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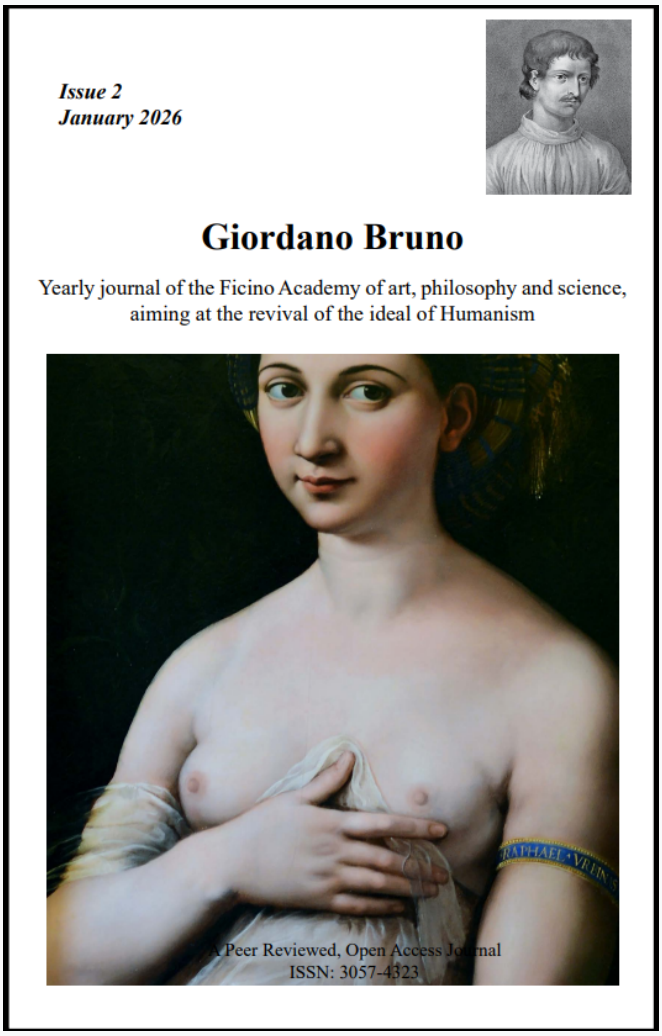

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Foteini Efthymiou

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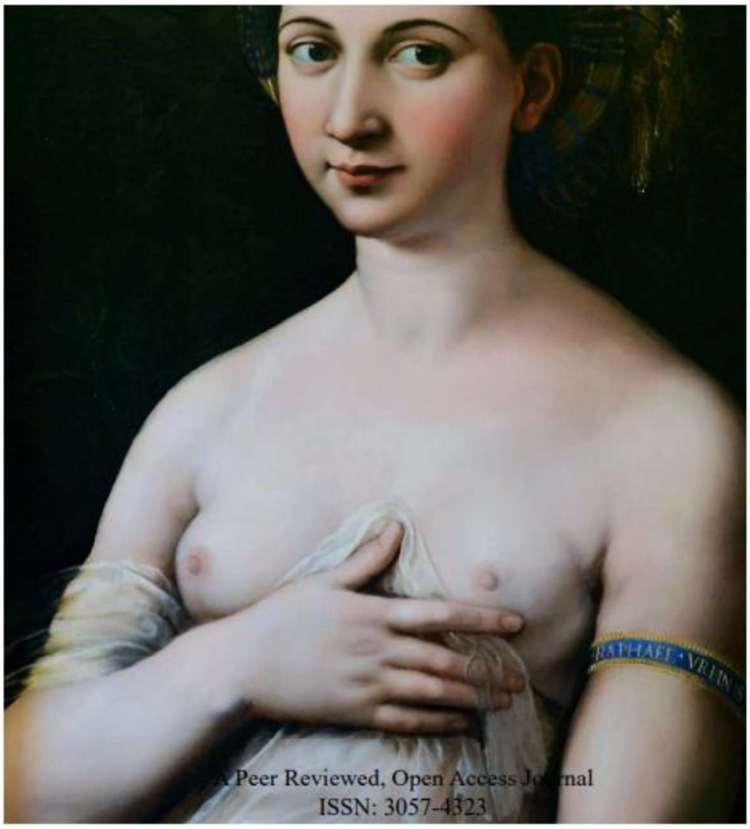

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From Medieval Aristotelianism to Modern Philosophies of Science: Key Stages in the Development of Scientific Thought

Foteini Efthymiou

University of West Attica, Department of Archival, Library and Information Studies

Email: foteuthim@uniwa.gr

Abstract

This essay examines four key periods in the evolution of scientific thought, from the medieval period to contemporary philosophy. It begins with the era of interdependence and tensions between Aristotelianism and theology (from Latin Europe of the Middle Ages to the 14th century). It continues with the period of the scientific revolution marked by Copernicus, Galileo, and Newton (16th and 17th centuries). It then examines modern philosophy through the contrast between rationalism and empiricism (ca. 1650–1780) and concludes with contemporary philosophies of science, from logical positivism to the theories of Kuhn and Feyerabend (ca. 1920–1980). During the Middle Ages, the conflict and attempts at reconciliation between Aristotelianism and theology were articulated both within the University and within the Church, leading to the Condemnation of 1277 and to the subsequent search for new theoretical perspectives in the 14th century. Copernicus' cosmology overturned the geocentric system, while Galileo's empirical confirmation of heliocentrism and Newton's formulation of a general theory of nature established the new scientific conception of the world. In modern philosophy, the fundamental differences between rationalism and empiricism concern both the sources and methods of knowledge and their limits. Descartes grounded knowledge in reason and innate ideas, whereas Locke and Hume emphasized the role of experience and the uncertainty of human understanding. Finally, logical positivism sought to define science through empirical verification and linguistic precision. At the same time, Kuhn and Feyerabend redefined the relationship between science and its historical and social context, highlighting the significance of change, discontinuity, and methodological pluralism. Overall, the development of science from the medieval period to contemporary philosophy constitutes a history of interdependence and opposition among theology, philosophy, and empirical inquiry, in which each stage of evolution has contributed to reshaping humanity's understanding of nature, knowledge, and its place in the universe.

Keywords: Aristotelianism, Theology, Medieval science, Condemnation of 1277, Copernicus, Galileo, Newton, Heliocentrism, Scientific Revolution, Rationalism, Empiricism, Descartes, Locke, Hume, Logical Positivism, Kuhn, Feyerabend, Scientific change, Paradigms, Methodological pluralism, Philosophy of science.

1. Introduction

The present essay offers a concise exploration of the evolutionary history of scientific thought, highlighting four significant periods as its main milestones. It draws primarily on interpretive approaches to the history of science developed by Vallianos (2008), together with related perspectives in contemporary Greek and international scholarship. These approaches provide a coherent historiographical framework within which key stages in the transition from medieval Aristotelianism to modern science can be analyzed. For readability and narrative coherence, most explicit references to this body of literature are placed at the end of each topic discussed.

Its starting point is the dominance of Christianity in Latin Europe during the Middle Ages, a period in which theology emerged as the prevailing science of the era. Theologians defended, at times fervently and at times more moderately, a new framework for understanding the creation and operation of the world, one that differed significantly from that of the Roman period, when cosmology was based primarily on ancient Greek thought. The coexistence of these two intellectual worlds inevitably generated both conflict and interdependence between Aristotelianism and theology. The essay first examines how medieval theology met the ancient Greek logos. It then focuses on the tensions and attempts at reconciliation between faith and reason, specifically between theology and Aristotelianism, both within the University and the Church. Furthermore, it investigates the contribution of Aristotelianism to the emergence and formation of medieval science, up to the Condemnation of 1277 and the developments of the 14th century.

