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ORIGINAL ARTICLE

From neo-idealistic historicism to Geymonat's materialistic and Agazzi's objectivistic realism: the roots of the Italian philosophy of science

De historicismo neoidealista a materialismo de Geymonat y realismo objetivista de Agazzi: las raíces de la filosofía italiana de la ciencia

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Abstract

Our paper explores the development of the philosophy of science in Italy, focusing on the shift away from the idealist and historicist dominance of Croce and Gentile. Ludovico Geymonat and Evandro Agazzi were central to this transformation, who embraced neopositivism's anti-metaphysical stance while affirming science as a form of advanced knowledge grounded in philosophical reflection. Both thinkers proposed non-metaphysical realist positions: Geymonat emphasized realism based on experimental practice and dialectics, distancing himself from historical materialism, while Agazzi emphasized scientific objectivity, defining scientific objects through empirical methods. Despite differing foundations, their views converge on three key principles: the contextual nature of scientific truth, the interplay between theory and observation, and the necessity of a realist reinterpretation of quantum mechanics. The study concludes by examining their distinct readings of Bohr's principle of complementarity, situating them within the broader discourse on the philosophical foundations of quantum theory.

Keywords: *Philosophy of science. Objective realism. Dialectic materialism. Historicist Neo-idealism. Complementarity principle.*

Resumen

Este estudio explora el desarrollo de la filosofía de la ciencia en Italia, centrándose en el abandono del dominio idealista e historicista de Croce y Gentile. En el centro de esta Transformación se encuentran Ludovico Geymonat y Evandro Agazzi, quienes adoptaron la orientación antimetafísica del neopositivismo, al tiempo que afirmaban la ciencia como una forma de conocimiento avanzado fundamentado en la reflexión

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filosófica. Ambos propusieron formas de realismo no metafísico: Geymonat enfatizó un realismo basado en la práctica experimental y el uso de la dialéctica, alejándose del materialismo histórico, mientras que Agazzi subrayó la objetividad científica, definiendo los objetos científicos mediante procedimientos empíricos. A pesar de sus diferencias, sus perspectivas coinciden en tres principios clave: la naturaleza contextual de la verdad científica, la interacción entre teoría y observación, y la necesidad de una reinterpretación realista de la mecánica cuántica. El estudio concluye con un análisis de sus distintas interpretaciones del principio de complementariedad de Bohr, en el marco del debate más amplio sobre los fundamentos filosóficos de la teoría cuántica.

Palabras clave: *Filosofía de la ciencia. Realismo objetivo. Materialismo dialéctico. Neo-idealismo historicista. Principio de complementariedad.*

Introduction

The emergence of the philosophy of science as an independent field of study and academic discipline was a relatively late development, apart from a few isolated figures, most notably the mathematician Federigo Enriques, full professor of geometry in Bologna and holder of the first chair in philosophy of science at an Italian university. This process failed to take root within the intellectual climate of neo-idealist philosophy, which held a dominant and uncontested position in Italian culture during the first half of the 20th century. The two leading exponents of this idealist and historicist tradition, Benedetto Croce and Giovanni Gentile, both upheld the thesis of the absolute primacy of the humanistic and historicist culture over scientific culture. They categorically denied the theoretical value of science, reducing its role to purely practical and applicative functions.

After the long dominance of idealist and historicist philosophy, the figures of Ludovico Geymonat and Evandro Agazzi initiated a profound process of re-evaluating the role of epistemology in the scientific enterprise. Geymonat's approach rejected historical materialism in favor of dialectic materialism to defend the autonomy of science, while Agazzi proposed a new form of realism based on the conception of scientific objectivity. Their contributions played a pivotal role in opening the Italian Academy in the second half of the 20th century, a fruitful discussion between philosophy and science, and metaphysics, almost completely absent in the neo-idealist devaluation of the role of science.

The structure of the paper is as follows: in section 2, we examine the neo-idealist criticism of science during the first half of the 20th century, focusing on its main exponents Croce and Gentile; in section 3, we analyze Geymonat's rejection of the neo-idealist and historicist thinking, proposing a reconciliation between Marxist philosophy and neopositivism, whereas in section 4, we look over Agazzi's primary role in developing the philosophy of science in Italy, with his project to reconcile his new original perspective of realism, based on his notion of object as a structured set of properties with the neopositivism approach. Section 5 compares the two realistic perspectives by Geymonat and Agazzi, in relation to the debate on the foundations of quantum mechanics, and in particular to their different interpretations of Bohr's complementarity.

