# PHILOSOPHY AND SCIENTIFIC RESEARCH IN MODERN EUROPEAN CULTURE

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***Abstract***

*The idea of unity was always a philosophy of thought, the ultimate aim of all metaphysical systems. All these systems aimed to overcome the multiplicity of phenomena of the empiric world, seeking a single, absolute principle that would explain them. The difference between philosophical systems consists only in determining the nature of this principle: matter, spirit, etc. Unification was ultimately equivalent to explaining, so that human thirst to explain phenomena was essentially translated by seeking their unity, the only principle which determines, ultimately, all of them. The issue was complicated in modern times, when, following detachment of philosophy and of increasing the differentiation of science, rose, on the one hand, the problem of explaining the unit of the world - thus the relationship between scientific and philosophical knowledge - and, secondly, the question of unity of science itself, of the particular scientific disciplines. Therefore, large modern philosophical systems have addressed, explicitly or implicitly the issue of science unity in close connection with the relationship between philosophy and science, thus knowledge unit problem in general.*

***Key Words:*** *logical empiricism, scientific revolutions, epistemological revolution, knowledge*

## 1. Introduction

Attempts to unify science in modern times have been numerous, but understanding how this unity can be reduced to two main principles: *metaphysical* *and scientistic*. (1) Rationalist conceptions (Spinoza, Descartes, Leibniz, Hegel) believe that science is a field of knowledge insufficiently unified, the complete and essential unity of knowledge can be achieved only in the metaphysical level. (2) Scientist-positivist conceptions of the unity of science (Bacon, Hobbes, Comte, Mach) saw science as a unified sufficient knowledge, with an internal unit, and considered unnecessary or even harmful the attempt of metaphysics. Metaphysical way of unification of science tends to reconcile metaphysics with science, but paying attention, in the traditional sense, to a higher metaphysical knowledge. Scientist-positivist conceptions rejected metaphysics, ultimately, which they consider as an outdated knowledge, in lack of accuracy and objectivity. The old criterion of explaining the complete unification, considered essential by metaphysical systems, is challenged by some modern conceptions which make the explanation of the criterion of accuracy, precision and objectivity, specific criteria of science. By applying different criteria, the two disciplines of human knowledge - metaphysics and science - come into conflict when absolutise specific criteria: the conflict between the scientific explanation, incomplete quantitative, but precise and objective and metaphysical explanation, comprehensive, fully consistent but insufficiently precise and objective. This conflict is based on values of overthrowing the relationship in explaining the world: the criterion of accuracy and objectivity claimed by knowledge of nature, passed before the full unity criterion, called by the eternal needs of the human soul, the absolutized metaphysical criterion.

It should be shown that these pure metaphysical or just scientiste tendencies represent only the extreme positions. Often, inside the dominant scientistic conceptions (Bacon, Hobbes, the French materialists) are metaphysical elements, as inside the dominant metaphysical conceptions (Descartes, Leibniz) are sufficient scientist elements. In fact, Ruytinx grouped concepts of Descartes and Leibniz, which added that of Condillac, in a special category of conceptions of the unity of science: mixed concepts, which subordinate both science and metaphysics to a common unit ideal of methodological nature. It may be noted, however, that this methodological ideal is essentially mathematical, thus scientist. However, these spiritualist philosophers consider, ultimately, metaphysics as fundamental science.

Modern conceptions of science unit may be classified by other criteria: *ontological* - when the key unifying factor is considered the object, the objective world - *epistemological* - when the science unit is based on the spirit of knowledge, on the device structure of our knowledge - or *methodological* - when the primacy of the object or subject is left to a single methodological factor. In the history of philosophy, science unity problem was related to the ideas like: fundamental science, science of science, classification of sciences, encyclopaedia of sciences, etc (3).

In the twentieth century, due to the high degree of differentiation of science and spraying them in a very large number of private sciences, science unit problem has become even more difficult. It is addressed mainly to scientist conceptions. Among them there is also the logical empiricism, which has also methodological and encyclopaedic tendencies. In his attempt to unify science, logical empiricism is based on two principles: 1) scientific caution, not to force, metaphysically, the unifying trend and 2) practicality, unification must consider only the needs of scientific research.

It can not be sufficiently appreciated the effort of logical empiricism (4) to create a unifying trend in terms specking science in so many particular disciplines. We note, however, that logical positivism - Neurath, Carnap, Frank, Rougier – do not follow the development of a *theory* explaining the unity of science as a real fact, but rather catching the action to unify the sciences, an action led by practical principles designed to promote the progress of scientific knowledge. Logical empiricism seeks only the unification of terminology of science, "only the essential unity of auxilliary processes of science."(5) All philosophers’ concepts of science unity are concerned almost exclusively with the unity of science or its unification and concern diversity, at best, as a necessary evil, and the metaphysical ones as simply evil. The metaphysical concepts that have dominated phylosophic thinking until the nineteenth century, the question of the relation between unity and diversity had not only a significant gnosiology but an axiological one: primacy of unity over multiplicity. Knowledge was related to the unit so that any step to increase the unity was considered as a step in the progress of knowledge. Thus of this first unity in knowledge is linked the primacy of metaphysics - regarded as an absolute science, fundamental - above individual sciences. We have seen that, in modern times, with the great development of science, the relationship between metaphysics and science has changed and this change is reflected in scientist concepts. But scientistic conceptions are concerned almost exclusively with the unity or the unification of science. Although diversity is accepted as a fact, or even as a condition for progress of science, the theory deals only with unity. Diversity is not integrated organic of science theory, as a component of it. This is because science is seen as static. But ignoring the dynamic elements, evolution does not allow giving a full, true explanation to science. Moreover, histories of particular sciences concerning these sciences as developing linear in their own substance, without regard to neighboring sciences and with all sciences, they have no explanatory value. Only by integrating the whole of science or knowledge of a particular science can shed light on the meaning and value.

