AYDIN SAYILI'S BOOK COPERNICUS AND HIS MONUMENTAL WORK (ANKARA 1973) AND THE POLISH BACKGROUND

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Abstract

The aim of Sayılı's book on Copernicus was to show the Copernicus heliocentric revolution in broader context which help us to catch this new idea as a part in development of science. The aim of my paper it to present Sayılı's book in broader context of philosophy and Polish tradition, however, Aydın Sayılı's scientific legacy is rather unknown in Poland.

It was a special double anniversary last year. Nicolaus Copernicus was born in the year 1473, it means 530 years ago. Moreover, Aydın Sayılı was born in 1913, also 100 years ago. In addition, there was a very interesting symposium on Aydın Sayılı's achievements organized by his Turkish successors working in the subject of history of science in November 2013. I found it an excellent opportunity to investigate Aydın Sayılı's book on Copernicus from my Polish and philosophical point of view. There are some controversies connected with Copernicus achievement discussed until now in Poland. The paper covers the following areas: What

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was published about Aydın Sayılı in Poland; Characteristic of the Sayılı's book and I point you out what is not present in the Aydın Sayılı's book on Copernicus, although it is important from Polish and more general point of view; Medieval Islamic/Arabic world and Copernicus works; Sayılı as a historian of science; Other Copernicus' achievements not mentioned by Sayılı.

Keywords: Copernicus, Aydın Sayılı, history of astronomy, philosophy of science, history of science

Özet

Sayılı'nın Copernicus üzerine yazdığı kitabının amacı, bu yeni fikri, Copernicus devrimini, bilimin gelişiminin bir parçası olarak, daha geniş bir bağlamda anlamamızda yardımcı olmaktı. Sunumumun amacı, felsefi bağlamda ve Lehçe geleneğinde Sayılı'nın kitabını tanıtmak ve Aydın Sayılı'nın bilimsel mirasının Polonya'da çok fazla tanınmadığını göstermektir.

Geçen yıl özel bir çift yıldönümü idi. Nicolaus Copernicus 1473 yılında doğdu, yani 530 yıl önce. Ayrıca Aydın Sayılı 1913 yılında doğdu, yani 100 yıl önce. Ek olarak, Kasım 2013'te bilim tarihinde çalışma yapan Sayılı'nın Türk halefleri, Aydın Sayılı üzerine çok ilginç bir sempozyum düzenlediler. Bunu, Aydın Sayılı'nın Copernicus üzerine olan kitabının felsefi ve Lehçe bakış açısı ile incelenmesi için mükemmel bir fırsat olarak gördüm. Zira bugüne kadar Polonya'da Copericus'un başarısına dair bazı tartışmalar vardı. Çalışma aşağıdaki alanları da kapsamaktadır: Polonya'da Aydın Sayılı hakkında yayınlar ve Sayılı'nın kitabının karakteristiği neydi? Ayrıca, Lehçe ve daha geniş açından önemli olmasına karşın Aydın Sayılı'nın Copernicus üzerine yazdığı kitabın neden mevcut olmadığına; Ortaçağ İslam/Arap Dünyası ve Copernicus'un çalışmasına; bir bilim tarihçisi olarak Sayılı'ya; Copernicus'un diğer başarılarından Sayılı'nın neden bahsetmediğine dikkat çekeceğim.

Anahtar Kelimeler: Copernicus, Aydın Sayılı, astronomi tarihi, bilim felsefesi, bilim tarihi

Motto:

Copernicus had infringed the hoary doctrine of the perfection of the celestial and the baseness of the sublunar words and had raised up the earth into heaven (Sayılı, 2012, p. 22).

Introduction

The aim of Sayılı's book on Copernicus[1] was to show the Copernicus heliocentric revolution in broaded context which help us to catch this new idea as a part

[1] There are two editions of De Revolutionibus in Turkish. The first appeared in 2002 "but there are bad comments about that book that the translator translated the text without knowing the subject itself. So I guess the second one is the first translation" Irem Aslan: Letter from 3.01.2014. I refer to the bilingual edition from 2012.

in development of science. The aim of my paper it to present Sayılı's book in broaded context of philosophy and Polish tradition, however, Aydın Sayılı's scientific achievement is rather unknown in Poland.

It was a special double anniversary last year. Nicolaus Copernicus was born in the year 1473, it means 530 years ago. Moreover, Aydın Sayılı was born in 1913, also 100 years ago. In addition, there was a very interesting symposium on Aydın Sayılı's achievements organized by his Turkish successors working in the subject of history of science in November 2013[2]. I found it an excellent opportunity to investigate Aydın Sayılı's book on Copernicus from my Polish and philosophical point of view. In order to complete successfully this task, I have decided to discuss the following topics: What was published about Aydın Sayılı in Poland; Sayılı's book from the contemporary Polish and more general point of view; Medieval Islamic/Arabic world and Copernicus works; Sayılı as a historian of science Other Copernicus' achievements not mentioned by Sayılı.