Criticism of the cognitive value of science in Italian neo-idealism

Neo-idealist philosophers, as already stressed, maintained the thesis of supremacy of humanistic and historicistic culture over the scientific one, with a particular underestimation of pure sciences, such as logic, mathematics, and theoretical physics.

Benedetto Croce held a particularly dismissive view of logic and pure mathematics, which he considered devoid even of the practical utility attributed to other empirical sciences. According to Croce: "mathematics are operative sciences, not only in their problems but also in their theorems, which are commonly thought to be purely contemplative"[1].

In *Logic as the Science of the Pure Concept*[2], Croce regarded mathematical concepts as mere "pseudo-concepts" that apply only to specific cases and are thus devoid of the universal validity of "pure concepts," such as the concept of substance. Concerning logic, derogatorily defined as logistics ("logistica"), he believed it was utterly incapable of representing our reasoning or mental processes. Similarly, Giovanni Gentile criticized physical theories as excessively abstract, arguing that these theories were based on principles of nature which, due to their ahistorical character, rendered them intrinsically dogmatic. Within this framework, however, the practical relevance of physics was acknowledged, and the study of its experimental applications was both encouraged and supported. From this perspective, the emphasis placed on the scientific and cultural role of Guglielmo Marconi, pioneer of radiocommunications and the first Italian Nobel laureate in physics, appears particularly noticeable. This explains how Marconi, despite being little appreciated by the academic scientific community, was appointed president of the newly established Academy of Italy, which the Fascist regime had created to replace the historic Accademia dei Lincei.

However, it seems truly paradoxical that, in a context so critical of science's cognitive role, idealist thinkers in Italy did not embrace the subjectivist implications of orthodox quantum mechanics, a theory, which gives prominence to the observer's role as a conscious subject irreducible to a description based on physical laws, but able at the same time to interfere with these laws, providing a compelling theoretical argument for idealism.

In such a framework, only two notable exceptions have to be mentioned. The first exception is that of the idealist philosopher Guido De Ruggiero, who in his treatise of history of philosophy De Ruggiero interpreted the "new atomism" of quantum theory[3] as compelling evidence of the active role of the mind in the physical world and as a definitive departure from the realist ontology of classical mechanics toward an explicitly idealist and teleological perspective. He highlighted how, whereas in the earlier atomistic conception the mind was external to the description of nature, in the new atomic theory the mind appeared as intrinsic to nature itself, and thus impossible to exclude from the framework of physical laws.

In a similar way, the theoretical physicist Giovanni Gentile Jr.[4], in his introduction to the Italian edition of James Jeans' *The New Background of Science*[5], supported the orthodox interpretation of quantum mechanics and criticized at the same time some of its founding fathers, such as Planck and Einstein, for their naive realism. Gentile completely endorsed the thesis, characteristic of orthodox quantum mechanics that limited the concepts of physical theories to only directable observable quantities.

Nevertheless, unlike Werner Heisenberg and other exponents of the Copenhagen school, who maintained a strictly operationalist point of view, the idea that observables were the only valid concepts of science was, for Gentile, a confirmation of the subjectivist conception of immanent idealism.

We have briefly recalled these two interesting "anomalous" positions with respect to the general situation, because in this case it was not historicist idealism that devalued science, but the main scientific theory that directly produced an argument in favor of idealism, questioning the capability of science to describe and represent a reality, independent of an observing subject.

Dialectical materialism and neopositivism in Ludovico Geymonat

After the Second World War, Italian philosophy started a process of rejection of neo-idealism, which, initially, was not accompanied by an adequate emancipation of the historicist perspective that had dominated Italian culture from the end of the 19th century. This is clearly evident in the revival of Marxist philosophy, particularly in the form of historical materialism, which reversed Croce and Gentile's idealistic historicism into a materialist historicism. Such a new perspective still maintains the idea that science is completely historically determined, thus continuing to limit its theoretical and cognitive value, as a consequence of its dependence on the historical and economic context in which it developed.