In each historical epoch, science has a particular structure; there is a certain relation between unity and diversity. Therefore, the history of scientific thought must take into account both the unity and diversity as science. Ratio of unity and diversity in science is not fixed but, given once and for all. There have been periods in history of science when the emphasis fell on the unity (during evolution), as there were others, periods of scientific revolution in which the emphasis fell on diversity. The progress of science was not achieved only by successive accumulation of new knowledge or passing from one theory to another more comprehensive and well-founded (evolution), but also by overthrowing the old explanatory schemes, of the old fundamental schemes. In this issue of knowledge of the mechanism for development of science, Thomas Kuhn made a big contribution; he was the author of an interesting and valuable theory of scientific revolutions (6). Developing deep science, says Kuhn, is not linear by staged knowledge accumulation, but by radical leaps, by succession of paradigm that is "universally recognized scientific achievements as a proxy for the research community type problems and solutions." (7) The period where research is done, is based on universally accepted fundamental truths, truths summarized in textbooks and in treaties, Kuhn called it a *normal scientific* stage. When the number and value of anomalies - thus unexplained phenomena in the dominant paradigm - grow, science is entering a stage of crisis, characterized by the struggle between new paradigm, emerging, and the old declining onee. The transition from one paradigm to another is a scientific revolution, "normal development of science" (8). Therefore, in the stage of normal science is a unity of science given by the fundamental principles accepted and generally used methods. The science of each period is a fully structured, within which to determine the conditions of validity of the truths to be discovered by ordinary researchers. Looking deeper at the history of science - studied in the past decade by many scientists - leads us to conclude that science develops in cycles units - certainly incomplete closed and closely related to earlier ones, not in a straight line through simple quantitative accumulation. The old unit splits and then forms a new structure of science. Science is developing gradually, but continuous progress is only within an evolutionary stage when kept its fundamental structure. The great progress of science is done, but by leaps, by revolution, when the coordinates change its explanatory structure and the place it occupies in the assembly of culture and social life. There is therefore a dialectical mechanism of development of science in which we find unity, but also diversity and continuity, but also discontinuity. "It was often noted, says Robert Lenoble, that developing knowledge was not always at the same speed. Some long periods of stability, during which not only details are retouching them, succeed during a downturn when science is radically transforming." (9)

In the era of the first scientific revolution, science structure underwent fundamental change, related especially to changes in the entire culture. During this period gnosiologic human relationships with the world - through science - have been woven with ontological and axiological relations with all forms of human activity, for scientific research is also a form of human activity. In this great historic turning point, the human condition has changed the world and the meaning of his life overturned the ratio of values. All these have favored the development of science in the huge modern era. Indeed, if in the Middle Ages to the fore was the report of man with God - hence the primacy of religion over the other branches of culture - from the Renaissance, the direct relationship of man and nature becomes an increasing value for that, from the seventeenth century, to pass before his relationship with God. Man medieval contemplative attitude towards the divinity took its place modern man's attitude towards nature. Hence the overthrow report of values in culture: religion and theology - in which man sought to improve relations with God - are replaced with modern science and philosophy related to it, by which man tends to improve living in the real world. Thus, the very emergence and development of modern science was due to the changing of human condition in the world of changing relationship with God and with nature.

Revolutionary changes in science during this period are related to changes caused by the whole culture, in part, as an important aspect of it, also science. "Natural Sciences, says Georges Gusdorf, appear as a constituent element of the culture of each period of civilization. Mathematics, physics, and biology returning to the man who created them: they are moments and aspects of the awareness sessions of the human condition that gets better as the spirits in every era of human adventure." (10) Science has influenced culture of the era and first influenced philosophy. Scientific revolutions occurred throughout the conceptual changes have affected the whole picture of world and general way of thinking. In a paper on the Copernican Revolution, Thomas Kuhn states that "its core was the transformation of mathematical astronomy, but it covered the conceptual changes in cosmology, physics, philosophy, as in religion." (11) Scientific revolutions are multidimensional, says the American scientist. They are never confined to one area, but affect several sciences, the whole conceptual framework and ultimately, all knowledge and human thought. Every scientific revolution, Kuhn argues, has two components: a specific, related to science that was done, and other intellectual one, which affects the general concept of the world. "Scientific concepts are ideas and as such they belong to intellectual history." (12) This extrascientific element affects the scientific revolution battle of ideas in that era and therefore, Copernican theory met with a resistence so great of intellectuals from outside science, linked to the old conception of the world. The resistance opposed to modern science by extrascientific factors, writes Georges Gusdorf, "just the fact that astronomy is due to affect the entire universe, the whole mental space, with its systems of axioms and truths taken for granted." (13) As for the link between the scientific revolution and the whole thinking of time, advocates Edwige G. Boriing, which notes, upgrading it, the old theory of the Zeitgeist (14), and K.D. Irani in theory of "conceptual framework" (*conceptual framework*). Replacing the Aristotelian physics by Galilean physics, says Iran has meant transforming the entire conceptual framework and the criteria of objectivity and causality. "It was a revolution in science that has not changed but the theories of physics, but the real criteria of intelligibility and explanation. It was not only a revolution in physics, but also the epistemology of physics." (15) Equally remarkable is pronounced the history of science and philosophy, Al. Koyré. Scientific thought, he said, has no place in an empty space, but "is always within a framework of ideas, of fundamental principles, of axiomatic records that, normally, were considered as belonging to the private property of philosophy." (16)

Producing so profound transformations that have affected the whole conceptual framework of scientific and philosophical thought, scientific revolution of the sixteenth and seventeenth centuries was also an Epistemologic revolution. Such revolutions - that marked the rise of human thought to a new epistemological level, transforming the structure of science and changing its relationship with religion and philosophy - were two in the history of human thought and the third occured in the twentieth century.