What was published about Aydın Sayılı in Poland

Although Aydın Sayılı's scientific achievement is rather unknown in Poland I would like to collect the scarce references to his person and his books.

There is a review of Sayılı's book *The Observatory in Islam and its Place in the General History of the Observatory* (Ankara 1960) written by Tadeusz Przypkowski in 1963. Przypkowski was a Polish historian of astronomy, gnomic and collector of old astronomical instruments. It is worth mentioning that his review while giving some competent information on the content of the book appears to be its deep analysis as well. Przypkowski emphasized Sayılı's criticism when he made distinction between pseudo-observatory and really observatory (Przypkowski, p. 575). Przypkowski added that long time the Islamic observatory were unknown for European due to its religious character (Przypkowski, p. 577). From other site, some small Islamic astronomical instruments which arrived in Europe were very useful and influenced future development of astronomy (Przypkowski, p. 577).

However, and the most important book, *Copernicus and his monumental work* (Ankara 1973) received no review only a short description in bibliography of works referred to Copernicus' achievement, no 5191 (Bibliografia Kopernikowska, 2003, p. 20). Nevertheless, Michał Kokowski, the best living Polish specialist in Copernicus legacy[3], translated some passages from this Sayılı's book (from sites 1–7) and published them in his book on Copernicus, printed in Poland in 2009.

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[2] In Memory of100th Anniversary of the Birth of Aydın Sayılı International Symposium on Ottoman Science and Philosophy in XVIth Century. Kastamonu 13 – 15 November 2013. I am glad that the organizers invited me and gave me a financial support. Special thanks are owed to prof. dr. Melek Dosay Gökdoğan.

[3] See prof. Michał Kokowski's personal website: http://www.cyfronet.krakow.pl/~n1kokows/home.html

What may seem strange, in May 2012, after the lecture of doc.dr Sema Onal (Institute of Philosophy, Kırıkkale University) which she gave in the Institute of Philosophy (University of Silesia, Poland) I found a two-page biographical entry of Sayılı in Polish version of Wikipedia. Unfortunately, it is not there anymore and I cannot remember who it was written by. However, it means that Sayılı's works are better known in Poland than it is documented.

Characteristic of the Sayılı's book

In 1973 the five hundredth anniversary of Copernicus birth in 1473 in Toruń (Poland) was celebrated in Poland (and not only in Poland). The Turkish historian of science, Sayılı, took part in this celebration and he " was the main speaker in the meeting organized in Ankara in 1973 by the Turkish Commission for the UNESCO" (Turker-Kuyel, 1996). What is more, " he was presented […] by the Polish ambassador in Ankara with a Copernicus medal in recognition for his work on the occasion (Turker-Kuyel, 1996).

Copernicus and his monumental work is an English version of the paper written in Turkish and „published under auspices of the Turkish National Commission for UNESCO for celebration held in Ankara on February 19th, 1973, the five hundredth anniversary of Copernicus' birth" (Sayılı, 2012, p. 14). Yet, what is of a particular importance is a Turkish version contains some translated passages of Copernicus *De Revolutionibus* , which were probably parts of the first Turkish translation. The question is whether they were translated from Latin or English and if they were translated by Sayılı.

In his book Sayılı poses a question:

> *In what respect did Copernicus consider his system superior from the stand-point of physics to Aristotelian cosmology? And again, to what extent was Copernicus justified in reaching these definitive verdicts, and what were the evidences he brought in support of these contentions? (Sayılı, 2012, p. 117)*

> *What were […] the reasons that made Copernicus believe his system to be physically true and at the same time astronomically superior to the Ptolemaic one? (Sayılı, 2012, p. 118).*

There are following parts of the book: Preface (written by Bedrettin Tuncel), Introduction, Copernicus and his Recasting of Astronomical Thought (Chapter I), The Birth and Genesis of the Copernican System (Chapter II), Copernicus' Contributions to Astronomical Thought and Knowledge (Chapter III), Copernicus and Cosmology (Chapter IV), The Nature and Characteristics of Copernican Thought (Chapter V), The Scientific Value of the Copernican Theory (Chapter VI), Conclusion. Unfortunately, it does not contain bibliography, which would be

helpful in reconstruction of Sayılı's scientific and intellectual background when he wrote this book and helpful in knowing his motivations and inspiration.

It is easy to see that this book was written by a historian of science who has got his own point of view in Copernicus' achievement, based on deep knowledge of astronomy in the past, not only Islamic/Arabic tradition. The aim of the Sayılı's book was "[…] to place Copernicus' work against its historical background both in prospect and retrospect" (Sayılı, 2012, p 99). From one hand Sayılı depicted Copernicus as somebody who was a "product of his time", as "the child of a revolutionary age" (Sayılı, 2012, p. 98, 99). On the other hand, presented as somebody who was ahead of his time (Sayılı, 2012, p. 98). The Turkish historian of science argued that Copernicus system was the second one after Aristotelian because they both gave "the idea of representing the universe as an organized whole" (Sayılı, 2012, p. 139). And such a conception to take a person not in "isolation either from the intellectual background from which he derived his motivations and inspirations or from his impacts on future lines of development" was assumed by famous Polish historian of science, Eugeniusz Rybka in his books on Copernicus (Rybka, 1964, 1972), too. For example, when he refers to Averroistic threads, not to Aristotelian philosophy although in Copernicus' book Averroes is mentioned only once whereas Aristotle four times.