Throughout history, human thought has continually returned to the fundamental questions concerning the origin and functioning of the world. Each era has either sought to extend existing paths and tools in pursuit of true knowledge or to invent and test new methods towards the same end. The second milestone in this journey is the period of the modern conception of nature, which, according to prominent historians of science such as Alexandre Koyré, encompasses roughly the 150 years from 1543, the publication year of Copernicus' work on heliocentrism, to 1687, when Newton's work on universal cosmology appeared. The great figures of the 16th century, such as Copernicus, Tycho Brahe, Kepler, and Galileo, as well as those of the 17th century, including Bacon, Descartes, and of course Newton, waged a courageous struggle against "*authority, tradition, and ... common sense*" (Koyré, 1991, p. 29), gradually leading to a revolutionary worldview. From this perspective, the essay outlines the gradual and challenging transition from Aristotelian and medieval approaches, especially regarding cosmology and the study of motion, to new scientific conceptions. This trajectory first led to Copernicus' heliocentric cosmology, which was later empirically confirmed by Galileo and culminated in Newton's general theory of nature, which synthesized and integrated the work of his predecessors.

From the 17th century onward, philosophical thought, reflecting upon the modern science that had arisen from the "*scientific revolution*", sought its own methods to reveal both the true source and the limits of knowledge. Within this context, two opposing philosophical currents emerged as milestones. Rationalism, founded by the French mathematician and philosopher René Descartes (1596–1650), and empiricism, represented mainly by the British philosophers John Locke (1632–1704) and David Hume (1711–1776). In this third period, the essay will present the fundamental differences between these two dominant schools through the works of their principal representatives and later offer an interpretation of their respective attitudes towards experience.

Logical positivism, a milestone in the intellectual life of the early 20th century and a development of 19th century positivism, underscored the supremacy of science, grounding it upon the principles of logic and empiricism. This rigorously logical interpretation, centered on the principle of verifiability, was also used to interpret the historical development of modern science. However, leading contemporary philosophers regarded it as inadequate, mainly because it excluded as "*metaphysical*" a portion of scientific theory itself. Moreover, it failed to provide a comprehensive account of the scientific phenomenon, which, from modern perspectives, encompasses historical, social, and cultural dimensions. The final section of the essay will therefore examine, on the one hand, the positions of logical positivism and, on the other, the views of two of the most significant representatives of the alternative historicist approach to scientific phenomena, Thomas Kuhn (1922–1996) and Paul Feyerabend (1924–1994).

2. Period I – From the Medieval Era to the Condemnation of 1277 and the 14th Century

Contrasts and Interdependence between Aristotelianism and Theology

Although the Church has often been accused of promoting faith and ignorance rather than reason and learning, historical research reveals a different picture. The Church Fathers, in their spiritual struggle to defend the Christian faith against its intellectual opponents and to elaborate Christian doctrine, had already realized by the 2nd and 3rd centuries the power inherent in the rational tools of classical education. Particularly during the period 1200–1650, a wealth of translations, arising from the fact that the Arabs had preserved Roman and, mainly, ancient Greek science and philosophy through numerous translations and interpretative commentaries, became a valuable "*spoils of war*" in the hands of Western scholars after the reconquest of Muslim Spain in the 12th century. This vast body of knowledge came to form the core curriculum of the medieval university. Central to the instruction were Aristotle's works on natural philosophy, logic, cosmology, and metaphysics, along with the writings of his commentators. Indeed, medieval theologians first studied the so-called liberal arts on an Aristotelian foundation before moving on to theology. The profound explanatory power of these works, especially in relation to major philosophical problems, was the principal reason theologians immersed themselves in them (Lindberg, 1997, pp. 212–213, 239–241, 285–289, 303–305; Asimakopoulos & Tsiantoulas, 2008, pp. 43, 93, 108–109).

Yet this same explanatory power, while intellectually appealing, also dangerously unsettled the established Platonic-Christian worldview of the previous millennium, precisely because it highlighted points of friction between Aristotelianism and theology. The most significant of these tensions were the following:

(a) Is the universe eternal, or was it created ex nihilo (from nothing)? The Parmenidean prohibition against creation from nothing, embraced by Aristotle, implied that the universe did not come into existence at a specific moment but has always existed. For theology, however, this constituted a grave error, since it rejected the doctrine of divine creation of the world.

(b) Can God intervene in the world? In the Aristotelian cosmos, objects possess immutable natures that serve as the substratum of orderly causal sequences, culminating in the Prime Mover. The Aristotelian God, being eternally unchanging, is incapable of intervening in the functioning of the universe. This position conflicted sharply with the Christian belief in a free and omnipotent God who can act within the world through miracles and divine providence and who possesses knowledge of all possible kinds of things that could be created.

(c) What is the nature of the soul? For Aristotle, the soul is the "*form*" of the body, that is, the set of properties and characteristics of every material substance and always exists as a unified whole with its material substrate. Thus, the human soul, as the form of the human body, ceases to exist after death due to the decomposition of the physical body. This view fundamentally contradicts the Christian belief in the immortality of the soul (Lindberg, 1997, pp. 307–311; Grant, 1994, pp. 36–37).

Conflicts and Attempts at Reconciliation between Aristotelianism and Theology in the University and the Church

As mentioned earlier, Aristotle occupied a central place in the curriculum of the medieval university, an institution that operated under the influence of the Church, either through its graduates who had risen to leading ecclesiastical positions, through theology students who taught philosophy as a means of supporting themselves, or through the mendicant orders of the 13th century that advocated active education (Lindberg, 1997, pp. 312–314).

It is therefore natural that the conflicts between the supporters of Aristotelian thought, who sought to strengthen rational activity, and the conservative adherents of Christian theology took place within the very heart of the university. These tensions profoundly affected this vital institution, through which "*Western Europe would organize, absorb, and extend the vast body of new knowledge [...] and would shape and disseminate a shared intellectual heritage for generations to come*" (Grant, 1994, p. 31). As the flourishing universities of Paris, Oxford, and Bologna developed new curricula centered on Aristotelianism, the traditional programs of the cathedral schools began to be displaced (Grant, 1994, pp. 32–33).

Wherever philosophers emphasized the conflict between theology and Aristotelianism, the Church intervened with decrees prohibiting their teaching. For example, in 1210, a decree was issued forbidding the teaching of Aristotle's natural philosophy at the University of Paris. By 1255, these prohibitions began to weaken, while at the same time, in Oxford, the teaching of Aristotle did not provoke similar difficulties (Lindberg, 1997, pp. 305-307).

The Influence of Aristotelianism on the Development and Formation of Medieval Science up to the Condemnation of 1277 and during the 14th Century

The development of Western science in the late Middle Ages continued within the university, with Aristotelianism as its central axis. However, it was not immune to the Church's dynamic intervention, as will become evident. In their efforts to address various philosophical, theological, and scientific issues, several distinguished 13th-century scholars, despite their great admiration for Aristotle and their contributions to the expansion of knowledge of his work, ultimately upheld the superiority of theology. Figures such as the Franciscan master of the Oxford school, Robert Grosseteste, the English Franciscan scholar Roger Bacon, and the Italian Franciscan Bonaventure, followed the Augustinian view that for the Christian, it is sufficient to believe that the cause of all things is the true God (Lindberg, 1997, pp. 314–320).

Nevertheless, Grosseteste, who argued that mathematics provides the reasons for natural phenomena, together with his contemporary Bacon, who emphasized the usefulness of mathematics in philosophical thought, are regarded among the founders of modern science. All these scholars contributed to the normalization of the relationship between medieval theology and Aristotelianism. Certain 13th century thinkers adopted a more liberal stance, seeking a synthesis between reason and faith. The Dominicans Albert the Great and Thomas Aquinas helped medieval science overcome some of its suspicions towards Aristotelianism and assimilate it more thoroughly. Albert is regarded as the founder of Christian Aristotelianism, as he studied Aristotle's works in depth, rejecting only what he deemed erroneous. His successor Aquinas held that reason and faith cannot be in opposition, since reason derives from God. Yet, by asserting that humans discover certain knowledge through observation and reason, he redirected theology towards a genuine engagement with Aristotle and towards the use of more rigorous scientific methods to explain the mysteries of revelation. Both, however, though harmonizing philosophy with theology, assigned to philosophy the role of theology's handmaiden (Lindberg, 1997, pp. 320–328; Asimakopoulos & Tsiantoulas, 2008, pp. 95–99, 119-129).

