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Science-philosophy relation and the prevalence of the heliocentric theory

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Abstract. The relation between philosophy and science has passed from many phases in history and still is an interesting topic. The value of falsifiability (or refutability) in science was stressed by Popper. Here, as a paradigm, the juxtaposition of the Earth-centered view of the universe and the prevalence of the heliocentric theory is examined. A new physics appeared in the West in the 17^{th} century, under the Cartesian philosophical canopy, the spirit of which had its deep influence on the savants of that period. This new physics, as defined by Galileo and Kepler, was not searching for purpose, but it was seeking for causes.

Key words. History of science – Philosophy of science – Natural philosophy

1. Introduction

In science, according to the philosophical view of Descartes (1986), doubt should be present in any problem arising in order to avoid possible errors and prejudices; through doubt we can be led to the discovery of an indisputable truth. So the Cartesian doubt in the area of science is the main methodological starting point, which leads us to the proof. Science is doubt and falsifiability (or refutability). Karl R. Popper (1959), for example, was critical against the inductive methods used in science. All inductive proofs are limited, he said, while he taught that falsifiability should replace the ability for verification as a criterion of the difference between the scientific and the non-scientific. Science is seen more in the frame of an unending search for objective knowledge, more than in the frame of a knowledge system. The principle of falsifiability is for Popper (1934) the criterion for the scientific or non-scientific character of a given theory. Thus, astrology, metaphysics and the Marxist theory are classified as *pseudosciences* because of their incapability to be subjected to the application of the falsifiability principle. For example, in a religious dogmatic structure there is no phenomenon that can refute the core of the theory and there is nothing that can make the foundations of the structure tremble. In science, when something new is discovered, anything that contradicts, even partially, to the prevailing scientific theory, then, sooner or later, the theory is replaced by a new theory. According to Popper (1959) scientists should rather try to disprove their theories than to verify them time and again (Theodossiou 2008, p.232). But let us consider our main topic, namely the prevalence of the heliocentric system and the controversy it created between science and Aristotelian and Platonic Earth-

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centered philosophy, which had been adopted by the Church. When Galileo observed with his telescope the four large satellites of Jupiter, in 1609-1610, the geocentric theory suffered a fatal blow, in spite of the reactions that followed by various scholars and the Roman Catholic Church, which had incorporated geocentric system as its favored one. For a certain period relations between the two camps were so tense that blood was shed in their sake; but it was rather the relation between the prevailing dogma and the coming change that made that happen, and not the relation between philosophy and science. It is an indisputable fact that the adoption of philosophical positions (which should be equally non-dogmatic with scientific theories) by religious, and hence dogmatic, institutions, hindered for a long time the development of knowledge and hence science. Giordano Bruno was burned at the stake because he was teaching the infinite worlds of philosophers Metrodorus of Chios and of Epicurus, and he questioned the prevailing geocentric system. Similarly, Galileo stood trial on suspicion of heresy and he was condemned into house arrest because the heliocentric system he was supporting was at odds with the Old Testament, according to which Joshua ordered the Sun to stop (and not the Earth) during the Gibeon Battle of Israelis against Canaanites.

2. Later incidents of opposition to the heliocentric theory

The revolution for the observation of the heavens came in 1609 by Galileo (1953), when for the first time in the history of astronomy he used a dynamic and pioneering instrument, the telescope, which gave him the ability to discover wonderful things in the firmament: from the phases of Venus to the 4 large satellites of Jupiter, a miniature planetary system. That year belonged to the first decade of the 17^{th} century; a century that marked a period of multiple crisis. Philosophy, religion and science itself found themselves into a maelstrom that shook the foundations of Western society, engulfing in its whirl the foundations of astronomy, the science of the heavens. The "peaceful" geocentric and at the same time egocentric system that was prevailing for many centuries gave its place to the correct heliocentric one. A new physics appeared in the West in the 17^{th} century, under the philosophical canopy of the Cartesian philosophy, the spirit of which had its deep influence on all his contemporary savants. This new physics, as was defined by Galileo and Kepler, was not interested in searching for purpose, but rather it was seeking for causes. The teleological model of understanding the Universe had now been fully unleashed from the bondage of Aristotelian philosophy. From the study of history and philosophy of the sciences it can be said that this was the time the subject is placed as central entity on the philosophical stage; however, its place is not secured, in spite of the blows against the "traditional" view on nature and human by the new science. It may be that the crucial role for the liberation from Aristotelism, or for this revolution of the natural sciences, belongs to the dynamical appearance of the new astronomy, which put the Sun in the place of the Earth; yet, several explanations have emerged based on a much wider understanding of the big change that took place in Italy and Western Europe. At least two to three centuries before 1609, the West was a boiling pot. Great scholars, such as Jean Buridan (*ca.* 1295-1358), Nicolas d' Oresme (1323-1382), Nicolaus Cusanus (1401-1464), Copernicus (1473-1543) and many others in the natural sciences, centuries before Galileo and Kepler, based on the Pythagorean and pre-Socratic Greek natural philosophers, had added their small stone to the building of the new physics; at the same time, they had ignited the great change in science and in the way to understand natural phenomena. A change that, stemming from the mentality shift in astronomy, was now focusing attention to switching the European scientific thought from theory to practice, through experiment, observation and the use of mathematics and their methods. Galileo (1564-1642), the first physicist with the modern meaning of the term, rejected through his experiments the common perception for motion, setting the base for modern mechanics, while Descartes (1596-1650) gen-