Sayılı described Polish school of astronomy in Copernicus' time and the high level and Aristotelian line in University of Cracow (Sayılı, 2012, p. 109, 111). Other universities where Copernicus studied were described by Sayılı as well: the University of Padua (Sayılı, 2012, p.109, 111), Bologna, Ferrara, Padua.

I can see two drawbacks of Sayılı's book:

1. From one hand it is a popular science book. As a consequence, readers are not informed by Sayılı on which literature he based this book and he admitted it in the *Introduction* (Sayılı, 2012, p.105). However, it is not helpful when I plan to analyse his book from a broader point of view. When I read *Copernicus* I pose a question for myself which positions from the very extensive and widely known literature referring to Copernicus achievement Sayılı knew and found valuable. Meanwhile I found reference to E. Zinner book *Entstehung und Ausbreitung der Copernicanischen Lehre*, 1943 (Sayılı, 2012, p. 121).
2. From other hand, when it is a popular book, there should be at least short information on people mentioned by Sayılı. It is likely that an average reader is acquainted with Galileo, Newton or Kepler. But he/she can have no knowledge on Albert Brudzewski (1446–1495), Georg Peurbach (1423–1461), Regiomontanus (actually Johannes Müller, 1436–1476), Domenico Maria de Novara (1454–1504), Erasmus Reinhold (1511–1553), Vesalius (1514–1564), Girolamo Cardano (1501–1576), Giovanni

Giovanni Bianchini (1410–1469) etc. Sayılı assumed that the reader knows the important figures from the history of science. Sometimes there are dates of the birth and death, written books, etc.

3. Unfortunately, there is not index of persons or index of subjects.

I suggest to prepare short biographical entries for people who are not well-known, subject and names indexes in the next edition of the Sayılı's book on Copernicus.

Sayılı's book from the Polish and more general point of view

It is obvious that the Polish literature on Copernicus is very large. There are different books on his life, education, scientific achievements etc. However, Sayılı emphasised some other aspects, mostly connected with his view of historian of science. Some of them are rarely present in Polish literature. In order to begin next stage in Polish – Turkish discussion on Copernicus' tradition I will point out some of them. In this part of my paper I would like to collect some remarks on comparison of Sayılı's book on Copernicus and Polish books on his revolutionary investigation. I point out what is not present in the Sayılı's book on Copernicus which is, however, important from our point of view. It is a question whether Sayılı known Polish school of interpretation of Copernicus' achievement. It was possible because some historian of science's books on Copernicus were published in English, too.

Polish commentators emphasise that Copernicus was born and died in Royal Prussia, a region in the Kingdom of Poland since 1466. However, some others called him a German scientist. We are glad that Sayılı regarded him as Polish. One of the arguments that he was Polish is connected with the origin of his family name," Copernicus". It comes from a garden plant - dill [*koper* in Polish]. Dill is an annual plant widely cultivated and commonly used herb in Poland. Copernicus father's ancestors came from a village *Koperniki* (Koper, 2014).

The next subject to mention is relativeness of the movement. It is commonly said in Polish literature that since his childhood Copernicus had observed barges on the river Vistula in Toruń where he was born and lived. Copernicus introduces his view on relativeness of the movement by writing:

> *This situation closely resembles what Vergil's Aeneas says: Forth from the harbour we sail, and the land and the cities slip backward [Aeneid, III, 72]. For when a ship is floating calmly along, the sailors see its motion mirrored in everything outside, while on the other hand they suppose that they are stationary, together with everything on board. In the same way, the motion of the earth can unquestionably produce the impression that the entire universe is rotating [Copernicus, 1978, I.8, p. 16].*

Sayılı referred to the Copernicus' predecessors as well as successors. According

to Michał Kokowski, it is the most significant feature of Sayılı's book (Kokowski 2009, p. 253). From one side, Sayılı drew attention to the fact that Peurbach and Regiomontanus stressed the importance of the sun in relation to the universe (Sayılı, 2012, p. 121). However, Regiomontanus criticized an idea of Eearth's movement so he cannot be treated as a predecessor of heliocentric system (Kokowski, 2009, p. 71). It is to be noted that Copernicus „refers to the advantage of explaining different phenomena with one and the same cause, which in this case is the motion of the earth" (Sayılı, 2012, p. 127). On the other side, "Copernicus had thus taken an initial and non-reversible step in the process of the birth and growth of modern science. His theory was bound to inspire new and fruitful ideas and to lead up to the Newtonian synthesis" (Sayılı, 2012, p. 213).