Inevitably, the systematic engagement with Aristotelian thought led some scholars to positions entirely contrary to the Christian doctrine of creation, making philosophy appear more threatening than ever. A champion of this radical tendency, extreme Aristotelianism, was Siger of Brabant (c. 1240 – c. 1284), who maintained that when philosophy is exercised correctly, without the influence of theology, it yields the correct conclusions. Similarly, Boethius of Dacia, a member of Siger's circle, distinguished between philosophical and theological reasoning and, most importantly, overturned the arguments that had defended the Christian doctrine of creation against the Aristotelians. The conflict reached its climax in 1267, when the conservative Neo-Augustinian Bonaventure (1221-1274) denounced the scholars who supported the eternity of the world and denied the possibility of immortality. Three years later, the Bishop of Paris prohibited the teaching of 13 Aristotelian theses, and in 1277 Bishop Étienne Tempier, acting on papal instruction, investigated the issue further. The result was the prohibition of 219 propositions drawn from Aristotle and various commentators at the University of Paris as heretical. A similar condemnation was issued in England a few days later (Lindberg, 1997, pp. 329–337; Asimakopoulos & Tsiantoulas, 2008, pp. 100-101, 127–130, 200–216; Grant, 1994, pp. 32–42).

What, then, became of the relationship between theology and Aristotelianism after the Condemnations of 1277? Undoubtedly, that year marked a temporary victory for conservative theologians over radical Aristotelianism, but not over Aristotelianism as a whole. In fact, during the following century, Aristotelianism consolidated its position in both undergraduate and advanced education. Yet certain articles of the condemnations raised pressing questions that, in turn, led 14th century scholars, most notably William of Ockham, Jean Buridan, and Nicole Oresme, to propose a series of new hypotheses. These views were characterized, on the one hand, by intense criticism of Aristotelian natural philosophy, questioning its ability to provide specific explanations for issues such as the origin and functioning of the world, and, on the other, by the acknowledgment of methodological distinctions and separate spheres of influence between philosophy and theology, thus establishing a form of "*viable peace*".

Finally, it should be noted that the dominance of the doctrine of the omnipotent God, who could create any world, helped 14th century philosophers realize that the surest way to discover what kind of world God had created was to go out into nature and observe it. And although these philosophers ultimately did not practice an empirical natural philosophy in nature but rather within logic, they nonetheless pointed towards a new path, that of the gradual dismantling of the medieval worldview, paving the way for the Renaissance, the Reformation, and the emergence of modern science (Lindberg, 1997, pp. 335–342; Asimakopoulos & Tsiantoulas, 2008, pp. 135–156).

3. Period II – The Scientific Revolution (16th–17th Centuries)

The Cosmology of Nicolaus Copernicus (1473-1543)

Without conducting observations himself, but rather relying on those of Ptolemy and maintaining the idea that the universe is spherical and finite, with the movements of celestial bodies remaining "Aristotelianly" circular, Nicolaus Copernicus, in his *De Revolutionibus Orbium Coelestium* (1543), announced the following propositions: that not all celestial spheres are reduced to a single common center, a claim false according to Newtonian physics; that the center of the Earth does not coincide with the center of the universe; that the celestial firmament extends much farther than the distance between the Earth and the Sun and is immobile; and that it is the Earth itself which moves, thereby creating the illusion of the Sun's motion. His major contribution lies precisely in this reversal of the prevailing worldview, which, as he himself notes in the preface of his work, is not a mere theoretical conjecture but a physical reality describing the actual structure of the cosmos. The Copernican revolution thus came into conflict with the so-called doctrine of double truth and prepared the ground for an entirely new conception of the universe and humanity's place within it. The Earth, and with it humankind, may have lost the privileged position it once held at the center of creation. Yet, human beings are now called upon to cultivate their innate capacities in order to secure their survival within the vast cosmos that unfolds before them, and to advance towards progress and self-determination without reliance on divine external forces (Papanellopoulou, 2016, p. 12; Vallianos, 2008, pp. 32–33).

As for motion, although Copernicus did not formulate an entirely persuasive alternative to the Aristotelian–Ptolemaic conception, which could not accept that the Earth moves, he nevertheless planted the seed for the future development of science among his successors. He argued that the Earth and terrestrial objects share a common nature. For this reason, all things belonging to the Earth merely participate in its natural rotational motion without being flung off by centrifugal force or left behind. Moreover, a body in free fall appears to follow a straight trajectory, which in reality is curved due to its participation in the Earth's motion. Future science replaced Copernicus' notion of "*common nature*" with a system of bodies sharing the same motion, grounded in the physical rather than the optical relativity of movement (Koyré, 1991, pp. 22–24).

The Empirical Confirmation of Heliocentrism by Galileo Galilei (1564-1642)

In 1616, the year in which Copernicus' work was placed on the Index of Prohibited Books by the Inquisition, Galileo Galilei, a secret but enthusiastic supporter of heliocentrism, was admonished by the Church authorities to cease spreading such unorthodox cosmological ideas. In 1632, he published his book *Dialogue Concerning the Two Chief World Systems*, in defense of the Copernican theory of the Earth's motion, a view for which he was ultimately condemned by the

Inquisition the same year (Drake, 1993, pp. 111, 114–115). As early as 1609, the Italian mathematician and philosopher had constructed his own telescope and carried out a series of observations, the most significant of which included the phases of Venus, demonstrating that the planet revolves around the Sun; sunspots, whose motion he explained as resulting from the Sun's rotation around its axis; the myriad stars of the Milky Way and the moons of Jupiter. These observations, in sharp contrast with the accepted cosmology, strongly supported a heliocentric system, the rejection of the Aristotelian notion of an immutable supralunar realm, and the homogenization of physical space, as well as the idea of an infinite and open universe. One of Galileo's most essential contributions, however, lies in his innovative methodological approach. He was concerned not only with telescopic observation but also with experimentation, particularly with motion. In both domains he focused on the regularities of phenomena, their precise quantitative measurement, and the correlation between the regularity of a phenomenon and the regularity of its causes, thereby rejecting the Aristotelian–medieval conception of the essential natures of bodies, which sought qualitative explanations of the first principles underlying phenomena (Papanellopoulou, 2016, pp. 15–18; Vallianos, 2008, pp. 34, 36–37).

This methodological approach, the mathematical formulation of laws governing an idealized nature, followed by experimental testing of these laws and examination of their implications, led Galileo to the law of uniform acceleration of bodies in free fall and to the principle of inertia, showing that bodies do not move out of a desire to return to their natural place, as the Aristotelians believed. The crucial outcome, therefore, was the emancipation of science from theological and philosophical constraints. Nevertheless, for Galileo, inertial motion, whether celestial or terrestrial, remained circular and uniform, since such motion reflected the harmonious order of a world perfectly organized by God. Mathematics thus attained a supreme, central position in the study of nature, and for this reason, Galileo was considered a Platonist (Koyré, 1991, pp. 31–32; Vallianos, 2008, pp. 36–37, 56–58).

A General Theory of Nature by Isaac Newton (1643-1727)

Isaac Newton made a decisive and universal contribution to the Scientific Revolution by constructing a general cosmology in his *Philosophiae Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy, 1687), "*by which all the men of our age have been educated*" (Gillispie, 1994, p. 135). In composing this work, he relied on Euclidean geometry and the newly developed infinitesimal calculus, emphasizing the value of mathematical description for understanding physical phenomena and concepts (Patiniotis, 2008, p. 47).