eralized the re-explaining of everyday experience and proposed a new image of reality beyond experience. Descartes (1986) tried to show through his philosophy that nature's reality is not similar to what our senses present to us. Our world is not a finite wholeness with an impeccable internal structure, as it was presented in Aristotle's view of Cosmos. Things changed in new astronomy, too; scholars, liberated from the tightly closed and powerful crystal spheres, started to talk about an infinite Universe that didn't have or was controlled from a natural hierarchy, while its unity was a result of laws governing it, laws valid for all its parts.

3. Why the heliocentric theory proponents were persecuted

The revivalist of heliocentric theory, Copernicus, was according to Martin Luther *"the fool who wanted to overturn the science of astronomy"* (Theodossiou 2007). Later on, Giordano Bruno was burned for his views and ideas, while Galileo was put under house arrest. Why? The answer lies in the fact that these scientists, by indicating the weakness of the geocentric theory were undermining in an essential way the egocentric philosophy of the man-centered Universe. The human-centered view was inherent in all ancient astronomy, capitalized with the Ptolemaic view for the Cosmos (with the Earth at the center of it). To this the view that human is the central creature of the Creator and everything else revolves around him, dovetailed nicely. The rare independence of thought combined with an integrated knowledge of astronomy and cosmology, a knowledge not easily attainable at that age, were the necessary prerequisites for Copernicus, Bruno, Galileo and Kepler (Koyré 1961) to expose persuasively the superiority of their heliocentric system version. That great proposition of Copernicus, which revived the heliocentric theory of Aristarchus of Samos, not only paved the way towards modern astronomy, but also helped to bring a decisive change in the way humans were facing the Universe. When people grasped that the Earth was not the center of the Universe but instead just one of the Sun's planets, the illusion of the central importance of humanity itself lost support. Therefore, the heliocentric theory was not favored by the Church because it did not comply with the Biblical "positions" and ancient Greek geocentric theory. When science contributed to the fall of the anthropocentric myth, first by showing that the Earth, the abode of man, is not the center of the Universe and next by showing that even human itself is a product of evolution, then the separation of its philosophy from the philosophical position of the Church was definite. Therefore, a kind of war was waged against the heliocentrists, not just because the system they supported was at odds with the Scriptures, but also because geocentric theory, which supported an absolutely motionless Earth, was in agreement with the "divine scientist" Aristotle. Since Aristotle had deeply influenced the mediaeval Catholic theology, the rejection of the geocentric theory would diminish the authority of the great philosopher and consequently the theology. It thus became clear that the support of the geocentric theory was essentially an issue of authority. This was the main reason Pope Urban VIII (1623-1644) moved the procedure against Galileo and included the work of Copernicus in the *Index Librorum Prohibitorum* (Koyré 1957). The space of the Universe in the new astronomy and physics departs from the set of the differentiated Aristotelian spaces, being identified with a homogeneous and isotropic space defined by Euclidean geometry, to finally become in the 19^{th} and 20^{th} centuries the space of non-Euclidean geometries. Kepler, as a mystic person, believed that the Universe was full of secret and transcendental forces. He was convinced that if he plugged the mystic mathematical harmonies into the study of the celestial sphere he could connect the planetary orbits with perfect geometrical solids. According to him, only the motions of the celestial bodies, eternal and perfect as they were, could be analyzed mathematically and geometrically, and astronomy should be based on principles of geometrical simplicity. After the observations and theoretical studies of Galileo and Kepler, the abdication of the