The first epistemological revolution occurred in ancient times with the advent of Greek philosophical and scientific thinking through the emancipation of religion and empirism. Indeed, in the ancient Oriental civilizations, thus human thought had, over several centuries, great progress, science was not independent, for general knowledge (philosophy) was the subject of religion and "private sciences" were subordinated to the narrow practice: agricultural, medical, craft etc. In Greek thought, science in the broad sense of the word including philosophy, science considered ideal, is self discipline. Greek civilization "will be the origin of a new conception on significance, role and overall structure of science, the concept much deeper, more abstract and more rational than all that preceded it." (17) Science becomes self-consciousness, becomes universal and critical. Greek scientists emancipated science of narrow and empirical practice. Indeed, knowledge and empirical formulas of the Egyptian become Greek theories and demonstrations with value of science. In the development of thinking, took place the shift from myth to logos and from the empirical to science. In the science about cosmos, they generalize our experience data, of the sensitive perception and common sense. Concrete-sensitive elements - water, earth, air, fire - acquire ontological value representing the essence of matter. Geocentric idea and the difference of essence between earth and sky - cornerstones of ancient cosmology - is also based, on everyday experience (18).

The second epistemological revolution took place in the sixteenth and seventeenth centuries when the modern science and philosophy established. In the Middle Ages had been a second emancipation of religion and even empiricism, emancipation done with ancient independent Greek philosophy and science.

Revolution itself, ie the transition to a new epistemological level, was done by the emergence of modern philosophical thought, science, which, unlike the ancient one, was not based on data and sensitive perception of common sense, but criticized these data, it was based on symbols and mathematical calculations, or on scientific experiences rationally organized, having as an ideal the quantitative determination of phenomena. However, science was not ontologique, was no longer concerned with the first causes, the essences, substances forms etc., but the things and phenomena. Hence the tendency of modern science to emancipate, not only by stepping out of religion, but also of metaphysics, ie the old philosophy that sought to explain things and phenomena by factors which were transcendant of things and phenomena. Increasingly, modern science establishes its own criteria for validation of its truth, different criteria than those of metaphysics. Only now is born the *scientific spirit itself*, opposed not only to religion and empirism, as *philosophical rationalist spirit of antiquity*, but also the *metaphysical spirit*. Science waives final and absolute explanation. However, by accumulating successive relative and provisional truths, science is able to progress.

The twentieth century has brought a new scientific revolution, a revolution in epistemological significance. Points of absolute support on mechanistic science - atomic, mass, space, time, etc. - prove to be relative and relativity theory, quantum mechanics etc. have brought a new scientific spirit, characterized by a greater removal of sensitive perception and common sense. "Every progress of science means a departure from common sense," says Einstein. Gaston Bachelard emerges the new scientific spirit, which is significant for the transition to a new epistemological level, in 1905, when "the Einsteinian revolution demolished the primary concepts were believed to be eternal and unchanging. Starting from that date, reason multiplied objections, dissociated and integrated fundamental concepts, attempted the most daring abstractions." (19)

So, the first scientific revolution was multidimensional, while being connected - as part of it – by the general philosophical and epistemological revolution. Therefore, unity and diversity of science in this period will be pursued in the broad sense of epistemological and spiritual revolution in general.

**2. Philosophy and astronomy**

The beginning stays in a certain way of *discovering* the work of Ptolemy. The study of his astronomical work, which only in the fifteenth century was translated into Latin, meant to appeal to an independent science to find the solution of specific problems of astronomy (20). To the astronomic knowledge of Ptolemy's work, astronomers as Peuerbach and Regiomontanus contributed, who translated it into Latin. The research of these geocentrists brought astronomers a greater contribution to the preparation of Copernican revolution than the cosmological speculative antigeocentriste conceptions of philosophers. Certainly, their influence was undeniable. Philosophers have shaken the general philosophy and traditional science, which no longer appears as absolute and definitive. They created the possibility of adoption or development of other scientific concepts most appropriate needs to explain natural phenomena. Some philosophers have anticipated even concepts that were later confirmed by science. However, philosophical influence on the scientific concepts was indirect and not direct, biased and not conclusive. Astronomers and other scientists have primarily sought scientific solutions to problems posed by special sciences. These solutions were usually found by astronomers themselves. Sometimes they could find in the arsenal of philosophical ideas. But in this case, scientists have operated a selection, choosing those philosophical ideas or suggestions that answered better to the needs of respective science.

Renaissance astronomers call to the theories of antiquity - including the Ptolemaic system - signified an effort of emancipation to scholastic philosophy and retrieval of self-consciousness of astronomy, indeed, for Renaissance astronomy, the first necessary step was not overtaking geocentricism, possibly with cosmologico-philosophical assumptions, but the emancipation of Aristotelian-scholastic cosmology and putting them on their coordinates. Or, that first step of emancipation was made by direct contact with mathematical astronomy of Ptolemy. Without emancipating for philosophy of nature and without orientation to mathematics, Renaissance astronomy would have reached Heliocentrism. First, because the geocentricism had beside the physics of time, and was below heliocentrism, only as a mechanical mathematical model. Then, the church would not permit the publication and dissemination of a heliocentric theory of physical meaning. Once turned on its natural track, Renaissance astronomy could do the next step: overcoming geocentricism. Confronting astronomical theory of Ptolemy's with observations acummulated, scientists have discovered many contradictions. Ptolemy had many additions and corrections in its astronomical system to agree with the facts of observation, that it became very complicated and inoperative to explain the challenges and astronomical phenomena. We are witnessing such a crisis of Ptolemaic system. Renaissance astronomers, who first observed the contradiction between recent astronomical observations, more numerous and more precise than those of the ancient Greeks and Ptolemy's system, were Peuerbaeh and Regiomontanus. They did not have the courage to reject the Ptolemaic system. Other astronomers - Fracastro and Amici - not being satisfied with the complicated system of Ptolemy, but not able to overcome geo-centrism, have appealed to the old prearistotelic geocentric system much simpler, but could not satisfy the Renaissance astronomy.