In summary, one of his most significant contributions was the mathematical formulation of the definitions of mass, momentum, force, absolute and relative space and time, as well as of the three axioms of motion and inertia. According to the first law of motion, "*Every body continues in its state of rest or uniform motion in a straight line unless compelled to change that state by forces impressed upon it*" a principle demonstrating that Newton legitimized Galileo's transformation of the concept of motion, from an Aristotelian process of change affecting bodies into a permanent and stable state, equivalent to rest (Gillispie, 1994, pp. 133–135; Koyré, 1991, p. 52). According to the second law, the change of motion is proportional to the magnitude of the force that causes it and takes place in the direction of the straight line along which the force is applied. Newton's innovation lies in his transcendence of the 17th-century mechanistic philosophy, according to which one body could move another only through direct contact. Force was now understood as an abstract quantity, its nature unknown but measurable by the change it produces in a body's motion. The third law states that to every action there is an equal and opposite reaction. Another of Newton's major achievements was the validation of Kepler's three laws of planetary motion, which he derived from his own three principles. In essence, he demonstrated that the planets move and are held in their orbits by an attractive force, and, significantly, he turned to the phenomenon of tides as empirical, earthly evidence for his theory (Papanellopoulou, 2016, p. 28; Patiniotis, 2008, p. 39; Vallianos, 2008, pp. 35, 105).

Newton thus concluded that there exists a single force acting on all bodies in the universe, the universal force of gravity, which is directly proportional to the product of the masses of the bodies and inversely proportional to the square of the distance between them (Figure 1). In doing so, he unified "*terrestrial and celestial physics on the basis of gravitational attraction*" (Patiniotis, 2008, p. 46).

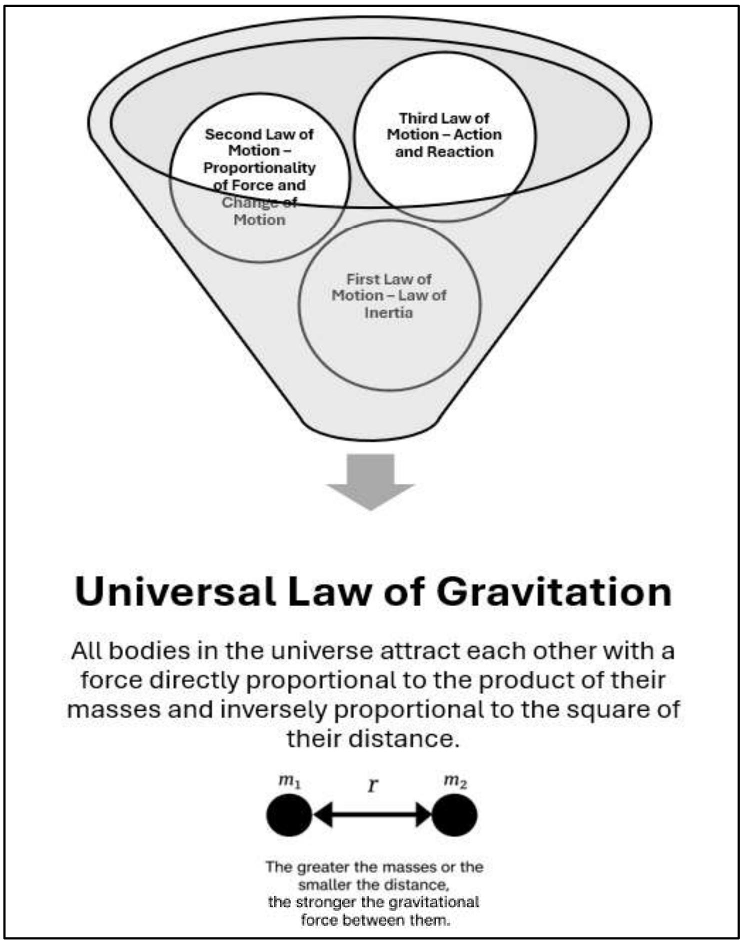

Figure 1. Universal contribution to the Scientific Revolution by Newton

For Newton, the truth of his theory did not arise from seeking the "*why*" of natural phenomena but rather the "*how*" they operate. This approach became evident in his second major work, *Opticks* (1704), where he skillfully described the method of induction, grounded in observation, experience, experimental verification, and accurate prediction, thus offering yet another profound contribution to the Scientific Revolution (Vallianos, 2008, pp. 105, 110, Patiniotis, 2008, p. 40).

4. Period III – Cartesian Rationalism and Empiricism in Locke and Hume (c. 1650–1780)

Fundamental Differences between Rationalism and Empiricism regarding the Source and Method of Knowledge

According to Cartesian rationalism, the human being possesses an innate cognitive power that enables a certain comprehension of truth. This cognitive capacity arises from two distinct mental operations.

(A) Insight, defined as the mind’s ability to achieve an immediate and indubitable apprehension of absolutely simple truths. It differs from sensory perception and imagination because it “*derives solely from the light of reason*.”

(B) Production, defined as the mind's ability to gradually expand specific and true knowledge in all possible directions, which is deduced in a logically necessary manner from already established knowledge (Athanasakis, 2014, p. 4).

This intellectual insight, which serves as the starting point of thought, may also be described as an axiomatic truth, namely a self-evident proposition innate to human consciousness. The emergence of such truths presupposes the precise determination of the method of thinking itself (Vallianos, 2008, pp. 83–84).

The Cartesian method (Figure 2) consists in a logical and deductive order, where things are arranged in series “*according to the sole criterion of the knowing subject’s capacity to infer them one from another, following a linear order strictly oriented from the simplest to the most complex*”. The internal criteria of this rationalist method are themselves axiomatic. First, the thinker must reject as false whatever offers the slightest occasion for doubt. Second, the degree of simplicity of objects as cognitive entities determines the logical order in which the mind conceives and arranges them, beginning with what is “*simple to the highest degree (maxime simplex)*” (Athanasakis, 2014, pp. 2–3, 5).

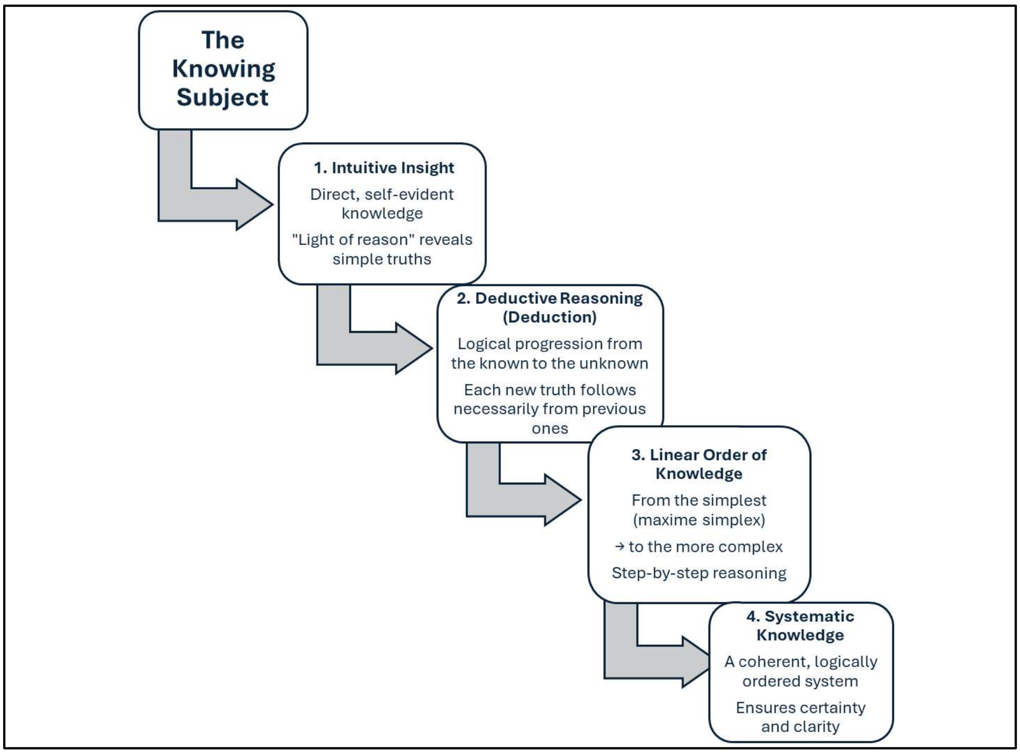

Figure 2. The Cartesian method

On the contrary, according to Locke's empiricism, knowledge does not stem from human's inherent cognitive power, as we saw previously, but from experience. The human mind does not possess innate ideas; rather, it receives various simple ideas as data, through the senses, either from external objects (shapes, colors, tastes, etc.) or from the inner operations of the self (existence, tranquility, disturbance, etc.). These impressions are involuntarily imprinted on the mind, which functions like a mirror reflecting the objects placed before it. From Hume's perspective, however, the empirical content deposited by the senses in the mind merely describes the way we feel and perceive the world. Hume's radical empiricism holds that the entire content of the mind consists of perceptions, which are divided into impressions (the objects of sensing) and ideas (the faint images of impressions in thought). Thus, there exists no idea that does not originate from some prior impression, and the impression itself constitutes "*the pure fact, or, which is the same thing, the origin*" **(**Athanasakis, 2014, pp. 16, 36–39, Vallianos, 2008, pp. 128–129).