This discussion took an innovative turn with the work of Ludovico Geymonat, who attempted a difficult reconciliation between Marxist philosophy and neopositivism, an approach that had previously received no attention in Italian philosophy.

Geymonat had studied in the 1930s in Vienna with Moritz Schlick, founder of the neopositivist movement, which aimed to construct a scientific worldview. Like classical positivists, also the new positivists held that science was the most authentic form of knowledge. Unlike its predecessor, however, neopositivism emphasized the role of formal logic, which had played no role in classical positivism and had been dismissed as completely irrelevant in the neo-idealist perspective. A primary goal of the neopositivist program was the elimination of metaphysics, considered not merely as a collection of false statements, as by classical empiricists, such as Hume[6], but as entirely meaningless speculations. This criticism applied to all major metaphysical debates, including those between idealism and realism, spiritualism and materialism, which were seen as sterile pseudo-problems.

Similarly, Marxist historical materialism clashed with neopositivism for its denial of science's primary role, and the thesis that science is historically determined and influenced by political, economic, and social contexts.

Thus, Geymonat's attempt to develop a philosophy of science that reconciled Marxism and neopositivism had to confront and seek to resolve two major problems:

– The neopositivist denial of the cognitive meaning of both realism and materialism
– The materialist-historicist rejection of the cognitive value of science.

The foundation of a philosophy of science based on an attempt at reconciliation between Marxism and neopositivism, which would form the basis of Geymonat's notable intellectual project, must therefore confront and seek to resolve two fundamental issues. First, the neopositivist denial of the philosophical meaning of the theses of realism and materialism; second, the Marxist historical materialist rejection of the cognitive value of science, insofar as it is viewed as historically determined.

In a collection of essays on the topicality of dialectical materialism[7] (1974), Geymonat effectively addressed the second issue by reinterpreting Marxism in terms of a non-historicist dialectical materialism. To this extent, he adopted Nikolaj Lenin's philosophical standpoint, which ascribed significant epistemic value to science, thereby rejecting not only historicism but also instrumentalist and pragmatist perspectives such as that advanced by Ernst Mach[8], which Lenin had criticized as idealistic in his *Materialism and Empirio-Criticism*[9].

This decisive rejection of historical materialism and full adherence to dialectical materialism led Geymonat to identify his non-historicist materialism with a form of realism. However, he came from a neopositivist tradition and approached the issue of realism with extreme critical caution. Indeed, in his famous essay on the relation between philosophy and philosophy of science[10], Geymonat asserted that scientific progress clearly affirms the realism of science. His view was that realism in science should emerge from scientific practice itself and be connected to his definition of realism as "the existence of something". For Geymonat, science was no longer just an activity of the mind, but a foremost human activity. Science, as an evolving and fallible activity shaped by experience, embodies the dialectical method. This perspective marked a turning point from both the traditional neopositivist view of science as the most advanced form of knowledge and the historicist conception of science as historically determined and subordinated to the context in which science is developed. According to Geymonat, science is a dynamic and historically contingent human endeavor, continually subject to revision and critique, yet endowed with an intrinsic epistemic value that transcends its temporal context. Therefore, in Geymonat's thoughts, realism becomes synonymous with materialism, and this is part of his broader attempt to reconcile logical empiricism with dialectical materialism.

Scientific realism and neopositivism in Evandro Agazzi

The other major figure in the development of philosophy of science in Italy is Evandro Agazzi. Like Geymonat, Agazzi carried out a significant effort to reconcile the neopositivist perspective with the realist request that characterizes his philosophical position.

Rejecting the neo-idealist devaluation of science, Agazzi recognized the importance of the new neopositivist perspective, which did not renounce the objectivist assumption and the cognitive value of science, both features of realism. He also acknowledged the value of neopositivists' emphasis on the formal tools of logic for analyzing the structure of scientific theories. However, he opposed the rigid operationalist and phenomenist view of science, which completely identified scientific concepts with their measurement procedures[11].

By abandoning this strict operationalism, Agazzi succeeded in avoiding the anti-realist outcomes of neopositivist philosophy, which he believed could in fact be compatible with realism.