In these conditions of crisis and the geocentric system of scolastico-Aristotelian philosophy appears *Nicholas Copernicus* (1473 - 1543). He was struck by the same discrepancy between astronomical observations and geocentric Ptolemaic's system. Examining other ancient systems, hoping to find a more satisfactory one, Copernicus could find that some ancient astronomers - Hicetas, Heraclid of Pont and Apollonius of Perga - argued that the Earth moves. The first two felt that the planets Mercury and Venus rotate around the sun, which in its turn rotates with Moon, Mars, Jupiter and Saturn around the Earth. Apollonius went further, sustaining that all five planets known then, rotate around the Sun and this around the Earth. From Archimedes' *Arenerele*, Copernicus was informed of the heliocentric system of Aristarchus of Samos. The idea of Heliocentrism Copernicus had in 1506. In 1512 he even drafted a statement of the principles of the new system of astronomy, but it was never published (21). The main problem was not the idea of heliocentrism, but the correlation of astronomical system with observation and calculations existing facts. For twenty years (1509 - 1529) Copernicus theory confronted with facts, comparing results of observations with different astronomical assumptions.

Noting the contradiction between the observational data and geocentric system, Copernicus had two options: either to deny the accuracy of the observations or to challenge the value of theoretical model used (geocentric system). "If Copernicus means a watershed in the history of scientific thought, this is because, accepting the best observational data (which were later accused of) fixed his attention on whether the change of mechanical scheme of the universe." (22) In the introduction to his famous work *De revolutionibus orbium coelestium*, published only in 1543, Copernicus blamed all astronomical systems on their inability to represent the movements of planets and to remain true to the principle of uniform motion circulations. Influenced by Pythagorean systems and taking into account the astronomical observations, Copernicus developed his heliocentric system. In the finite universe centre, confined to the sphere of fixed stars, is the Sun, around which revolves – by a circular and uniform motion - all planets, including the Earth. The planets did not move freely, but are attached to some cruguri materials as transparent spheres of ancient astronomers. Sustaining the daily and the orbital rotation of the Earth, Copernicus criticized "arguments" based on traditional physics of Aristotle. The system has the merit to uniform and systemize movement of all known planets, based on heliocentric system, the system confirmed by Kepler, Galileo and Newton's subsequent researches. Copernican heliocentric system created the general framework within which later developed astronomy, mechanics and even physics, and marked the "beginning of a radical renewal in the development of astronomy and science in general, beginning of the so-called *new science*." (23) Removing the Aristotelian hierarchy of cosmos, with natural places and privileged directions, Copernicus imagined cosmos with a homogeneous space, the basic requirement for applying mathematics. By integrating the Earth among the other planets, Copernicus unified cosmos (Aristotle divided it into two worlds with different laws and structures) in which run the same general laws. With the unification of the cosmos, he created the condition for unification of science itself, the mechanics of the Earth and Heaven.

Perhaps the most modern part of the Copernican concept was however overcoming common sense - the main lever of Aristotelian cosmology - and founded on mathematical calculations. Copernican system includes traditional elements, refuted by subsequent astronomy researches (24). Copernican cosmos is finite and limited by the sphere of fixed stars, as the Aristotelian-Ptolemaic, but that is slightly larger and differently structured. Circular motion of the planets, which will be invalidated by Kepler's research, is also a traditional element, which has nothing to do with science, but is a belief based on faith in the divine character of heavenly bodies, the only compatible with circular movement considered perfect. Alexander Birkenmayer believes that this traditional element played a positive role in Copernicus' heliocentric option (25). The Polish researcher goes further, arguing that the great astronomer remained the adept of Aristotle's physics, that "there is no contradiction between Aristotle and Copernicus" (26). Copernicus would have changed only some aspects which enable him to support astronomic ideas on daytime and orbital motion of the Earth. Trying to highlight the new *scientific* elements, Birkenmayer minimizes *philosophical* significance and even physical Copernican revolution.

Indeed, inserting the Earth among the other planets, Copernicus overthrew, in principle, the essential opposition of Aristotelian doctrine from the sublunary and the heavenly world. The earth is not opposed - by the constitution and the constitutive material laws of motion – to the other planets. Moreover, Copernicus openly criticized the "arguments" based on traditional physics of Aristotle. Of course, new physics was not created yet, and Copernicus, was criticizing some Aristotelian ideas, and remained the adept to other ones. From the traditional elements of design to a greater part is occupied by Pythagorean ideas. Under the influence of pitagoreic ideas that had a true cult for sun worship, came to Copernicus heliocentric concept. Here is the Pythagorean "demonstration" that the father of modern astronomy founded his idea that not the Earth, but the Sun is the center of the Universe. "Who else, in the splendid temple which is the world, would have put this lamp in a better place, where can light all at once? Indeed, not unjustly some named it as the World eyeball, others Soul or her adviser, Trismegistus calls it visible God, and Electra's Sofocles, the All-seer. For, seated like in a royal throne, the Sun governs the family of celestial bodies that surrounded him." (27)

This is a paradoxical thing. The great idea of heliocentrism, which revolutionised astronomy and created the framework for mechanics and even the birth of modern physics, has used arguments that have nothing in common with science. While boldly defied common sense, basic element of ancient science, Copernicus was not fully emancipated of axiological elements of this science. The essence of the Pythagorean argument is the same as in Aristotle: the place of honor is due to the noblest celestial body. It does not integrate in the Aristotelian concept. Indeed, Aristotle's *upper-lower* position is not *center-periphery*, as the Pythagorean, but *above* (heaven), *down* (Earth). The central position of the Earth is in the geocentric system neutral to the axiological point. In Aristotle, the Earth is indeed considered inferior and therefore is "down", but not limited to the Sun, but to all other heavenly bodies. In the heliocentric system of Copernicus, the Earth is elevated to celestial body, with the same dignity as other planets. It is true that the Sun is considered the noblest and therefore occupies a central place. But among the sun and other planets is not an opposition of nature, such as the heavenly world and the Aristotle sublunary one.