Sayılı indicated some of Copernicus philosophical assumptions, for example:

> *[Copernicus] uses such terms as the harmony or symmetry of the word, or his references to aesthetic considerations" (Sayılı, 2012, p.104);*
>
> *the sun must be the most important body in the universe. […] the centre must be the most important part of the universe" (Sayılı, 2012, p.128).*

On the other hand, according to Sayılı, "We should not allow the fact that he [Copernicus] occasionally uses such [philosophical] terms" because he did not derive his system from "metaphysical lore or that vague tendencies and predilections" (Sayılı, 2012, p. 104). Hence, although there are lots of philosophical theses assumed by Copernicus, based mainly on Aristotle's philosophy, Sayılı emphasises more the influence of natural science on Copernicus, not philosophical assumptions: „Copernicus did not frame his new theory under the influence of philosophical tendencies" (Sayılı, 2012, p.104). And in this point there is a place of Aristotle's authority, as Sayılı wrote: „Copernicus leaning toward physical astronomy was, generally speaking and in its fundamental characteristics, like that of the Aristotelians" (Sayılı, 2012, p. 114).

Copernicus was called by Sayılı "sole and solitary violator of the sacrosanct doctrine" (Sayılı, 2012, p. 120) who worked on his heliocentric system for a long time. According to Sayılı, the order of preparing papers was as follows. Prior to 1506 or 1507, after his discovery, Copernicus prepared a draft form of his book. Then, between years 1512-1514, he wrote a small six-page manuscript called today *Commentariolus*[4] (Sayılı, 2012, p. 115) and this work was never printed, only sent as a gift to Copernicus' friends. However, Birkenmajer argued that *Commentariolus*

4 The whole title is as follows: *Nicolai Copernici de hypothesibus motuum coelestium a se constilutis Commentariolus*. It contains concise presentation of heliocentric model of universe. It is the first version of Copernicus heliocentric model, there are some difference between model from *Commentariolus* and *Revolutionibus* (Birkenmajer 1900a, p. 71).

was prepared around 1507 and it was the first Copernicus heliocentric writing (Birkenmajer, 1900, p. 70). This point of view is commonly repeated by current Polish historians of science (Dobrzycki, 1975, p. 133; Kokowski, 2009, p. 69; compare Rabin, 2010).

Copernicus frequently referred to Plato and Neoplatonic philosophers in *De Revolutionibus* and *Commentariolus*. Some scholars suggest that Renaissance Neoplatonism, especially the philosophy of Marcilio Ficino (1433-1499), encouraged Copernicus in assigning the sun a special role in the universe. Sayılı did not broadly discussed the influence of Plato's and Neoplatonic on Copernicus' discovery (Sayılı, 2012, p. 119) and the question on Ficino' philosophy impact is completely omitted. However, I would like to stress the fact that Ficino's books were in university library in Cracow when Copernicus studied there and it is likely that Copernicus had his own copy of Ficino's 1484 Latin Plato (Knox, 2002, p. 405-406). Nevertheless, it is a question from whom Copernicus grasped the idea of exalting the sun. There are the five main assumed solutions to this question:

1. From Peurbach and Regiomontanus as suggested by Sayılı: "Assertions concerning the great importance of the sun in relation to the universe, pointing out its function as a powerful source of heat and comparing it to a pilot or a ruler, are found also in Peurbach and Regiomontanus […] It is possible […] that such ideas […] came to the attention of Copernicus during his stay in Italy, through his teacher Domenico Maria Novara, Regiomontanus had, in his correspondence with Novara's teacher Giovanni Bianchini" (Sayılı, 2012, p. 121).
2. From Philolaos, who displaced the earth from the centre of the universe and assumed that in the centre of everything rested Cenral Fire and it is not the sun. The sun and the earth made a rotation around central fire (Sayılı, 2012, p. 119-121).
3. From ancient tradition, for example, Cicero, Lucretius, Pliny, Sophocles, Hermes Trismegistus (Knox, 2002, p. 409, 411; Birkenmajer, 1924).
4. Direct from Ficino's philosophy: Given that Copernicus consultes Ficino's Latin translation of Plato, it is very tempting to suppose that Ficino was Copernicus' source, or at least one of his sources" (Knox, p.414, comp. 408, but Knox doubt in this suggestion).
5. From Jan z Głogowa's lectures, who was Copernicus' professor at the University of Cracow and knew Ficino's *Liber de sole at lumine* (1489) (Wasiutyński, 2007, p. 71).

At that point it should be noted that

> *What preoccupied Copernicus philosophically was the earth's motion, not the sun's location at the centre of the universe.[…] If we want to argue that Ficino's philosophy, or Neoplatonic philosophy generally, made a decisive contribution to Copernicus's hypothesis, then it is not Copernicus's sun symbolism but his arguments in support of geokinesis that should hold our attention (Knox, p. 411, 412).*

Copernicus learned little or nothing of importance for his heliocentric hypothesis from Ficino. Ficino's revival of Neoplatonic philosophy would have to wait for another generation – Bruno, Galileo and Kepler – before it made a decisive contribution to the development of modern science (Knox, p. 418).

