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MATHEMATICAL VIEWS IN 16TH CENTURY DUBROVNIK

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ABSTRACT: In his work *Dialogo sopra la sfera del mondo*, Nikola Nalješković understands mathematics in the Aristotelian tradition, whereas Miho Monaldi accepts Plato's point of view in the work *Irene overo della belleza*. Platonic interpretation of mathematics in late-sixteenth-century Dubrovnik indicates a tendency toward new mathematical and natural philosophies.

Several books about astronomy, physics and philosophy of nature were written in Dubrovnik in the 16th century, but there was not even a single mathematical study. However, there are some works in which, although they treat other issues, direct or indirect mention of mathematical questions can be found. The first among them is *Dialogo sopra la sfera del mondo*, written by Nikola Nalješković (before 1510-1587), which dealt with the celestial sphere and was published in Venice in 1579. The second one is Miho Monaldi's (1540-1592) *Irene overo della bellezza*, which was also published in Venice in 1599 after the author's death, alhough it is assumed he had written it a few years

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before he died, most probably as a result of the discussions that were usually held in the cultural circle influenced by Nikola Gučetić.

In *Dialogo sopra la sfera del mondo* Nalješković comments on the medieval astronomical research about the celestial sphere by Sacrobosco, a book that was published several times from the invention of printing until the end of the 16th century. Nalješković's research contains five dialogues, the first of which was dedicated to mathematics, while the remaining four represent an astronomy commentary on four chapters of Sacrobosco's astronomy. The identical five chapters of which the first one discusses mathematics can also be found in the author's books which were written as comments on Sacrobosco's work. Among these are the 16th century authors Alessandro Piccolomini and Christopher Clavius.[1]

Nalješković was very much influenced by Aristotle, not only in astronomy and philosophy of nature but also in mathematics. This is why he, like Aristotle, divided mathematics into two fields - arithmetic and geometry, and following the Aristotelian theories he determined their fields of research. There are two different kinds of quantities (quantita'), said Nalješković, discrete and continuous ones. The discrete quantities are multitudes (moltitudine) and the continuous are magnitudes (magnitudine). The former are numbers and the latter represent geometric elements. Consequently, arithmetic deals with numbers and geometry with geometric elements. The difference between them is in the fact that discrete quantities can increase infinitely but cannot be divided infinitely into whole numbers, while the continuous quantities can be divided infinitely. The first quantities (discrete ones), according to today's nomenclature, are natural numbers and arithmetic deals only with them. Continuous quantities are such as, for example, a line which can be divided infinitely.

In his further studies Nalješković explains geometric terms such as point, line, surface and solid, giving them definitions which were based on Euclidean studies. Therefore, his definition of a point is: A point is so little that it can be neither enlarged nor divided. After he gave his definition of a line, which similarly to Euclidean definition was a simple longitudine without any width, Nalješković elaborated some of the Aristotelian explanations regarding this issue and so he did when he explained the terms of surface and solid. Strangely

[1] Alessandro Piccolomini, *La sfera del mondo.* Venezia:1566; Christopher Clavius, *In sphaeram Joannis de Sacro Bosco commentarius,* Venezia:1596.

enough he only superficially mentioned the triangle, circle, pyramids and other similar terms without entering into any deeper explanation.

Nalješković's comprehension of mathematics was completely based on the Aristotelian theories. In contrast, Miho Monaldi's mathematical points of view were quite different, and followed the Platonic theories phenomena, which could also be found among some other members of Nikola Gučetić's cultural circle.

In *Sopra le metheore d'Aristotile*, which was published twice, in the years 1584 and 1585, Nikola Gučetić chose Miho Monaldi as an interlocutor with whom in a sort of dialogue he discussed the phenomena in terrestrial area taking the Aristotelian theories as a starting point. At the beginning of this dialogue Gučetić praised Monaldi as an erudite and a very distinguished man who, as he pointed out, was his close friend, too.[2] Serafin Crijević pointed out that Monaldi had made a fantastic progress both as a philosopher and a mathematician.[3] Francesco Appendini was of the same opinion.[4]

Miho Monaldi[5] wrote many books, most of which were unfortunately lost. Only three of them were published by his nephews. Among the lost studies there might have been some mathematical ones too, but it is not known to us. Monaldi's mathematical points of view could be estimated only according to his studies about beauty in which Monaldi comments on mathematics.

Although Monaldi nowhere explicitly expresses his views on mathematics, throughout *Irene overo della bellezza* it is clear that his ideas about mathematics are those of Pythagoras and Plato. Mathematics for him would have an extrasensory reality, out of which the world of experience is a part that supplements it and is its copy. Mathematics is present in natural things and it represents the order of things. Order, however, does not come out of mathematics, as many of his contemporaries thought, but on the contrary, mathematics derives from order. According to Monaldi, and in accordance with Platonic ideas, the order is perfect in celestial parts, so that numbers derive from celestial order.[6]

[2] Nicolo Vito di Gozze, *Sopra le Metheore d'Aristotile.* In Venetia: 1585, p. 1r.

[3] Serafin Crijević. *Bibliotheca Ragusina*, vol. III, JAZU, Zagreb, 1977, p. 473.

[4] Francesco Maria Appendini. *Notizie istorico-critiche sulle antichitB storia e letteratura de' Ragusei*, Tomo II, Ragusa: Martecchini, 1803, p. 70.