The Heliocentric system was fast enough known in Western Europe. Its adoption, however, was much slower and more difficult. In the XVI century, Copernicus had followers in Germany (Rheticus, Rotmann, Măstlin, Kepler's teacher), England (Record, Field, Digges), Italy (Benedetti, professor of Galileo, Giordano Bruno). Most of his followers of XVI century did not accept Heliocentrism as expressing physical reality of the universe, but only as a working hypothesis as a mathematical new technique, superior to Ptolemaic one. In the way of spreading Copernicism two categories of obstacles stood: some ideological, some scientific. Copernicism was a heavy blow to the religious outlook and Aristotelian cosmology. Therefore heliocentric doctrine has met with strong resistance from the church. But the Catholic Church did not seize from the beginning the antireligious significance of the heliocentric system. A Spanish theologian - Diego de Zuniga - said in 1584 that "The Bible is not in contradiction with pitagoreic conceptions of Copernicus revived today". Some Catholic theologians around the Pope urged Copernicus to publish his work *De revolutionibus*..., which they appreciated as having a high scientific value. "Indeed, the Catholic Church did not seem to have noticed the danger of copernicanism before Giordano Bruno drew the latent consequences." (28) Protestants responded without delay. Luther and Melanchton condemned heliocentrism - even before the publication of the work *De revolutionibus*... - showing that it is contrary to Scripture. This fact determined Ossiander, the publisher of the work of Copernicus *De revolutionibus*..., to introduce a preface - long regarded as the author of it - that gives pure mathematics, theoretical, heliocentric interpretation, presenting it as a simple case of working, without physical significance. It does not the express purpose of Copernican concept, but has made possible its spread and its mathematical exploitation aspect.

However, underlining the strong mathematical aspect was not due only to needs to avoid the opposition of the church. In reality, the heliocentric system did not have time for physical reasons, which Galileo would bring only in the eighteenth century. Hence the only limiting was the mathematical aspect of many followers of copernicanism of the sixteenth century. Another reason for the limited mathematical aspect was that the world was about enough for such metaphysics, that scholastic abused. Therefore, even a representative of the new thought, *Petrus Ramus*, rejects the new astronomy that he considered too laden with physical and metaphysical assumptions, as the old one. He would have wanted "an astronomy of pure calculation and free of any connection with cosmology." (29)

Significant for understanding pure mathematics of astronomy in the second half of XVI century is the conception of the great astronomer *Tycho Brache* (1548 - 1601). It rejects the Copernican heliocentrism supporting a similar concept with Heraclid of Pont and Apollonius of Perga: planets move around the Sun and the Earth around it. Although essentially geocentric, Brache's system precludes the heliocentric only physically. "On the mathematical point of view - but not the physical one - means absolutely the same as the Copernican system." (30) Tycho Brache brings even some physical arguments against the heliocentric system: if the earth were moving, then the beatings of the cannon in Eastern and Western directions should be unequal. The fact that their length is equal has also been an argument against copernicanism (in physical interpretation). In the old physics, dominant then, Brache's argument was perfectly valid. Laying the foundations of new physics, Galileo will successfully combat the arguments of the Danish astronomer.

A confirmation of the new astronomy and also a denial of the old Aristotelian cosmology brought two astronomical phenomena: nova of 1572 and comet of 1577. The emergence of a moving star beyond the last planet, really set the precise astronomical observations, was a heavy blow to the dogma of immobility of the sky, in the sphere of fixed stars. Even more significant of validating new astronomy was the emergence of the comet in 1577. If this comet was in the sublunary world then the phenomenon appeared normal, because there is a world of change, of disturbances. Observations have shown however that it was in the area so supralunary, in the heavenly world, which is still a further element of change in the heavens, infirming the traditional dogma. At researching these astronomical phenomena the leading role was played by Tycho Brache. He also established that all comets trajectories they sought crossed the orbits (Copernicus) or spheres (traditional astronomy) of the planets. By "breaking" these, the Danish astronomer had made an important contribution to the emancipation of astronomy of traditional elements.

**3. Philosophy and Physics**

Unlike astronomy, the physics of the Renaissance was much more modest, bordering the general framework of Aristotelian science. In fact just the absence of new physics explains most of the inertness of Copernican astronomy. But its spread - because of its explanatory and its confirmation by further observations and calculations – meant the important shock of Aristotelian physics that was in conflict and creating the general framework for new physics.

If observations on astronomical phenomena in astronomic space dimensions contradicted Aristotelian science, physical experiences, which allowed so many technical advances, they were at small scale and were in line with everyday experience and common sense - the foundation of peripatetic science. On the other hand "Aristotle's physics, supplemented by the *Mechanic problems*, was presented as a theoretical well-balanced construct, deeply agreeing with common sense and everyday life experiences, and could provide a solid business to reasoning and to practitioner’ activity." (31) The shortcoming of Aristotelian mechanics in explaining the lack of movement could be substituted with *impetus* theory developed in the Middle Ages and the Renaissance, a theory whose assimilation does not generally affect the peripatetic physics.

Unlike mathematics and astronomy, which could emancipate medieval science through a renaissance that resorting to different models of ancient science, physics has not received such a model. Only Archimedes could offer a special science: *static*. However, it was too little to build upon the framing of modern physical science.

The principal and most original forerunner of science, early on in the Renaissance, was undoubtedly *Leonardo da Vinci* (1452 - 1519). The opponent of livresc and speculative science - as was the scholasticism - Leonardo was a genius of technique, or rather of technology, because his technique is not empirical. Methodological perspective that is based on his creation is a combination of experience with math or, more precisely, rational organization of experience and using mathematics. Mechanics - the science that was the basis of its experience and technical inventions - is the paradise of mathematics, said the illustrious representative of the Renaissance. They were, however, in that time, more as goals. With all praise brought to theory, Leonardo did not leave us any work on theory and his inventions were based more on brilliant intuition, often expressed in drawings and analysis of specific cases. And then, his inventions did not require new technique or mechanics. "Leonardo's mechanics is based on Aristotelian principles...with some interpretations and additions - in particular the *impetus* theory - to the scholars of the Middle Ages" (32).