At the end of this item I would like to make a remark on Sayılı's book from more general, European's culture point of view. Even through Copernicus was compared to other great scientists and humanist of his times, Sayılı did not mentioned the influence of Copernicus' discovery on next generations of humanist. And it was very significant. At this point, a word should be said about I. Kant (1724-1804), J.W. Goethe (1749-1832), F. Nietzsche (1844-1900) and S. Freud (1856-1939). They assumed that due to Copernicus discovery on the Earth not in the middle of the universe, the position of man became lower. As a consequence, human beings were not any more privileged observers of the universe. What is more, it was seen as an important reason of nihilism and atheism in European thought since XVIth century (Kokowski 2009, p. 98, 263). I give you an example of Nietzsche and Goethe arguing:

> *Ist nicht gerade die Selbstverkleinerung des Menschen, sein Wille zur Selbstverkleinerung seit Kopernikus in einem unaufhaltsamen Fortschritte? Ach, der Glaube an seine Würde, Einzigkeit, Unersetzlichkeit in der Rangabfolge der Wesen ist dahin, — er ist Thier geworden, Thier, ohne Gleichniss, Abzug und Vorbehalt, er, der in seinem früheren Glauben beinahe Gott („Kind Gottes", „Gottmensch") war… Seit Kopernikus scheint der Mensch auf eine schiefe Ebene gerathen, — er rollt immer schneller nunmehr aus dem Mittelpunkte weg — wohin? in's Nichts? in's „durchbohrende Gefühl seines Nichts"? (Nietzsche, 1887).*

> *Of all discoveries and opinions, none may have exerted a greater effect on the human spirit than the doctrine of Copernicus. The world had scarcely become known as round and complete in itself when it was asked to waive the tremendous privilege of being the centre of the universe. Never, perhaps, was a greater demand made on mankind — for by this admission so many things vanished in mist and smoke! What became of our Eden, our world of innocence, piety and poetry; the testimony of the senses; the conviction of a poetic — religious faith? No wonder his contemporaries did not wish to let all this go and offered every possible resistance to a doctrine which in*

> *its converts authorized and demanded a freedom of view and greatness of thought so far unknown, indeed not even dreamed of. (Goethe, 1808).*

Or another one made by I. Kant. Copernicus changed the place of the sun and the earth as Kant the place of subject and object:

> *we assume that the objects must conform to our cognition. […] We here propose to do just what Copernicus did in attempting to explain the celestial movements. When he found that he could make no progress by assuming that all the heavenly bodies revolved round the spectator, he reversed the process, and tried the experiment of assuming that the spectator revolved, while the stars remained at rest. We may make the same experiment with regard to the intuition of objects (Kant, 2003, B XVI).*

Sayılı focused only on scientific influences of Copernicus ideas, he did not mention any Copernicus' impact on European culture and humanities although it was significant as well.

Medieval Islamic/Arabic World and Copernicus

The influence of Islamic/Arabic and especially Ottoman Turkey's tradition on Middle Ages and the Renaissance in Europe is obvious (Birkenmajer, 1900, p. X). The transmission of scientific ideas was not only in the subject of astronomy but also in cartography, trigonometry, medicine etc (Sayılı, 2012, p. 168-169). As Rosińska wrote*:*

> *It is true that Cracow astronomers in the fifteenth century were more interested in the works of Islamic astronomers than in West European compilations […] During the registration of astronomical treatises known in Cracow in the fifteenth century-a work carried out by the Center of Copernican Studies at the Polish Academy of Sciences-there came to light in numerous copies the treatises of Masha'allah, Abu Mas'har, Abu Bakr, Sahl ibn Bishr, al-Farghani, al-Kindi, Thabit ben Qurra, al-Rasi, al-Quabisi, al-Hasan ibn al-Haytham, Ali ibn abi'r-Rijal, Ali ibn Ridwan, and Jabir ibn Aflah (Rosińska 1974, p. 239).*

It is only a question of details and it should be stated that the full description of influence of Islamic/Arabic scientists and philosophers on Copernicus is not finished (at least in is not published in European languages). Copernicus mentioned directly five Islamic/Arabic astronomers in the full version of *De Revolutionibus*:

Averroes (1126-1198) – once, in book I, ch. 10;

Alpetragius (d. 1204) – once, in book I, ch. 10.

Al Battânî (850-929) – 19 times, in book I. ch. 10, book III, ch. 2, 6, 9, 13, 16, 17, 20.

Arzachel – four times, in book III, ch. 2; 14, 17, 20.

Thabit ibn Qurra – twice, in book III, ch. 13, 14.

Sayılı did not refer to Arzachel and Thabit ibn Qurra.

Long time before Copernicus the Arabic/Islamic astronomers critically referred to Ptolemy's astronomical system and it is emphasised by Sayılı as well (Sayılı, 2012, p. 135). He mentioned Marâga Observatory founded in 1259 (Sayılı, 2012, p. 136, 169). The activity of Marâga school was widely described by Sayılı in another book (Sayılı 1960).