[5] On Miho Monaldi see the book by Ljerka Schiffler-Premec, *Miho Monaldi: Ličnost i djelo. Zagreb:* Odjel za povijest filozofije, 1984.

[6] Michele Monaldi, *Irene overo della bellezza*. Venezia: Salicato, 1599, p. 48r.

Mathematics deals with numbers and figures, so it is divided into arithmetics and geometry. But there is also a correspondence between natural things and mathematics, so in the same way as a species derives from other species in nature, in mathematics figures derive from other figures, and numbers from other numbers.[7]

Mathematics here is not the subject of discussion, but it is intermediately introduced through discussions about beauty. Namely, beauty exists in ratios, which is a component of a particular forms. Perfect beauty can be found in celestial part that is spheral, and the sphere is the perfect form. Beauty can be found in natural things, but in artificial ones too, such as palaces, houses, loggias, arches, columns etc., in which geometric structure is given.[8] Apart from that geometric beauty there is arithmetic beauty too, which contains number in its base.

Several times in the Pythagorean sense Monaldi points out that numbers are reduced to figures.[9] But figures are also connected with celestial spheres.[10] On the other hand, musical harmonies can also be found in celestial bodies, that is, in the proportion of distances between planets and the centre of the world.[11] That is how Monaldi connected arithmetics, geometry, astronomy and music in a Pythagorean and neo-Platonic sense into a unique system of quadrivium.

Writing about order in the universe Monaldi mentioned the order of spheres. Starting from the outer sphere of fixed stars, other spheres continue in the following order: Saturn, Jupiter, Mars, Sun, Venus, Mercury and Moon.[12] Monaldi is thinking about perfect celestial area in the Pythagorean and Platonic sense, so the perfect beauty is the beauty of the celestial area, and this beauty is accepted directly from the intellective world, and then it is transferred to the terrestrial area in which, under influence of celestial order, the order is also achieved. In this terrestrial area the highest sphere is that of fire, which keeps the contiguity with the celestrial area, then beneath it there is air, then water and finally earth.[13]

7 M. Monaldi, *Irene overo della bellezza*, p. 119r.
8 M. Monaldi, *Irene overo della bellezza*, p. 48r.
9 M. Monaldi, *Irene overo della bellezza*, pp. 48r and 119r.
10 M. Monaldi, *Irene overo della bellezza*, p. 48r.
11 M. Monaldi, *Irene overo della bellezza*, p. 141r.
12 M. Monaldi, *Irene overo della bellezza*, p. 59r.
13 M. Monaldi, *Irene overo della bellezza*, p. 59v.

The transfer of influences from celestial to terrestrial area is done by the planets' light which reaches the terrestrial area. In this sense Monaldi shows the same attitude as most of his contemporaries. Monaldi interprets this problem through astrology. For him Jupiter and Venus are very beautiful and useful planets. The Sun is generous and superb, and the Moon has no vice. Mercury is wise and other good planets support it. On the contrary Mars and Saturn are noxious. Such a qualification of values and influences of planets was characteristic for almost all medieval authors, as they had taken this concept from the Arabs. Monaldi points out some outstanding phenomena which prevents sunlight from reaching the Earth, and first of all there are the solar and lunar eclipses. When the Moon comes between the Earth and the Sun there is a solar eclipse, and a lunar eclipse occurs when the constellation of the Earth is between the Moon and the Sun. In these constellations the influence of the Sun and the Moon is reduced.[14] Monaldi also mentions that we must not think of the influence of Mars and Saturn as noxious ones, but only less good and useful, as they have less light.[15] All the planets, nevertheless, are used for keeping and reviving the existence of things in the lower parts.[16]

This interpretation of astrological influences has its roots in the Arabian interpretation of the Aristotelian teaching about the influences of the celestial area on the terrestrial ones. When interpreting the structure of the world his friend Nikola Gučetić was also influenced by Aristotle and his interpretation of natural phenomena were within the framework of the Aristotelian teaching. The same Nikola Gučetić, on the contrary, represented the Platonic interpretation of beauty, and wrote a book about it.[17] Gučetić, similar to Monaldi, connected mathematics with beauty.

In the end we can say that there were two concepts of mathematics in 16th century Dubrovnik. One was the Atistotelian, as for example in Nalješković's research of the celestrial sphere. The other was Platonic, as in Nikola Gučetić's and Miho Monaldi's research about beauty. The Platonic understanding of mathematics in Dubrovnik at the end of the 16th century was very important,

14 M. Monaldi, *Irene overo della bellezza*, p. 77r.

15 M. Monaldi, *Irene overo della bellezza*, p. 78r.

16 M. Monaldi, *Irene overo della bellezza*, p. 77r.

17 Nicolo Vito di Gozze. *Dialogo della bellezza*. Venezia: Ziletti, 1581. About this study see the book by Ljerka-Schiffler-Premec. *Nikola Gučetić*. Zagreb: Studentski centar Zagrebačkog sveučilišta, 1977, pp. 15-28.

because the predominance of mathematics enabled a gradual transfer to other concepts of the natural philosophy. Even a slight sign of such an understanding by the Dubrovnik authors of that time showed that there were such trends in Dubrovnik at the end of the 16th century.