In the XVI century some remarkable progress especially in mechanics were made, thanks to Tartaglia, Benedetti and Stevin - without revolving this science. *Niccolo Tartaglia* (1500 - 1557) laid the foundation of a new science: balistics. But the dynamics behind the *Nova Scientia* - although it is presented in a form *more geometrico* - is essentially traditional. A more important contribution to the development of physics in the Renaissance brought *Giambatista Benedetti* (1530 - 1590), professor of Galileo and great rival of Aristotelian physics. He rejected notions of *hard* and *easy* on the old natural physics which consider them absolute, insisting on their relatives. Benedetti complained that Aristotle denied the real existence of the void and infinite, that he did not see the role of mathematics in natural science and did not understand the motion. He perfected the doctrine of impetus, but he failed to overcome it. Criticizing the empiricist and qualitative physics of Aristotle, Benedetti has sought to build a new physics, from Archimedes’ static and using mathematical methods. He has made an important step towards modern physics, but remained tributary to the old physics by the theory of impetus and understanding movement as a change (Aristotle) and not as a state, as one of modern science.

Remarkable successes have won the physical sciences through Simon Stevin’s researches (1548-1620), named "Archimedes of the Renaissance", indeed; he was inspired by the work and methods of the great Greek scholar, making important contributions to the development of statics and hydrostatics, especially. Experts noted that from Archimedes to Stevin this science did not achieve any progress.

Therefore, the physics of Renaissance - especially mechanics - has obtained remarkable successes in particular technical problems. She won successes in theory, but they relate more to the theory of phenomena in specific areas, without undermining the general theoretical basis of Aristotelian and medieval physics. They have prepared the ground for research of the one that would revolutionize the science: Galileo Galilei.

Also other natural sciences - chemistry, geology, anatomy, medicine, zoology, and botany - have made progress in this period, not covering but overthrowing the old conceptual framework. More important, perhaps even revolutionary success of anatomy was designed to create favorable conditions for the development of medical sciences. The dominant concept in the anatomy of the Middle Ages and the Renaissance was galenic, impregnated with a certain amount of aristotelism. The progress of research in anatomy were decisively stimulated by the process of desanctity of human body, which has allowed a gradual and ever larger scale, making of dissections. The decisive blow that was given to the traditional conception of Galen was *Andreas Vesalius*. In the year that Copernicus published his work *De revolutionibus orbium coelestium*, which has revolutionized astronomy, appeared also the work of Vesalius *De humani corporis Fabrica* (Basel, 1543), "which has revolutionized knowledge about the structure of the human body." (33) As the Copernican revolution, perfected by Kepler, Galileo and Newton initiated the development of astronomy, mechanics, cosmology and even physics contributing to the image of classical science of the universe, so Vesalius' anatomical revolution resulted because of Harwey, Descartes, Lamettrie's subsequent contributions, to the complete emancipation of animal and human body from the supernatural, in its consideration of a mechanism that operates independently and can be studied with objective methods: the animal-machine (Descartes), man-machine (Lamettrie) etc. This work exerted a strong positive influence on medical sciences, because modern medicine is based on anatomy, whose base Vesalius set.

**4. Conclusions**

These are the most significant achievements of Renaissance science, which paved the way for modern science that will be built in XVII century. They are divergent factors from traditional science, which authority undermines. It is true that Aristotelian physics was not yet overthrown, but it was not a fundamental criterion for validating the truths, and some scientists - Benedetti, Stevin and others – attacked it frontally, denying its value. Medieval Renaissance science has undermined gains, contributed to its collapse. Not a less important contribution to the work of dissolution has brought various philosophical concepts of time, which ruined the ontological basis of traditional science. Shocking the conceptual framework of medieval science has led to eliberation of scientific and philosophical thought, which have now become all the ways open. Scientific thinking was integrated in the new spirituality of the Renaissance, characterized by ingenuity, by confidence in the creative capacity of man, with the assertion of originality to great personalities, by boldness and spirit of adventure. All this helped to prepare minds to create - in the seventeenth century - a new science. New was tried on all possible ways. Renaissance, says Al. Koyré, can be characterized by the phrase "everything is possible."

But when "everything is possible" not only truth is born, but error, too. Indeed, given that the old paradigm of science was about disintegration and the new paradigm is not yet formed, safe coordinates were missing, needed for creative spirits to guide and organize the facts of observations accumulated. Often ran out under the control of reason, imagination gave rise to very different concepts, even contradictory, some lower than Aristotle, who at least had a consistent and rigorous logic that was based on a certain natural order. Lack of new ontology or general methodology to establish the conditions of possibility of science explains the existence of a certain disorientation, confusion and credibility that favored the flourishing - with new scientific theories ever - and the *occult* sciences: magic, astrology or alchemy. The presence of elements of magic or astrology we also noted in the systems of Renaissance philosophers: Marsilio Ficino, Telesio Bernardino, Tomaso Campanella, even in the works of new science representatives, as Johannes Kepler.

While he exaggerates by saying that the Renaissance would have destroyed Aristotle's Physics, Al. Koyré is essentially right when he writes that "after having destroyed physics, metaphysics and ontology of Aristotle, the Renaissance found itself without physics and ontology, ie no ability to decide in advance whether something is possible or not. It seems possible that our thinking always prevails over reality, and reality ... is placed in what is possible, in the world of Aristotelian ontology is infinity of things which are not possible, infinity of things that we know in advance that is false." (34) Lack of a single conceptual framework of a general paradigm of science explained the great diversity of views and methods, the coexistence of old science with the new one, of rational and scientific elements with the irationalist and magic ones. All this prove the existence of a crisis of the unity of Renaissance science, diversity dominating unity. In fact, under the lack of a single conceptual framework, was lacking the solid foundation on which a unitary science was built. There were certain partial units - made up of remnants of ancient science or new scientific elements, etc. - but the basic, general unity of science of that time was also lacking.