What is more interesting, there are some similarities between geometrical, mathematical and astronomical solution assumed by Copernicus and astronomers from Marâga school, despite works of Tûsî and Shâtir they were rather not translated into Latin (Rosińska, 1974, p. 239). Sayılı enumerated the impact of Islamic/Arabic tradition on Copernicus in following subjects:

"[…] the model used by Copernicus to correct this glaring discrepancy of the Ptolemaic model with observed facts was based on the use of secondary epicycles in the same way as it was utilized […] by the Islamic astronomer Ibn Shâtir" (Sayılı, 2012, p. 135).

"Parallelism also exists between Ibn Shâtir and Copernicus' models serving to account for the motions of Mercury and Venus" (Sayılı, 2012, p. 135-136).

"As Copernicus generalized the use of Ibn Shâtir's double epicycle device by applying it to planetary motions, Ibn Shâtir's model for lunar motion is considered to have been a source of inspiration for Copernicus" (Sayılı, 2012, p. 136).

"In Ptolemy's model for Mercury one of the constituent motions took place along a straight line segment. Copernicus replaced this by a device consisting of two circles […] The small circle rolls within the larger one, always remaining tangent to it. […] This device had been utilized […] by […] Nasîr al Dîn al Tûsî" (Sayılı, 2012, p. 136).

Nevertheless, Sayılı drew attention to the fact that the above mentioned astronomical solutions "pertain to the technical refinements" which did not cancel "The fundamental innovations brought by the Copernican theory" (Sayılı, 2012, p. 136).

Now, I would like to go back to the Tûsî device, broadly discussed in the Copernicus' literature. It was very important solution from philosophical point of view because there were two different kinds of motions in the Aristotelian tradition. As it is well known, the circular motion takes place in celestial region (between the moon and stars), the rectilinear below the moon. The so called Tûsî device shows "that rectilinear motion can be produced by the combined action of two circles and demonstrates (although Nasîr does not mention it) the unten-

ability of the dogmatic view that celestial and terrestrial motions are essentially different" (Hartner, p. 12). It was one of reasons why Copernicus' cosmos is not Aristotelian any more. What is more, the Copernicus' earth became a planet and was in heaven. In consequence, rectilinear motion became "a heavenly phenomenon as well" (Rosen, 1985b, p. 115).

The combination of two circular movements into a harmonic one was used by Copernicus twice. Firstly, in *Commentariolus*:

> *If in fact this oscillating motion occurs along a straight line, it is nevertheless possible for a motion of this kind to be produced by a combination of two spheres (Copernicus, 1985, p. 87).*

Secondly, in the third book of *De Revolutionibus*, chapter IV, Copernicus explained how the pendulum movement is composed from two circular movements.

What is more, it is not only similarity in the ideas. There is a drawing and the proof of the process in *De Revolutionibus*. And the Copernicus' drawing is very similar to the one presented in Tûsî's book *Tadhkira* (Hartner, 1973; Saliba, 2009) when he explained the combination of two circular movements. The main and still open topic is the problem of the similarity between the Copernicus' drawing and the drawing given by Tûsî. Hartner wrote that "even Copernicus' lettering is the same as Nasîr" (Hartner, 1973, p. 12), other historians of science emphasised some differences there (Vesolovskij, 1973). There are at least three main solutions assumed by different historians of science working in this subject (comp. Kokowski 2009, p. 77–79).

1. Copernicus knew Marâga school's works, it is only the question where and when as well as in which form he learned those works. Since Copernicus did not know Arabic he must have read the work in Latin translation when he studied in Italy (Swerdlow, Neugebauer).
2. There is no proof that Copernicus borrowed the combination of two circular movements into a harmonic one from Islamic/Arabic scholars. It is very important to realize that Albert Brudzewski, Copernicus' professor from University of Cracow, "knew the composition of circular movements into a linear" was impossible (Rosińska, 1974, p. 240). Brudzewski wrote on it in 1482, in his commentary to Peurbach:

> *Some people imagine that the moon has two epicycles, a bigger and a smaller one in which the moon is contained. This is how the superior epicycle is moving in the movement of declination and reflection. And that is why the spot appearing on the moon appears always at the same place. Without that additional epicycle this would have been impossible (Rosińska, 1974, p. 240).*

> *Nevertheless, this idea was introduced earlier, in 1430, in work written by Sandivogius of Czechel, on Geradus' Theorica planetarum:*
>
> *In order to save the apparent movement of the moon and to prevent the consequences that might be at variance with the philosophy of nature, the moon's sphere should be integrated into seven orbits .... The seventh one finds itself in the very depth of the epicycle and moves along in the direction opposite to that of the epicycle and yet equal to it, while carrying the moon's body in such a way that it is fixed to that orbit. And the orbit has been assumed to justify the fact that the spot on the moon's disk always appears in the same disposition (Rosińska, 1974, p. 241).*

3. The principle of adding circular movements (called Tûsî device) is present in Proclus commentary to Euclid's *Elements*.

At this point, a word should be said that Sayılı did not discuss the subject of producing straight line motion from two interlocking spheric motions.