"The epistemology of neopositivism, although deeply influenced by Mach's thought, ended up more or less explicitly accepting a realist view of science. We are not concerned here with how coherent that shift was; it is enough to note that such a development was imposed by the cultural program of the entire movement, which claimed science as the only genuine source of knowledge"[12].

Another element shared by both neopositivism and realism is represented for Agazzi by their common empiricist foundation:

"The obsession with which neo-empiricism sought to impose absolute fidelity to experience–and to reduce theoretical components of science to experience–can also be seen as an effort to secure science's solid link to reality"[12].

As for the other unsolved issue: reconciling neopositivism with realism, undermined by the neopositivist critique of metaphysical theses (which remained unanswered in Geymonat's materialist realism), Agazzi proposed a form of scientific realism grounded in the concept of scientific objectivity, which is closely aligned with the empiricist outlooks of neopositivism[13].

Agazzi's concept of objectivity assumes that the relationship between subject and reality ensures a connection between knowledge and reality itself. Scientific theories are constructed using theoretical terms whose purpose is to explain experiential facts. These theoretical terms retain their link to experience by being connected to properties defined experimentally. This operational aspect is precisely where the connection between theoretical concepts and their physical meaning is established[14].

Although these theoretical terms are not directly "observable," they cannot be reduced entirely to operational terms. Otherwise, one would fall back into the strict operationalism that Agazzi criticizes as anti-realist.

Theoretical terms, thus, acquire a definite meaning within the context of the theory they belong[15]. Only the theory as a whole can be interpreted empirically and correlated with potential observations. In Agazzi's view, an object is understood as:

"... a structure of relations, most of which may result from operations, but whose 'being together' is not justified by any single operation–yet must be objectively verifiable"[16].

Agazzi maintained the role of scientific theories as a more ontic view, where scientific theories reconstruct structures, which derive from a reality independent of us.

In Agazzi's framework, physical objects are sets of structured relations (in a sense similar to a bundle of properties[17]) that become objective because they are verified by observational propositions obtainable in each science.

"The realist position is one in which there is an inclusion relationship between the objective and the real: Everything that is objective is real, though not everything that is real is objective"[16].

This sets the foundation for a kind of realism in which knowledge of an object requires the verifiability of the object's existence. With this term, Agazzi refers to the idea that scientific theories articulate and describe an image of reality that is considered adequate or representative. In response to critics–particularly those with more historicist leanings–who challenge the evolving nature of scientific results, Agazzi contends that scientific knowledge embodies a form of truth that is relative, but not diminished in importance because of it. By "relative," he simply means that such truth is confined to a specific domain, within which it maintains full objective validity.

Geymonat's and Agazzi's contribution to the debate on quantum mechanics: materialistic versus realist interpretations of Bohr's complementarity principle

The attempts proposed by both Ludovico Geymonat and Evandro Agazzi share a common thread: seeking an accord between neopositivism and a realistic perspective. Geymonat tried to achieve this through a redefinition of dialectical materialism, but this led to a metaphysical stance in which human rationality came to represent the entirety of possible reality. Agazzi, on the other hand, attempted a new definition of scientific realism, as discussed in the previous paragraph. A common point in both interpretations of scientific theories lies in the notion that scientific knowledge is relative. In other words, all propositions are true only within specific contexts, where they must hold true across all possibilities within that context. Contrary to Croce's idea of "pure concepts," Geymonat's view of objectivity is fundamentally different. His perspective is deeply connected to an intrinsic relativism based on various dimensions (such as history and interpretation). Scientific knowledge progresses through the development of new theories and interpretations; it is precisely this dynamic quality that enables the advancement of scientific understanding. Agazzi, by contrast, maintained a more consistent realist view regarding the role of scientific theory. His approach reconstructs structures derived from a reality independent of human perception. This realism is supported by the idea that objects can be inferred from and measuring operations.

To better understand the differences between these two realistic accounts, it is worth lingering over how Geymonat and Agazzi have addressed the problem of interpreting the most controversial physical theory of the 900.