Renaissance science had a universal international nature, tending to cover the entire field of ancient universal science. "As all cultural movement of Renaissance, writes Francesco Albergamo, scientific research had an international character and found its right conditions of difusion in Italy, Spain, France, England, Flanders, Germany, Bohemia, Poland, ie where bourgeoisie, with its own structures was ruining economic feudal world, it created new forms of life that fosters humanization and secularization of culture in general and scientific and technical progress in special." (35) Thus, the Renaissance science was very little differentiated, encyclopedic and universal. All these demonstrate that the lack of unitary and single science did not mean narrow-mindedness or to limit the areas and isolate disciplines. Indirectly, internationalism, universalism and not specialised science favour its unity. But they could not solve the crisis of Renaissance science unit, essentially characterized by the struggle between old science and new in-training science.

Renaissance science aspires to direct research nature, of things and concrete, private phenomena. Hence the nominalist trend, ie the priority of the individual and of the concrete individual to the universal represented by Aristotelic speculative science. Hence desontologing science, priority on the essence of the phenomenon and of immutable substance, was reducing research on the relationship between phenomena. All this fits into the overall process of dissolution of the old units of science and training of new elements of science directly related to research of particular phenomena. As a consequence of this orientation to the concrete particular, a methodology based on observation and experience was born that will encourage the trend of diversification. This trend has favored by the revival of ancient science in Alexandrian era, an autonomous science towards philosophy and which was representing a certain degree of differentiation from Aristotelian science, dominant in the Middle Ages.

Another important moment was the differentiation of science itself. Instead of a general science of nature, dominant in the Middle Ages, in the Renaissance, appears *astronomy* (previously used in the cosmology, that is, ultimately, in Aristotelian physics), *statics, hydrostatics,* etc. and some very special sciences as *ballistics*, for example. There is, therefore, a certain diversity, only that it not occurred through specialization, but, either through emancipation of general science (astronomy maths) or by the resumption and development of science from antiquity (hydrostatics) or by the formation of new species of Sciences from empirical techniques (ballistics).

Regarding enciclopedism and universalism, specific to Renaissance, they do not relate to science itself, its nature and structure, but especially to consciousness, to intellectual horizon of human culture and science. Universalism and enciclopedism are features rather of humanism than scientism of Renaissance and was manifested primarily in the philosophy. Each philosopher tends to give a unified and comprehensive picture of the world, but these unitary images are very different. The unity is rather of creative consciousness, and that why is individual, not as general and objective as in science. Renaissance Universalism is more the feature of conscience than science.

Renaissance science, as far as science was new, was created by specialist scientists, not by humanist philosophers. It is true that there were many scientists with an encyclopedic base and even humanist. Copernicus, for example, was an astronomer, doctor, lawyer, and theologian and had certainly a philosophical training. However, when he made astronomical research, he had acted neither as a theologian nor the philosopher. Revolutionizing astronomy, Copernicus did not base on the antigeocentrist cosmological concept of Cusanus the philosopher, but from the researches of astronomers including geocentrists Peuerbach and

Regiomontanus. It is true that for the support of heliocentrism, Copernicus also brought arguments of Pythagorean philosophy and was convinced - as in fact some theologians - that his astronomical theory did not contradict religion. However, philosophical arguments are put in the service of a theory based on a special science and possible compatibility with religion did not invalidate the autonomy of astronomy as a special science. Beyond differences in actual, objective science, there is a differentiation and autonomy of science in the conscience of scientists. Empowerment of values began in the conscienceness of major creative personalities and then materialized in particular intellectual disciplines.

While there was not a fundamental unity of all sciences as in the modern era, the science of Renaissance formed the seeds of unity of a new science. Unifying elements are not of ontological nature, but of methodologic and cosmological one. The concerns are about general, all grouped around the two methods: mathematical and experimental, their encounter was at the base of the new science, created by Galileo, Descartes and Newton.

Emancipated itself in a certain degree of metaphysics, science of Renaissance lacks an ontological unity, which the Aristotelian and medieval science had. Instead, the cosmological unity becomes larger than theirs. Indeed, Copernican cosmos is not split in two - supralunary and sublunary world, different in material constitution and prevailing laws - but is a unitary cosmos with a homogeneous space (not structured like the Aristotelian) and dominated by the same general laws. Unification of the cosmos has led to the unification of mechanical science that on Aristotle was split in two: one terrestrial and one celestial. New science, although it would actually be created only in the eighteenth century, the unit would be built on the foundation of Copernican cosmos as in the Renaissance. The new physics, whose base Galileo and Newton would provide, was prepared by Copernican astronomy.

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2. Rationalist conceptions tend to an absolute and cvasitotalitary unity of knowledge.

3. Jacques Ruytinx, *La problématique philosophique de l'unité de la science*, Paris, 1962, pp. 19-21.

4. See also Tomită Ciulei, *De Sensu. Historical and methodological essay of empiricism in gnoseologic exertion*, ed. Lumen, Iasi, 2006, pp. 306-329.

5. Otto Neurath, ”Une encyclopédie Internationale de la Science Unitaire” in *Actes du Congrès International de Philosophie Scientifique*, Paris, 1936, Unité de la Science, Paris, 1936, p. 55.

6. Cf. Thomas S. Kuhn, *The Structure of the Scientifics Revolutions*, Chicago, London, 1967.

7. *Ibidem*, p. X.

8. *Ibidem*, p. 12.