Sayılı's conception of history of science

Although it is not a goal clearly expressed by the Turkish historian of science, he pointed out at least three tasks of history of science in the *Introduction* to the book *Copernicus and his Monumental Work*: to show a broader context; to describe the mental process, to collect ever existing questions immemorial, to indicate when an important work is duly grasped (Sayılı, 2012, p.104).

The main task of history of science is to show new idea in a broaded context**.** As Sayılı noted:

> *the person of our central figure must needs not be taken in isolation either from the intellectual background from which he derived his motivations and inspirations or from his impacts on future lines of development. […] ideas of wide scope are more significant than those pertaining to matters of detail (Sayılı, 2012, p. 101).*

There are four kinds of the background: present and future; knowledge and historical events. Hence, Sayılı realized the task to describe Copernicus' achievements from the four points of view: (1a) knowledge present to Copernicus, (1b) historical events important to his discovery; (2a) knowledge as a repercussion of his discovery, (2b) historical events as a consequence of his discovery. It is an objective task of history of science. Let me illustrate those tasks with Sayılı's words:

(1a) „the fund of knowledge which was available to him and was conductive to the formation of the most significant of his ideas. […] To interpret the Copernicus ideas against the historical background" (Sayılı, 2012, p. 101)

(2a) " the new world view expounded by Copernicus had wide and profound repercussions" (Sayılı, 2012, p.101).

Other astronomers and philosophers mentioned previously drew their inspiration from Copernicus: Tycho Branche, Galileo, Kepler, Newton, Descartes. They „enunciated new doctrines or propounded new theories, they did so in the spirit of Copernicus (Sayılı, 2012, p. 215).

On the basis of his vast and often first-hand knowledge Sayılı competently did a statement that Copernicus " took a nonreversible step in the intricate process of opening the new age and closing the old one" (Sayılı, 2012, p. 100).

To realize this objective task is a part and parcel helpful stage in order to gain Copernicus "mental picture of the genesis and growth of his theory " (Sayılı, 2012, p. 101). It is a subjective task of history of science described by Sayılı in a following way:

> *Try to reconstruct with certitude and in its actual details the mental process by which Copernicus arrived at his word-shaking discoveries. […] To gain a reliable mental picture of the genesis and growth of his theory by helping us get hold of his seminal ideas (Sayılı, 2012, p. 101).*

The Turkish historian of science added that his task could be sometimes wellnigh hopeless (Sayılı, 2012, p. 101), however, he managed to do it.

The two mentioned above tasks of history of science allow us to show a new idea as an answer to "long-standing question of major importance" (Sayılı, 2012, p. 101). This one I would like to call the third task of history of science.

As a result it might be said that Copernicus' genius arose from all achievement of his time. Sayılı's history of astronomy is a part of history of all sciences and humanities and, what is interesting specially to me, the philosophy of science is not mentioned by him in the book *Copernicus…* However, it is still open question whether dealing with history of science is or is not involved into philosophical assumption, especially in the conception of pattern of scientific development.

Sayılı's book on Copernicus did not give us the answer to the question what kind of science the history of science is: 1) a branch of history, 2) a branch of science, 3) an inter-disciplinary science,4) a trans-disciplinary science. I am only sure that he did not assume history of science as a branch of philosophy.

There is one more subject to mention here. Sayılı studied together with Thomas Kuhn in Harvard University in the 40-s in 20th century. Sayılı and Kuhn were strongly connected with George Santor, the professor of both of them. Santor was "one of the foremost pioneers in the field of the history of science and one of the most central figures in securing for it the status of an independent academic discipline" (Turker-Kuyel, 1996). Sayili

> *obtained his Ph.D. degree in the history of science in 1942 from Harvard University which was apparently the first such degree to be given in that discipline anywhere (Turker-Kuyel, 1996).*

Kuhn graduated from Harvard in 1943 where he received his master's degree in physics in 1946, and his doctorate in 1949, also in physics. (Bird, 2013). Kuhn is an author of famous book on Copernican revolution published in 1957 and an author of changing paradigms in science (presented in Kuhn 1962). Santor distinguished two specializations in history of science: "vertical" and "horizontal". Sayılı's "horizontal" specialization in the history of science was the World of Islam and "vertical" history of physics " (Turker-Kuyel, 1996).

Sayılı and Kuhn did not collaborate although they both worked in the field of history of science, graduated the same university and studied with the same professor. Sayılı was mainly a historian of science, Kuhn mainly a philosopher of science. However, I would like to indicate some expressions from Sayılı's book which show that they have little in common. There is an example of thinking in the spirit of Kuhn's theory when Sayılı wrote that in Copernicus' time two systems Aristotelian and Ptolemaists lived side by side and Copernicus' new theory replaced them both (Sayılı, 2012, p. 114). What is more, Sayılı used some expressions peculiar to Kuhn. For instance, Sayılı wrote on anomalies in planetary motions (Sayılı, 2012, p. 123) or the „second inequalities, i.e., the cycles of stations and retrogradations in planetary motions" called „anomalies" (Sayılı, 2012, p. 125). He used the expression "scientific revolution" (Sayılı, 2012, p. 100), too. I shall add that both words: "anomaly" and "scientific revolution" are also present in *De Revolutionibus*. And the quotations below are worth taking into consideration in the aspect discussed here:

> *The Ptolemaic system was unable to answer questions concerning planetary distances and their sequences. […] the Copernicus system had all of sudden clarified those problems and thrown light on them in an unexpected manner (Sayılı, 2012, p. 113).*
>
> *The key to Copernicus' success in inaugurating a new era in the history of science lies herein. The Copernican system was not only superior to the Ptolemaic system from the standpoint of astronomy, but it was also equal to the task of rivalling Aristotelian physics on favourable terms (Sayılı, 2012, p. 162, compare p. 208).*
>
> *Copernican revolution was undoubtedly pregnant with new developments, and its essential feature was characterized to a greater extent by its constructiveness. […] But the closing of the one era and the opening of the other were not two distinct and contiguous or consecutive processes; they rather merged together and overlapped, to large extent at least (Sayılı, 2012, p 100).*

Others Copernicus' achievements

Copernicus is word-wide known due to his heliocentric system, however it is only one of his achievements. One of many other was mentioned by Sayılı. He described Copernicus' contribution to the calendar reform, which was quite an important topic of his days:

> *Copernicus' help was sought in the work for adjusting the calendar. But at that point Copernicus thought that time was not ripe as yet for such an undertaking. He was of the belief that calendar reform had to be based on more precise knowledge of the length of the year and of the motion of the moon than was available at the time […] The calendar reform was made finally by Erasmus Reinhold in 1582. Actually, it was made on the basis of astronomical tables prepared by Reinhold, however "they in turn were based upon those of the De Revolutionibus (Sayılı, 2012, p. 139–140).*

He formulated an economics law, according to which "bad money drives out good", later referred to as the Gresham-Copernicus law. Copernicus wrote two papers on money and published them in 1519, 1526. There was a historical and economical ground to write those treatises described by Rosen as follows:

> *Paper money had not yet been introduced. Ordinary business transactions were conducted with coins made of an alloy of silver and copper. Without fanfare, the percentage of silver to copper was being steadily reduced by the authorities. The resulting economic dislocation was carefully considered by Copernicus in a study which is the earliest entirely empirical discussion of the monetary question (Rosen, 1985a, p. 169).*

Copernicus is connected with Turkey not only because he mentioned many times Al Battânî (born in Harran, that time Mesopotamia, now Turkey) or because of Sayılı who wrote a very good book on the background, significance and the consequences of Copernicus' revolution. It is not a common knowledge that Copernicus did a translation from Greek into Latin and published in 1509 letters of manners written by Byzantine historian, Theophylactus Simocattes**,** who died in 640 in Istanbul. This translation was published in Cracow in 1509 and was dedicated to his uncle, bishop Lucas Watzenrode of Varmia. Those letters are translated into English and advices given by Simocattes are still relevant. Let me give you an example of it:

> *After borrowing you were happy. When you are asked to repay, you are said. And when you encounter your creditors, you are paralyzed with fright as through thinking that you are falling into some dreadful horrors. You look about you at the crossroads and inspect the doors in your desire to avoid the wrath of your creditors, just as people in danger of shipwreck during a big storm seek refuge in a harbour. Moreover, you add misfortune to misfor-*

> *tune. For you pay back your debt to some by borrowing from others. This is the behaviour of those who, out of fear of dying, destroy themselves. But borrowing brings manifold troubles to people and is more dangerous than the spontaneous regeneration of the legendary hydra. In accordance with all sound thinking, beware of borrowing. For in that way you will be free to gaze at the sun's rays and quite calmly breathe the open air anywhere (Simocatta, 1985, p. 34).*

Conclusion

The aim of my paper is to present Sayılı's book *Copernicus and his Monumental Work* in broader context of philosophy and Polish tradition. I hope there is a renaissance of Copernicus' achievement coming to Turkey related to the first edition of Copernicus' *De Revolutionibus* translated into Turkish. It is a good reason for extended-ing discussion of impact of Arabic/Islamic astronomy on Copernicus and Copernicus' impact on Arabic/Islamic development of astronomy. The knowledge exchange between our both cultures and civilisation was and still is significant. If there were not Islamic contribution to astronomy, there would not be Copernicus' revolution. If there had been no celebration of the 5th hundredth anniversary of Copernicus' birth in Poland, there would not have been Sayılı's book on Copernicus. I would like to finish with the following Sayılı's sentence – and as far as my knowledge is concerned I can say I completely agree with him: "*It may be said that […] Copernicus succeeded not only to bring about a revolution in astronomy but also made a substantial contribution to the birth and growth of modern science" (Sayılı, 2012, p. 150)*. In other place Sayılı wrote: "about a century before Copernicus, the illustrious Turkish astronomer Uluğ Bey had asserted that science oversteps national and linguistic boundaries and is invariant with respect to time" (Sayılı, 2012, p. 216). And I wholeheartedly agree with Uluğ Bey, who died two decades before Copernicus was born.

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