The empirical method of knowledge acquisition, according to Locke, rests on the combinatory capacity of the mind. The mind combines the various simple ideas *ex post facto* (after the sensory experience has occurred), whether they possess *primary qualities* (shape, motion, etc.) or *secondary qualities* (color, smell, etc.), forming internal representations of worldly objects. Simple ideas are expressed through words that cannot be further defined (e.g., white, liquid, sweet), and their combinations yield complex ideas (e.g., milk), expressed by a definition corresponding to the natural object it describes. According to Hume's empiricism, however, the method for investigating knowledge is grounded in the "*laws of the association of ideas in the imagination*". More specifically, when one attempts to examine a recurring situation of temporal succession, spatial contiguity, similarity, and so forth between two events, one concludes that there exists a causal relationship between them. Yet this causal relationship is not a law of nature, but rather a feature of human cognition, namely that of habit (custom), which compels the imagination to expect that, once one event appears, the other will follow. Thus, these are the general principles of association, which reveal nothing about the true properties of the inner structure or functioning of nature (Athanasakis, 2014, pp. 40–43; Vallianos, 2008, pp. 123, 129).

Fundamental Differences Between Rationalism and Empiricism Regarding the Limits of Knowledge

According to Cartesian rationalism, the human mind's cognitive capacity enables understanding of nature and its laws through the application of the axiomatic method. In turn, the human comprehension of nature depends on the extent to which a person understands the attributes of its creator, that is, of God. Therefore, the limits of knowledge, though constrained by finite human reason, expand as the human conception of God becomes broader and deeper. From the standpoint of empiricism, the limits of true knowledge begin where the inherent incapacity of the subjective and imperfect senses, as well as of the mind, prevents them from objectively grasping the pure ontological core of experiential data, of both the external world and the inner self. In other words, the "*real essence*" of bodies, that "*something, I know not what*" of Locke, lies hidden behind their appearances. It merely sustains the network of properties that humans are able to perceive, ensuring their stability over time, yet never allowing us to recognize what it truly is (Athanasakis, 2014, p. 14; Vallianos, 2008, pp. 85, 125).

The limits of human knowledge become even narrower according to Hume's skeptical empiricism. Since the empirical content of the mind consists of perceptions (impressions and ideas as faint images of impressions), which arise from a mental habit forming the basis of the subjective belief in a causal connection between things, then "*the validity of all theoretical generalizations about the world is purely probabilistic*" (Vallianos, 2008, p. 129). Moreover, since perceptions, or beliefs, take the place of knowledge, then knowledge itself, as conceived by rationalism (through innate insight and deduction) or even by Locke (through simple and subsequently combined complex ideas) is, by definition, impossible (Athanasakis, 2014, p. 50).

Table 1. Fundamental Differences Between Cartesian Rationalism and Empiricism by Locke and by Hume

Comparative Overview			
Aspect	***Rationalism (Descartes)***	***Empiricism (Locke)***	***Skeptical Empiricism (Hume)***
Source of Knowledge	*Innate reason*	*Experience (sensation & reflection)*	*Habit and association of ideas*
Method	*Axiomatic deduction*	*Observation & Combination of ideas*	*Psychological association*
Limits	*Finite but expandable via divine understanding*	*Bound by the limits of sense and perception*	*Narrowed to probability and belief*
Certainty	*Possible through reason*	*Partial and unstable*	*Impossible*

The Attitude of Rationalism Towards Experience as Reflected in the Work of Descartes

Descartes, in seeking a way out of excessive doubt regarding the reliability of everything, arrives at the axiomatic realization that I, who discover (through insight and deduction) that I am engaging in some mental act, even if that act is one of doubt, therefore think, and thus exist. From this anthropological axiom and based on what has been discussed above regarding the source, method, and limits of knowledge in Cartesian rationalism, Descartes' negative stance towards experience becomes evident. He regards experience as "*the wavering testimony of the senses or the deceptive judgment of a poorly composed idolizing power*". In his *Meditations on First Philosophy*, he observes that the senses, from which he had previously derived everything he had taken as true, sometimes deceive us "*and it is prudent never to trust completely those who have deceived us even once*". This same critique of the uncertainty of sensory experience constitutes the first axiom of his method of thinking, which he formulated precisely in his *Discourse on the Method for Rightly Directing One's Reason and for Seeking Truth in the Sciences* (Athanasakis, 2014, p. 4-5, Vallianos, 2008, p. 82).

Descartes continually justifies his negative attitude towards experience by referring to various examples of the unreliable operation of the senses, such as optical illusions, hearing impairments, and even dreams. A characteristic example is that of the piece of wax, which, although it changes form when it melts, we still regard it as the same substance. He therefore concludes that the knowledge of a thing does not arise from our deceptive senses but from a pure act of thought: "*The mind, working in abstraction from the data of experience, penetrates into the realm of the primary qualities of beings. It then constructs an ideal, mathematical image of reality*" (Vallianos, 2008, pp. 80–81). Thus, for Descartes, mathematics is the only discipline capable of expressing with precision the essence of the structural characteristics of all that exists (Mentzeniotis, 2008, pp. 84–85).

The Attitude of Empiricism Towards Experience in the Work of Locke and Hume

Locke, through his work, established empiricism as the major epistemological movement of the 18th century, which systematically investigated the origin, means of acquisition, and limits of knowledge based on sensory perception. His attitude towards experience as the source of knowledge is not merely positive but foundationally affirming, since he argues that the human mind possesses no innate knowledge, as in rationalism, but rather resembles a blank slate (*tabula rasa*) upon which information is inscribed through the senses, derived from both the external world and the inner self. Locke, however, displays moderate realism towards experience when addressing the issue of the unreliability of the senses. He acknowledges that the objects of both the external and internal worlds, along with their properties, are often imprinted upon the mind as blurred images, a position that rationalism rejects as experience (Vallianos, 2008, p. 122, 124).

Empiricism, nevertheless, makes use of experience to explain that simple ideas, that is, the information the mind receives from both the external and internal environment through the channel of the senses, although often inscribed upon the mind in a blurred or indistinct way, sometimes do correspond to the true properties of things, the so-called "*primary qualities*", such as motion, solidity, or shape. Ultimately, empiricism emphasizes that this correspondence renders sensory data, the primary qualities, the foundation of scientific knowledge of the external world. The remaining simple ideas, however, such as taste, smell, or color, do not correspond to the true properties of things. Nevertheless, objects, by virtue of the arrangement of their *primary qualities*, are capable of producing within us such ideas as those of color, taste, and so forth. Therefore, when applied to science, empiricism can yield at least "*a theoretical image of the natural system that is as close as possible, both logically and practically, to objective reality*" (Glymour, 2007, pp. 141–142; Vallianos, 2008, p. 124).

Hume, perhaps the greatest philosopher of the 18th century, approaches experience with epistemological skepticism, asserting that although it is possible that "*there exists a material world in itself, independent of our senses*", this ultimately cannot be proven (Vallianos, 2008, p. 128). His central conclusion is that induction cannot be justified either by appeal to reason or by appeal to experience. Therefore, belief in laws and theories is nothing more than a psychological habit, acquired through the continual repetition of our finite observations (Chalmers, 2014, p. 29).