9. Robert Lenoble, ,,Origines de la pensée scientifique moderne,, in *Histoire de la Science. Encyclopédie de la Pléyade*, Paris, Gallimard, 1957, p. 369.

10. Georges Gusdorf, *De l'histoire des sciences à l'histoire de la pensée*, Paris, Payot, 1966, p. 41.

11. Thomas S. Kuhn, *The Copernican Revolution Planetary Astronomy and the Development of Western Thought*., Harvard University Press, Cambridge, 1957, p. VII.

12. Thomas S. Kuhn, *loc. cit*., p. VIII.

13. Georges Gusdorf, *op. cit*., p. 281.

14. See also: Edwig G. Boriing, *Dual Rol of the Zeitgeist in scientific Creativity*, „Scientific Monthly”, nr. 2/1955.

15. Kaikhosrow D. Irani, *Conditions of justification in the History of Scientific Descover*, in *Organon*, 1966, pp. 6-9.

16. Alexandre Koyré, *Influence of Philosophic Trend on the Formation of Scientific Theories*, „The Scientific Monthly”, nr. 2/1955.

17. *General history of science*, published by René Taton, Edit. Ș tiințifică, vol. I, Bucureşti, 1970, p. 205.

18. In Aristotelian cosmology and physics elements of sensitive perception are the starting point of design and everyday experience validation criterion of truth. But not only Ionians, Empedocles and Aristotle betray in their conceptions of experience sensitive data generalization, but the entire Greek philosophy. Even ancient matematism was geometric and figurative, that matematism was qualitative rather than quantitative, as the modern one. Penetrated into deep layers of consciousness, generalization based on everyday experience on sensitive perception influenced the very way of thinking. Plastic-figurative element appears to be characteristic of Greek thought and therefore we find it even in the most abstract concept: To atomistic, to Pythagorean, and even to Plato, which explains the sensitive world by natural elements, elements that are based on compositions of triangular shape. "Greek way of thinking is generally directed to body-ideal creations, a plastic way" - noted Lucian Blaga (*Trilogy of Values*, p. 31). But this way of thinking is not plastic but due to stylistic coordinates with modeling function of the Greek spirit, but is the result of integration into the deepest layers of consciousness of human experience that assumes the metaphysical meanings of Greek culture. Detaching the supernatural, which had the mission to organize the General myth of religion, Greek thought was put into the natural world in which man lives and had proposed to rationally explain the world from the certainties of everyday experience based on sensitive perception.

19. Gaston Bachelard, *La formation de l'esprit scientifique,* Quatrième edition, Paris, 1965, p. 7. This is, in Bachelard's view, the third stage of evolution of the scientific spirit. "The first period, representing pre-scientific phase would also include classical antiquity and Renaissance centuries and new efforts by the XVI and XVII and even XVIII. The second stage representing scientific training period at the end of the eighteenth century and extending over the entire nineteenth century and early twentieth century " (Ibidem).

20. In addition to his work of astronomy, physics and geography, Ptolemy left an interesting philosophy writing entitled Περί κριτέριον καῖ ήγεμονικοο published until 1663. Issues of theory of science are also discussed in his fundamental Μαθηματι ¬ κή συντάξς (Maths syntax). Starting from the Aristotelian classification of the theoretical sciences (mathematics, physics and metaphysics or theology) and practice, Ptolemy separated from Stagira considering that not metaphysics (theology), but maths is the supreme science. By examining the inert and immutable forms of existence - figure, size, space, time - mathematics reached a perfect knowledge. It can provide services to other theoretical and practical sciences rising them to the degree of scientific knowledge. This is very significant for understanding his relationship with Aristotle and for the significance that gave to his astronomical system. The rise of mathematics proves the Platonico-Pythagorean influence and is incompatible with the subordination of astronomy toward physics, as it is in Aristotle and scholastic philosophy. Not mathematics is subordinated to physics, but rather physics must take into account, , in its theories, the results mathematics got. (See Izydora Dambska, *La Teorie de la Science dans les oeuvres de Claude Ptolémé* in *Organon*, no. 8 / 1971).

21. Discovered much later, this work is intitled *De bypothenibus moium coelestum a se constituis commentariobus* was published in 1878.

22. Claudio Constantini, La Scienza net secoli X VII - X VIII. Introduzione, in Grande Antologia Filosofica, vol. XII, Milano, 1968, p. 4.

23. A. Pasquinelli, *Copernico, Keplero, Galilei. Introduzione* in *Grande Anatologia Filosofica* vol. XVI, p, 60.

24. See also Jerome R. Ravetz, *Traditional and Innovatory Elements in The Cosmologie of Nicolaus Copernicus*, in „Organon" no 2/1965 şi Alexander Birkenmayer, *Les elements traditionnels et nouveaux dans la cosmologie de Nicolas Copernic*, in „Organon" no 2/1965.

25. "And although this axiom was not based on purely metaphysical assumptions, assigning heavenly bodies a more perfect nature than the nature of terrestrial things, I consider that it played a positive role during the birth of heliocentric system" (Alexander Birkenmayer, *loc. cit*., p. 43.)

26. *Ibidem*, p. 45.

27. Nicolas Copernic, *Des Revolutions des Orbes Célestes*, traduction par A. Koyré, Paris, Felix Alcan, 1934, pp. 115-116.

28. A. Koyré si R. Taton, loc. cit., vol. II, p. 80.

29. *Ibidem*, p. 79.

30. *Ibidem*, p. 80.

31. A. Koyré si R. Taton, *The physics (of the Renaissance)* in *The general history of science,* vol. II, p. 93.

32. *Ibidem*, p. 98.

33. M. D. Grmek, *Anatomy,* in *General history of science,* vol. II, Edit. Ș tiinţifică, Bucureşti, 1971, p. 146.

34. Alexandre Koyré, *Etudes d'histoire de la pensée scientifique*, Presse Universitaire de France, Paris, 1966, p. 39.

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