception both of the observer and the observed things being in motion: „Omnis enim quae videtur secundum locum mutatio aut est propter spectatae rei motum, aut videtis, aut certe disparem utriusque mutationem" [43]. Although the common opinion among the historians of sciences attributes the principle of relativity to Copernicus [44], nevertheless this idea

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[38] *De Revolutionibus*, Ad S.D. Paulum III.

[39] Walther Kranz: *Kosmos*, „Archiv für Begriffsgeschichte; Bausteine zu einem historischen Wörterbuch der Philosophie", Band 2, Teil 2, Bonn, 1957.

[40] For the discussion on the nature of earth's movements see Jerome R. Ravetz: *Origins of the Copernican Revolution*, „Nature", 189, 1961, pp. 859—860.

[41] Cf. Edward Rosen: *Was Copernicus a Pythagorean?*, „Isis", 53, 1962, pp. 504—508.

[42] Cf. Alexandre Koyré: *„The astronomical Revolution"*, New York, 1973, pp. 24—25.

has already been expounded by St. Thomas who said: „Quod enim motus appareat, causatur vel ex motu visibilis, vel ex motu videntis" [45]. The principle of relativity however, although theoretically known was first applied by Copernicus with a mathematical precision in his practical observations of heavenly bodies.

The principle of relativity of our sense perceptions Copernicus applies to his heliocentric pressupposition that in the order of intelligibility there are in things ratio compositionis, which bring up „nexum motus et magnitudinis orbium". As a Renaissance man Copernicus saw the structure of things in symmetry, and the form of things in harmony: „Invenimus igitur sub hac ordinatione admirandam mundi symmetriam, ac certum harmoniae, nexum motus et magnitudinis orbium, qualis alio modo reperiri non potest" [46]. In this way *ratio compositionis* enables the order of intelligibility to be based on both, mathematics and sense perceptions, and as inspired his followers to search for mathematical „harmony in nature" which Kepler expressed as being there „for the sake of fuller knowledge", and to acquire, as Galileo puts it „the truth of which mathematical demonstration give us the knowledge... Nature being inexplorable and immutable, and never passing the bounds of the laws assigned her" [47].

3. THE PRINCIPLE OF GRAVITY

The scientific truth, however, can be found not only in the cognitive powers of the knower, but also in the things themselves, namely in regard to their nature and properties. Aristotelian natural philosophy recognized the property of things being in motion in the natural inclination of things to rest at their natural places. Studying at the Jagiellonian University in Kraków Copernicus was not only familiar with Johannes Buridanus' theory of impetus [48], but he was most pro-

[43] De Revolutionibus, I, 5.

[44] Ludwik A. Birkenmajer commenting on the above quoted sentence of Copernicus states: „For the first time, clearly and with full understanding of the issue involved, one of the basic principles of modern dynamics — the principle of relativity of motion — has been expressed in this sentence", „Mikołaj Kopernik: *Wybór pism*, Kraków, 1920, p. 62.

[45] *In de coelo*, II, lect. 11, no. 2.

[46] *De Revolutionibus*, I, 10, p. 30.

[47] Quoted after Lee R. Ward: *God and world order*, St. Louis, 1961, p. 122.

bably influenced by it to the extent of changing the Aristotelian theory of appetitus naturalis into the concept of gravitas [49]. Gravity, however, for Copernicus, is not a property of individual things but the universal characteristic of the nature as a whole [50].

The principle of gravity as a universal characteristics of the nature as a whole enables Copernicus to place the sun into the very center of the universe: „Ipse denique Sol medium mundi putabitur possidere quae omnia ratio ordinis, quo illa sibi invicem succedunt, et mundi totius harmonia nos docet, si modo rem ipsam ambobus (ut aiunt) oculis inspiciamus" [51].

The principle of order played a most significant role in Copernicus' view on nature of heavenly bodies and was the fundamental philosophical premise of his heliocentric system. Now, accepting the principle of relativity and gravity as universal law of nature Copernicus simplified the scientific investigation, and consequently gave the heliocentric idea such a mathematical form which would be consistent with the phenomena observed by sense perceptions. In his own words Copernicus confesses that in scientific exploration we should follow not ours but nature's sagacity: „Sed naturae sagacitas magis sequenda est, quae sicut maximo cavit superfluum quiddam, vel inutile produxisse, ita potius unam sepe rem multis ditavit effectibus" [52].

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[48] About Buridanus' impetus theory see A. Maier: *Zwei Grundprobleme der scholastischen Naturphilosophie*. Roma, 1952.

[49] *De Revolutionibus*, I, 9, p. 24: „Equidem existimo, gravitatem non alius esse, quam appetentiam quandam naturalem partibus inditam a divina providentia epificis universorum, ut in unitatem integritatemque suam sese conferant in formam globi coeuntes".

[50] Cf. Szczepan Szczeniowski: *Dyskusja*, „Sesja Kopernikowska", op. cit., p. 269: „A decisive role in the further development of mechanics was played by Kepler's laws of planetary movements based on the extensive material of observations of Tycho Brahe. Newton deduced these laws from his own principles of mechanics and formulated the law of universal gravity on the hases of his principles and Kepler's laws. But it is worth while remembering that the first hints at universal gravity are met with in Copernicus' work". Cf. also Doris C. Hellman: *Copernicus and comets*, „Actes du XIe Congrès International d'Histoire des Sciences", Wrooclaw, 1968, I, pp. 66—70.

[51] *De Revolutionibus*, I, 9, p. 25.

[52] Ibidem, I, 10, p. 28.

CONCLUSION

Copernicus' heliocentric order of the universe based on the principle of simplicity, relativity and gravity allowed him not only to revolutionize the astronomical views, but to bring a fundamental revision into the relationship of philosophy and astronomy on one hand, and theology and astronomy on the other hand. However, not being himself by profession either philosopher or theologian Copernicus' innovation into philosophical or theologocal issues were not expounded upon in his system as such, but only implied as postulates in his approach to the natural phenomena.

Challenging both, the double truth theory and the well established doctrine of the superiority of one knowledge over an other one (in his case, the theological or philosophical truth in astronomy over scientific and mathematical one), Copernicus defended the integrity of human knowledge. Unfortunately, however, the consecutive development of Copernican Revolution followed more or less in the path of Osiander's doctrine of hypotheticity of scientific truth. This in turn resulted in relativistic attitude of modern and contemporary scientists and consequently led them to either agnosticism or scepticism. Scientific truth would be seen as possessing hypothetical character only and as such it would consist in provisional supposition or a mere assumption of something independently of the truth itself. The distinction between methodological device in scientific investigations, and the provisional character of scientific truth would beceme neutral. Now, this „suppositive" or „asumptive" character of any scientific hypothesis led the theoreticians of sciences to an evaluation of scientific truth according to different criteria, resulting in various relativistic attitudes, such as phenomenalism, conventionalism, instrumentalism, operationism, etc.