5. Period IV – Contemporary Philosophies of Science: From Logical Positivism to the Theories of Kuhn and Feyerabend (c. 1920–1980)

The Position of Logical Positivism on Scientific Change and on the Relationship Between the Scientific Phenomenon and Its Broader Historical and Social Context

Logical positivism, which developed among circles of philosophers primarily in the German-speaking countries, arose in opposition to the irrationalism that spread in the period following World War I, as well as to the totalitarianism of Nazism and Stalinism. At the core of its philosophy lies the theory of meaning of propositions, which holds that a statement is meaningful only if it makes known the conditions of empirical reality under which it can be either verified or falsified. In addition to the theory of meaning, based on the principle of verifiability, important methodological assumptions of logical positivism include the logical analysis of scientific language and the theory that the language of science is composed of both observational and theoretical terms. A further fundamental assumption of logical positivism is that the hypothesis, which the scientist must formulate in such a way as to allow for its experimentally testable consequences, also serves a heuristic function. Through the identification of the most robust hypotheses, the so-called context of discovery is established, followed by the context of justification, that is, the experimental verification or falsification of their consequences.

Consequently, logical positivism recognizes experimental science as the sole genuine instrument of progress. Although it refuses to legitimize a purely theoretical term unless it can be correlated with physical processes and entities, it ultimately accepts that such a term, despite lacking empirical meaning, is nevertheless necessary for the logical formulation of any hypothesis. For this reason, logical positivism adopts the hypothetico-deductive observational method, which endows a theory with "*an internal logical structure that allows a series of conclusions to be derived from its basic assumptions*". The aforementioned fundamental assumptions of logical positivism outline, albeit briefly, its identity, from which both its normative and descriptive character can be deduced. On the one hand, it sets strict boundaries and norms governing scientific practice and ethics; on the other, it maintains that only within these limits and based on these norms can the scientific methods employed from the Scientific Revolution to the present, be effectively described (Vallianos, 2008, pp. 163-176).

This regulative character of its fundamental assumptions inevitably leads to a conception of science that is closed to the historical and social context within which it is formed, practiced, and occasionally transformed. Science, enclosed within the strict boundaries imposed by these assumptions and grounded in certain true propositions, the so-called axioms of mathematical logic, has only one possible course: a continuous, linear, and unified progression towards true conclusions, the so-called theorems. A continuous and linear progression, because true conclusions arise cumulatively from the experimental testing of the ever-increasing observational data of empirical reality. Precisely because of this position, the proponents of logical positivism attribute to science the scepter of the one and only well-founded truth and of objective progress, in contrast to other forms or practices of knowledge-seeking. A unified progression, because even in cases where older scientific theories must give way to newer ones, the latter do not reject but rather incorporate the former as "*special cases*" (Theodorou, 2008, pp. 89–90).

Kuhn's Position

This stereotype of an introverted, linear science, placed at the highest pedestal of cultural forms and refusing to acknowledge any extra-scientific factors in its development, found its counterpart in the 1960s through Kuhn's philosophy (Vallianos, 2008, p. 201). As a physicist who later turned to the history of science, Kuhn realized that a more complete theory of science must also include its historical dimensions. According to his definition, the scientific phenomenon aims to identify certain core concepts and goals of collective consciousness, which take shape within a network of "*worldviews and practices that characterize the cultural condition of a given society*" (Chalmers, 1994, p. 139).

Starting from this pursuit, the various revolutionary scientific changes take place. These changes constitute the distinct markers of scientific progress and development.

The model that briefly depicts scientific evolution or otherwise the structure of scientific revolutions, based on Kuhn's theory (Figure 3), concerns the following:

- Pre-science, namely the period of uncoordinated activity of immature science.
- Normal science, namely the period of scientific and cultural consensus and verification of the existing theory, which leads to the foundation of the so-called "*Paradigm*". During this period, scientists devote themselves to solving puzzles related to the central scientific problems and are characterized by a strong confidence in their eventual solution. However, this confidence is accompanied by a fundamental tension, since the discovery of new aspects of reality gives rise to anomalies that the current theory is unable to accommodate.
- Crisis, namely the period during which a critical mass of negative experimental data accumulates, leading on the one hand to a climate of uncertainty, and on the other hand to the emergence of new, groundbreaking hypotheses.

- Scientific revolution, namely the period during which the new Kuhnian "*Paradigm*" emerges, understood as a morphological shift, a discontinuous and asymmetrical scientific leap, which cannot be objectively evaluated.
- The new scientific community now claims authority, and once this authority is established, a new period of normal science follows, one that, after some time, will eventually lead to another crisis (Chalmers, 1994, pp. 139–156; Vallianos, 2008, pp. 201–207).

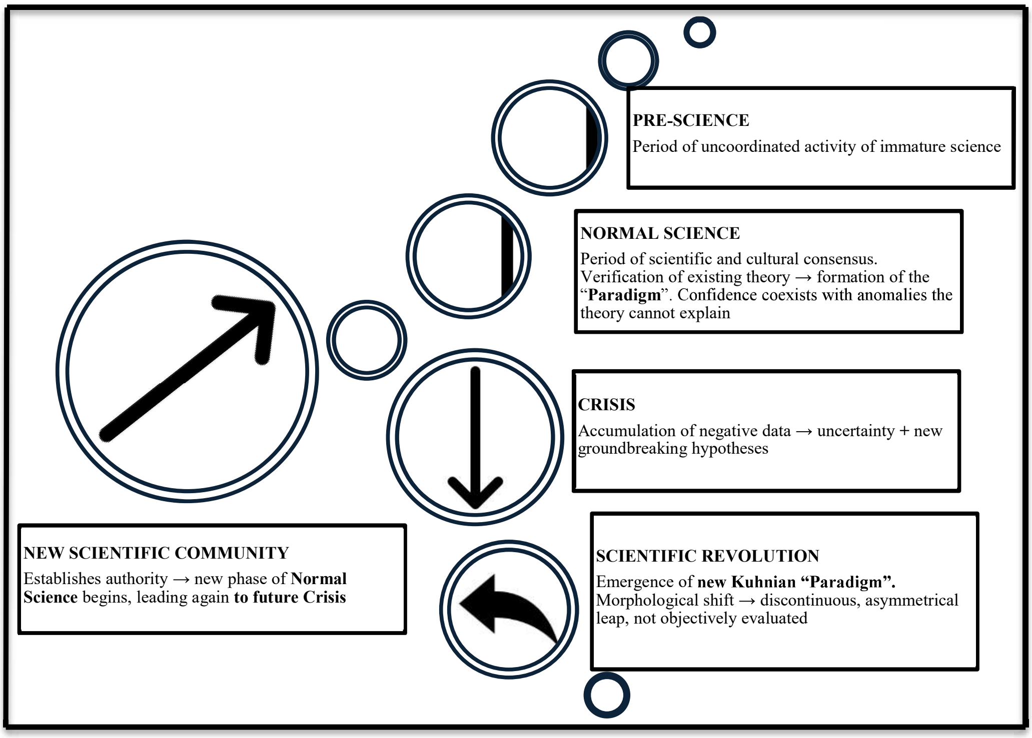

Figure 3. The structure of scientific revolutions, based on Thomas Kuhn's theory

Using the aforementioned model as a tool, science is viewed not through the one-dimensional lens of a logically rigid adherence to predetermined forms, but rather as a multifaceted socio-cultural activity. Its course is not characterized by historical continuity, but by dynamic progress marked by non-linear shifts and discontinuous leaps. This occurs because, while the scientist experiences the shift as a transition from an illusion to a true perception, the historian's perspective reveals that the scientist is, in essence, seeing new things while looking at the same old objects. For Kuhn, the scientist moves from one true perception to another and begins to live in a different world. These different worlds, the "*Paradigms*", each operated according to their own evaluative criteria, often incompatible with those of others. Moreover, they developed through a variety of networks of interpersonal relationships and objectives among all those involved in each scientific "*Paradigm*". Consequently, scientific change, namely the historical puzzle composed of these various "*Paradigms*", cannot be assessed rationally or on the basis of a common standard. Inevitably, science is positioned as an equivalent means of promoting society, among other systems of thematic classification of reality and quests for truth (Theodorou, 2008, pp. 91, 93).