Earth from its planetary throne was a reality. The eternal crystal spheres of the closed Aristotelian geocentric system with the perfect internal arrangement and strict hierarchy gave place to a new cosmology that favored an infinite Universe without any natural hierarchy. Kepler (1992), with his book *Astronomia nova* (1609), came into conflict with the then prevailing ideas. The adoption of the material moving force he proposed was a blow against divinely created cosmic order, imposed in Western thought by Aristotelian physics. Galileo with his pioneering observations and Kepler with his theoretical insight were the true founders of the new heliocentric system and the discoverers of the laws governing our planetary system; both in 1609, with the first telescopic observations and the publication of *Astronomia nova*, which put astronomy on a new base, since Kepler therein presented two of his three laws of planetary motion: The orbits of the planets are ellipses, the one focus of which is occupied by the Sun, and the line joining a planet and the Sun sweeps equal areas during equal time intervals. It can be said that the observational justification of the heliocentric theory began with Galileo and its mathematical foundations were laid exclusively by Kepler. It must be noted that these questions are important not only because the terms "science" and "scientific" dominate in our age (Koyré 1961). The problem of the boundaries of science is also of great sociopolitical importance. The understanding of what is or is not science influences more or less the scientific policy of the State, and this has consequences for the advancement of the scientific or corresponding technological research. For example, some universities keep laboratories dedicated to "paranormal research", which is at odds with natural science and has up to now failed to give a single law for the "paranormal phenomena". Of course, a certain answer to the question of what is science and what gives it its validity and effectiveness could be given - as in the Middle Ages - by resorting to some authority, such as Aristotle or some other ancient philosopher. But it seems that this solution causes problems. A tradition is known about the Pisa experiment conducted by Galileo: in order to disprove the Aristotelian belief that the heavier bodies fall faster than the lighter ones, Galileo released from the Leaning Tower of Pisa simultaneously two objects, one light and one much heavier than the first, to fall to the ground from the top of the Tower. The objects reached the ground at the same moment, not caring for what Aristotle would say. The professors of the University of Pisa, instead of acknowledging Aristotle's fallacy, argued that the two bodies did not reach the ground simultaneously; while some that saw the truth thought that their eyes had played a trick to them, since Aristotle did not agree with that outcome. Therefore, the appeal to any authority does not offer necessarily a good answer to such questions. In the example of the above Pisa experiment tradition one can discern a widely held view of our age concerning what is science. It is the view of empiricism: All knowledge is acquired through experience, the immediate perception of objects and phenomena through our senses. Galileo and Kepler escaped from the view that true knowledge can be acquired only through the study of classic ancient texts, the writings of authorities such as that master of universal knowledge, Aristotle. According to Koyré (1961), the 17^{th}-century scientific revolution smashed the ancient Greek notion of Cosmos, the Aristotelian vision, a world of first impressions, and replaced it with an Archimedean Universe of precision, of space "geometrization" and of measure. The real world is not considered anymore a closed, finite and hierarchically structured wholeness, as limited by the mediaeval approach, which explained the world based on the Bible in accordance with ancient Greek geocentric views; instead, it is an open, infinite and vague Universe, defined by natural laws and by its fundamental components. The clash in the crucial field of cosmology and the different way to approach and study nature was the point of transit to the final theory of the Universe without an "edge". This clash was provoked by the works of great scientists and philosophers of the 16^{th} and 17^{th} centuries, including Copernicus, Kepler, Galileo, Descartes and Newton. As

Bertrand Russell (1946) writes: *"Kepler and Galileo proceeded from the observation of separate events to the formulation of accurate quantitative laws; with their aid future events could be predicted in detail. They annoyed a lot their contemporaries, because not only their conclusions were in stark contrast to the beliefs of that period, but also the blind faith to an authority allowed the savants to limit their researches in the libraries and the professors were utterly upset by the idea that they would have to observe the world in order to learn exactly how it is."* In this passage Russell gives the main characteristics attributed to science by the so-called positivist philosophers, such as John Stuart Mill and Herbert Spencer, or the more recent ones M. Schlick, O. Neurath, R. Carnap and others. In very broad lines, for positivism science means sure and proved knowledge. Science provides the only method to reach absolute certainty. The scientific theories are built based on general and personal prepositions. According to positivism, we start from the partial, i.e. the personal propositions that describe observations, and we end up with the general, that is the universal propositions, which are the laws of science. The two basic principles of the original positivism are: 1. Every piece of knowledge that pertains to events-phenomena is based on the "positive" elements of experience (the term "positive" means affirmative) 2. Beyond the world of natural phenomena there is the world of pure Logic and pure Mathematics. Positivism is secular, anti-theological and against metaphysics; it sticks to the testimony of observation and experience: positive knowledge and experiment. Positivism, by rejecting metaphysics helped to supersede preoccupations of the past and forwarded the development of the logical physical thought. In a positivistic world view, science is considered the way we can discover the truth and understand the world as good as possible, so that we will be able to predict or change it (Theodossiou 2008, p. 94).

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