1. In the preface to the book on the materialistic interpretation of quantum mechanics and edited by his scholar Silvano Tagliagambe[18], Geymonat criticized historical materialism for having previously prevented the possibility of appreciating the philosophical relevance of quantum mechanics, considered as a theory deeply influenced by the historical, social and economical context of the capitalist society and because of this complete historical conditioning and lack of autonomy, completely devoid of cognitive value. However, if we are willing to abandon the historicist materialistic perspective in favor of dialectical materialism and then recognize in scientific theories the most advanced form of human knowledge, we can approach, according to Geymonat, in a new way the debate on the foundations of quantum mechanics.

From this point of view, the reinterpretation of Bohr's principle of complementarity proposed by Geymonat and Tagliagambe appears very noteworthy.

As is well known, the principle of complementarity can be applied not only to the classically compatible notions of causality and space-time, but also to pairs of classically incompatible concepts, such as particle and wave. These represent two distinct ontological frameworks that, before the advent of quantum mechanics, were described by two distinct classical theories: Newtonian particle mechanics and Maxwell's wave theory of radiation. This "bipartition," as Agazzi emphasizes, underpinned the classical conception of physics.

The development of the corpuscular theory of radiation first, and of the wave theory of matter later, led to the breakdown of this bipartition, without, however, enabling the full coexistence of both wave-like and particle-like properties within a single physical context, as de Broglie had tried to do with his pilot wave theory. With Bohr's principle of complementarity, the dual wave-particle nature of atomic objects is affirmed, while simultaneously acknowledging the impossibility of reconciling all wave and all particle properties within the same experimental framework. This point is vividly illustrated by Feynman's famous double-slit experiment with single electrons or photons, where the determination of the particle's path, characteristic of particle-like behavior, eliminates the interference pattern that is indicative of wave-like behavior. This wave-particle dualism thus becomes a genuine dilemma within Bohr's complementarity, an almost Hamletian dilemma concerning the simultaneous being and non-being of either particle or wave.

According to Geymonat and his school, particularly as argued by Tagliagambe, this dilemma might be overcome by abandoning the negative dialectic of Kierkegaardian existentialism[19], which sees the opposition between wave and particle as an insurmountable dilemma between two mutually exclusive representations through which we attempt to construct a conceptual image of natural phenomena.

A first way proposed to overcome this negative existential dialectic is to replace it with the positive Hegelian view of dialectical materialism[20], wherein the opposition between thesis and antithesis, corresponding here to wave and particle, is resolved in a synthetic and unified vision of a new concept. However, there is no clear indication of what this new concept would correspond to, nor is there any empirical criterion available to define it operationally. In this light, it becomes evident that we are dealing with one of those metaphysical pseudo-concepts dismissed as meaningless by the criteria of logical empiricism.

A second way to dissociate complementarity from the negative connotations of existentialist dialectics is to reinterpret complementarity, following the physicist Omelyanovskij and Fock[18], not as a consequence of a limitation in principle of our mental categories, as Bohr claimed, but rather as a contingent limitation due to our use of macroscopic instruments in the investigation of the microscopic world. And since the process of interaction between measuring apparatus and measured object cannot be eliminated or arbitrarily reduced for the Planck postulate, this means that experimental physicists observe only a global process involving both the instruments and the atomic object, and never the intrinsic properties of the latter. The wave-like and particle-like properties of the microscopic world would be thus only two different ways, mediated by measuring apparata, by which microscopic systems reveal themselves at the macroscopic level.

This is the concept of relativity to our observational means, a view already partially anticipated by the empiricist philosopher and physicist Frank[21], who proposed to interpret complementarity in terms of our experimental apparatus limitation. According to this point of view, there are two types of instruments: those that measure the particle properties of the atomic objects and those that measure its wave-like properties.

This reinterpretation of the complementarity principle appears non-convincing already in the analysis of the behavior of atomic particles in the classic double slit experiment, where it is possible both to detect the localized impacts of the particles on the detecting screen and their wave-like distribution of these impacts in interference fringes. We are faced, therefore, with a single physical situation in which we can detect both particle and wave-like properties in a single experimental device, even if not all particle and wave-like properties. Indeed, the knowledge of the path followed by the particle passing with one or the other slit destroys as is well known the wave-like behavior. Such a result, showing the coexistence between a wave-like (interference) and a particle-like (localized detection) property of the electron, is perfectly consistent with Bohr's principle of complementarity, but incompatible with Fock-Geymonat's materialistic reinterpretation of the principle.