Feyerabend's Position

From Feyerabend's perspective, perhaps the most radical of the modern philosophers of the history of science, the relationship between the scientific phenomenon and its historical-social environment is approached through the following key ideas:

(a) "*Anything goes*";

(b) The asymmetry of different scientific theories makes it impossible to compare them on the basis of logical criteria;

(c) Science does not necessarily constitute the highest form of knowledge, and adopting an alternative attitude towards it, by lifting various methodological, ideological, cultural, and political constraints, can broaden the freedom not only of scientists but of every individual (Chalmers, 1994, pp. 211–228).

Feyerabend's "*anything goes*" emerges from his claim that even during the period of modern science, after which today's rationalistic tendency prevailed, "*no method was obligatory and none was forbidden*" (Vallianos, 2008, pp. 219–220). The new physics of that era triumphed not so much because of the empirical, experimental methodologies and mathematical computational methods that were applied, and later legitimized, but rather through a range of socio-cultural factors such as ideological conflicts, clashes of scientific beliefs, political influence, imagination, and above all, the rupture with established theories and accepted facts (Theodorou, 2008, p. 98). All these elements together constitute the very essence of epistemological anarchism.

Such anarchism constitutes Feyerabend's so-called "*anti-method*", which holds that scientists should remain free from methodologies that provide prescriptive rules for selecting theories and research programs. The asymmetry between two rival theories invalidates any logical evaluative criteria. According to Feyerabend, this occurs because the fundamental principles governing each theory may be so radically different that the concepts of one cannot be accurately translated into the language of the other. Consequently, different theories cannot agree on any logical, empiricist-style observational statement (Chalmers, 1994, pp. 213, 215-216).

Comparison, according to Feyerabend, becomes possible only through alternative criteria, historical, sociological, and cultural in nature, such as whether a theory is linear or non-linear, coherent or incoherent, conservative or progressive. In the discussion on logic, Feyerabend introduces the notion of "*natural interpretations*", explaining that "*truth in experience is determined only after the intervention of reason, but in the broad sense of the term, which includes elements not traditionally recognized as formally rational, such as tradition, ideology, and imagination*". The so-called "*natural interpretations*" are the ideologies that, as mental presuppositions, shape the empirical evidence of scientists. These are not added afterwards to supposedly objective observations; rather, they are the very conditions that make thought and experience possible in the first place (Chalmers, 1994, p. 217, Theodorou, 2008, pp. 98-99).

Armed with his "*anti-method*", a stance against the normative dictates of exalted rationalism on the one hand, and with the notion of the asymmetry of theories, which Kuhn also embraces when he describes his own "*Paradigm*" as asymmetrical and not objectively assessable, Feyerabend defends the scientist's right to free choice among a plurality of methodological approaches, ranging from the most intuitive to the most rigidly logical. By analogy, just as scientists should be free to act as individuals unbound by methodological prejudices or the constraints imposed by governments and corporations, so too should every person have the freedom to evaluate science itself according to the criteria embedded within the assumptions of the shared consciousness of the human group to which they belong. From this perspective, science may be regarded simply as one more human activity "*among a multitude of others, an activity that holds no special prestige compared to the rest*" (Vallianos, 2008, pp. 218-219).

This approach does not diminish science but rather situates it within the framework of a modern theoretical pluralism, one that is essential "*for the discovery or even the transformation of the characteristics of the world in which we live*" (Theodorou, 2008, p. 98); in other words, for evolution and progress. If, to this theoretical endeavor of epistemological anarchism, aimed at overturning the notion of scientific superiority over other forms of truth-seeking, we add the demand to eliminate the privileged connection between science and political power (Vallianos, 2008, p. 220), we may approach Feyerabend's ideal society, where science would be taught in an ideologically neutral state alongside the myths of primitive societies, so that "*everyone may have the necessary information for a free choice*" (Chalmers, 1994, p. 225).

6. Recapitulation

In its attempt to utilize ancient Greek thought for its own benefit, the Church essentially contributed to its preservation, thus creating a relationship of mutual dependence between the two. However, their contrasts became particularly pronounced in crucial cosmological questions, such as those of the eternity or not of the world, the omnipotence or not of God, and the immortality or not of the soul.

Aristotle was placed at the center of education in the medieval university, resulting in conflicts between the proponents of Aristotelian thought and the conservative supporters of Christian theology, which led the Church to prohibit the teaching of doctrines derived from the interpretation of his works, from 1210 to 1255. In essence, medieval science was shaped by the diverse influences that Aristotle's physics exerted on the thought of philosophers and theologians regarding the creation and functioning of the world.

Some of these thinkers, mainly Franciscans, advocated for the normalization of relations between philosophy and theology; others assigned philosophy the role of theology's handmaiden; and some became advocates of extreme Aristotelianism, provoking the Church's decisive reaction through new prohibitions in 1277. The 13th century was marked both by the consolidation of Aristotelianism and by a temporary victory of conservative theologians over radical philosophers, a development that led 14th-century scientific thought towards an empirical natural philosophy of Logic, paving the way for the Renaissance and modern science.

The new science that emerged from the contributions of leading thinkers over the 150 years of the so-called Scientific Revolution encompasses a wide range of features, beginning with the Copernican shift from geocentrism to heliocentrism and culminating in the Newtonian synthesis. Summarizing the work of great scientists, this synthesis is governed by universal and necessary laws, such as that of gravitation.

Among the developments of this era are the adoption of new methodologies such as observation and experimentation, a broader use of mathematics and the development of infinitesimal calculus, the unification of terrestrial and celestial physics, the geometrization of space, the transformation of existing concepts such as motion and force, the discovery of new natural phenomena, and, most importantly, the beginning of the establishment of rational human being as the master of nature. During this period, the rational human being transcends the medieval conception of the world and sets "*European society on the path of political self-government and material progress*" (Vallianos, 2008, p. 19).

Building upon the achievements of the Scientific Revolution, philosophical inquiry turned to a new and fundamental question, how knowledge itself is acquired and validated. The basic disagreement between rationalism and empiricism regarding the source of knowledge lies in the fact that, according to the former philosophical movement, knowledge arises from the powers of the mind, insight and deduction. In contrast, according to the latter, knowledge originates from experience, which the senses receive from the external and internal environment and then transmit to the mind as the obscure content of either simple ideas, or impressions and ideas derived from those impressions.

In terms of method, rationalism upholds the logical, deductive or axiomatic approach as the only reliable path to the knowledge of truth. In contrast, empiricism employs the method of ex post facto combination of empirical data, which could also be described as induction, from the particular to the general.

In a more skeptical version, empiricism is grounded in the principle of association, which holds that the observed regularities are not explained by the inherent properties of things, but rather by the associative way in which the repetition of contiguity, temporal succession, and similarity is represented in the human mind and memory.

It is also inferred that, according to rationalism, finite human reason can expand the limits of its knowledge insofar as it deepens, through the axiomatic method, its understanding of the attributes of God, who is identified with nature. In contrast, according to empiricism, knowledge is limited, contingent, and probabilistic, since it depends on the inherent imperfections of human senses, which not only fail to grasp the true essence of objects but also rely on purely subjective beliefs to explain the causal connection of phenomena, thereby rendering any theoretical generalizations about nature and its future behavior mere conjectures.

Building on these distinctions in epistemological approaches, we turn to how modern philosophies of science interpret scientific change and progress. Whereas logical positivism employs as its unit of assessment for scientific change, development, and progress the individual, axiomatic theory of the meaning and verifiability of propositions, Kuhn uses instead the discontinuous and asymmetrical dynamics of the "*Paradigm*". At the same time, Feyerabend introduces the concept of "*natural interpretation*", which lends scientific reasoning the richness and diversity of all elements traditionally unrecognized as formally rational.

Logical positivism views scientific change introspectively, adhering to strict logical forms in a one-dimensional and linear manner, while rejecting extra-scientific influences. Kuhn, by contrast, presents it through the sociocultural lens of non-linear, discontinuous, and asymmetrical leaps, positioning science as an equal among social, historical, and cultural endeavors in the pursuit of truth.

Finally, Feyerabend agrees with the notion of asymmetry and the consequent inadequacy of any logically objective evaluation of the various narratives of truth, among which he includes science itself, and identifies within scientific progress relativistic and anarchistic elements, such as the principle that "*anything goes*". In an ideal society, these elements would liberate both scientists and individuals from any rigid constraints that hinder development and progress.

In light of these perspectives, contemporary scientific thought stands at the intersection of rational rigor and cultural plurality, a dynamic field that continually redefines its methods and boundaries. Looking towards the future, science may no longer seek a single, absolute truth, but rather embrace an ever-evolving dialogue among diverse ways of understanding the world and humanity's place within it.

Bibliographic References

Chalmers, A. F. (1994). *What is this thing called science?* (G. Fourtounis, Trans.). University of Crete Press. In Greek: Chalmers, A. F. (1994). *Τι είναι αυτό που το λέμε επιστήμη;* (Γ. Φουρτούνης, Μετάφ.). Πανεπιστημιακές Εκδόσεις Κρήτης.

Drake, S. (1993). *Galileo* (T. Kyprianidis, Trans.). University of Crete Press. In Greek: Drake, S. (1993). *Γαλιλαίος* (Τ. Κυπριανίδης, Μετάφ.). Πανεπιστημιακές Εκδόσεις Κρήτης.

Gillispie, C. C. (1994). *The edge of objectivity: An essay in the history of scientific ideas* (D. Kourtovik, Trans.). Cultural Foundation of the National Bank of Greece. In Greek: Gillispie, C. C. (1994). *Στην κόψη της αλήθειας: Η εξέλιξη των επιστημονικών ιδεών από το Γαλιλαίο ως τον Einstein* (Δ. Κούρτοβικ, Μετάφ.). Μορφωτικό Ίδρυμα Εθνικής Τραπέζης.

Glymour, C. (2007). Realism and the nature of theories. In A. Baltas (Ed.), *Introduction to the philosophy of science* (pp. 139–177). University of Crete Press. In Greek: Glymour, C. (2007). Ο ρεαλισμός και η φύση των θεωριών. Στο Α. Μπαλτάς (Επιμ.), *Εισαγωγή στη φιλοσοφία της επιστήμης* (σσ. 139–177). Πανεπιστημιακές Εκδόσεις Κρήτης.

Grant, E. (1994). *The foundations of modern science in the Middle Ages* (Z. Sarikas, Trans.). University of Crete Press. In Greek: Grant, E. (1994). *Οι φυσικές επιστήμες τον Μεσαίωνα* (Ζ. Σαρίκας, Μετάφ.). Πανεπιστημιακές Εκδόσεις Κρήτης.

Lindberg, D. C. (1997). *The beginnings of Western science* (H. Markolefas, Trans.). National Technical University of Athens Press. In Greek: Lindberg, D. C. (1997). *Οι απαρχές της δυτικής επιστήμης* (Η. Μαρκολέφας, Μετάφ.). Πανεπιστημιακές Εκδόσεις Ε.Μ.Π.

Athanasakis, D. (2014). *Issues of epistemology, history and philosophy of science from Descartes to Hume.* In *Supplementary Material* of module EPO31. Hellenic Open University. In Greek: Αθανασάκης, Δ. (2014). *Θέματα γνωσιολογίας, ιστορίας και φιλοσοφίας της επιστήμης από τον Descartes στον Hume.* Στην ενότητα *Συμπληρωματικό Υλικό* της Θ.Ε. ΕΠΟ31. Ελληνικό Ανοικτό Πανεπιστήμιο.

Asimakopoulos, M., & Tsiantoulas, A. (2008). *The natural and human sciences in Europe* (Vol. 1). Hellenic Open University. In Greek: Ασημακόπουλος, Μ., & Τσιαντούλας, Α. (2008). *Οι επιστήμες της φύσης και του ανθρώπου στην Ευρώπη* (Τόμος Α΄). Ελληνικό Ανοικτό Πανεπιστήμιο.

Vallianos, P. (2008). *The natural and human sciences in Europe: The scientific revolution and the philosophical theory of science. The rise and transcendence of positivism* (Vol. 2). Hellenic Open University. In Greek: Βαλλιάνος, Π. (2008). *Οι* *επιστήμες της φύσης και του ανθρώπου στην Ευρώπη: Η επιστημονική επανάσταση και η φιλοσοφική θεωρία της επιστήμης. Ακμή και υπέρβαση του θετικισμού* (Τόμος Β΄). Ελληνικό Ανοικτό Πανεπιστήμιο.

Theodorou, P. (2008). A comparative assessment of the contributions of Kuhn, Lakatos, and Feyerabend to the philosophy of science. In V. Kaldis (Ed.), *The natural and human sciences in Europe: Texts on the history and philosophy of science* (pp. 89–106). Hellenic Open University. In Greek: Θεοδώρου, Π. (2008). Μία συγκριτική αποτίμηση των συνεισφορών των Kuhn, Lakatos και Feyerabend στη φιλοσοφία της επιστήμης. Στο Β. Καλδής (Επιμ.), *Οι επιστήμες της φύσης και του ανθρώπου στην Ευρώπη: Κείμενα ιστορίας και φιλοσοφίας των επιστημών* (σσ. 89–106). Ελληνικό Ανοικτό Πανεπιστήμιο.

Koyré, A. (1991). *Western civilization* (V. Kalfas & Z. Sarikas, Trans.). Ypsilon. In Greek: Κοϋρέ, Α. (1991). *Δυτικός πολιτισμός* (Β. Κάλφας & Ζ. Σαρίκας, Μετάφ.). Ύψιλον.

Mentzeniotis, D. (2008). The mathematization of nature. In V. Kaldis (Ed.), *The natural and human sciences in Europe: Texts on the history and philosophy of science* (pp. 79–85). Hellenic Open University. In Greek: Μεντζενιώτης, Δ. (2008). Η μαθηματικοποίηση της φύσης. Στο Β. Καλδής (Επιμ.), *Οι επιστήμες της φύσης και του ανθρώπου στην Ευρώπη: Κείμενα ιστορίας και φιλοσοφίας των επιστημών* (σσ. 79–85). Ελληνικό Ανοικτό Πανεπιστήμιο.

Papanellopoulou, F. (n.d.). *Scientific revolution.* Supplementary material for module EPO31, Hellenic Open University. In Greek: Παπανελλοπούλου, Φ. (χ.χ.). *Επιστημονική επανάσταση.* Συμπληρωματικό υλικό για τη Θεματική Ενότητα ΕΠΟ31, Ελληνικό Ανοικτό Πανεπιστήμιο. (*Το κείμενο αυτό γράφτηκε για τις ανάγκες διδασκαλίας της θεματικής ενότητας ΕΠΟ31 του Ελληνικού Ανοικτού Πανεπιστημίου και με αυτή την ιδιότητα αναρτάται στον ιστοχώρο της θεματικής ενότητας. Οι φοιτητές και οι φοιτήτριες μπορούν να το χρησιμοποιήσουν ως συμπληρωματικό υλικό μελέτης και ως βοήθημα για την εκπόνηση γραπτών εργασιών. Δεν επιτρέπεται να το διανείμουν, να το αναπαραγάγουν ή να το τροποποιήσουν. Τα πνευματικά δικαιώματα ανήκουν αποκλειστικά στη συγγραφέα.*)

Patiniotis, M. (2008). Newton and Newtonianism in 18th-century Europe. In V. Kaldis (Ed.), *The natural and human sciences in Europe: Texts on the history and philosophy of science* (pp. 39–54). Hellenic Open University. In Greek: Πατηνιώτης, Μ. (2008). Νεύτων και Νευτωνισμός στην Ευρώπη του 18ου αιώνα. Στο Β. Καλδής (Επιμ.), *Οι επιστήμες της φύσης και του ανθρώπου στην Ευρώπη: Κείμενα ιστορίας και φιλοσοφίας των επιστημών* (σσ. 39–54). Ελληνικό Ανοικτό Πανεπιστήμιο.