This last point of view have been definitively refuted by experiments that have confirmed of a new version of complementarity, called smooth[22], according to which one can have partly the path, partly the interference, that is, a form of complementarity no longer sharp between waves and particles, but between a partly wave image and a partly corpuscular image, which can coexist, but only partially, showing that complementarity is a smooth variation between wave-like and particle-like behaviors.

Despite these objections, the important takeaway from Geymonat's proposal is the attempt to bridge the philosophical discussion with the interpretation of quantum mechanics, an area that has traditionally underestimated the role of philosophical arguments.

From a different perspective, we find Agazzi's analysis of the interpretation of orthodox quantum mechanics. The philosopher examines the relationship between classical concepts and the Copenhagen interpretation. The key point of his analysis is that a straightforward application of classical physical concepts is not only difficult when applied to the quantum realm, but also incorrect. Evandro Agazzi articulated his concerns in *Waves, Particles, and Complementarity*, where he critically discusses the overly strong operationalist framework proposed by the Copenhagen school. Specifically, Agazzi argues that the use of instruments does not determine the physical concepts they are intended to measure. To address these issues, Agazzi proposed the thesis of a "contextual" view of the meaning of physical concepts: "Which allows us to conceive of concepts as authentically new when they are arrived at via the composition of already known intensions"[23]. For Agazzi, a single physical concept is subject to different characterizations depending on the contexts in which it is employed. While this idea is not new in philosophy, this stands in opposition to constructivist views, which assign primacy to the social role of the scientific community, such as the function of "language games" in Wittgenstein's later philosophy: "We can also think of the whole process of using words […] as one of those games by means of which children learn their native language. I will call these games "language-games" and will some- times speak of a primitive language as a language-game"[24]. The further step taken by Agazzi is to relate these linguistic problems to an ontological level, where the use of terms also implies a way of interpreting physical properties or objects. Thus, in the classical context, a concept may appear endowed with certain properties, while in the quantum world; it may lose those properties and acquire new ones. The interpretative problem raised by the Copenhagen interpretation may find a solution if one assumes that classical concepts, considered at a purely formal level, can appear as elements of a new semantic combination, in which apparent contradictions disappear, as they are linked to the semantics of classical denotation rather than to the concepts themselves.

"It is not fully appropriate to consider theories as true or false, but rather as more or less adequate. Now, it may well happen that a particular theory, which turns out not to be adequate from several points of view and is therefore replaced by another, remains partially adequate from certain points of view; and this is enough to afford an understanding of its predictive success. This success depends on those parts of the theory which are adequate"[25].

Agazzi's approach to the philosophy of physics raised a fundamental point in the field of philosophy of science: the conception of scientific objectivity. His proposal to critically reconsider the interpretation of classical objects opened a new debate that could challenge the Copenhagen interpretation. An important example that grew out of this philosophical analysis can be found in the examination of the pilot-wave theory[26] as an alternative interpretation of orthodox quantum mechanics. However, the physicist Franco Selleri' proposal was dismissed by a series of experiments[27] that tried to confirm his hypothesis, the most famous of which is Jean-Pierre Vigier, who was motivated in the search for a realistic and causal interpretation of quantum mechanics. Although the experiments fail in confirming the ideas advanced by Selleri, the study of the proposal was undertaken to develop a form of realism of properties capable of satisfying the neo-positivists' demands for an object's reality tied to the verifiability of its properties. The central idea around this new proposal said that when we affirm the reality of the attributes or predictable properties of an object, we implicitly also affirm the reality of the object itself, thereby once again assuming a form of independence from our perceptions. A weak variant of realist interpretation of the wave function, recently proposed, is based on the idea of attributing physical reality not only to the particle but also to its absence[28]. By employing entanglement, one describes a state in which the absence of the photon at one location (e.g., Bologna) implies its presence elsewhere (e.g., Florence). The detection of the photon's absence causes the collapse of the wave function, thus modifying the physical state. This approach seeks to overcome Born's interpretation by recognizing the reality of both the particle and the wave function, while nonetheless preserving complementarity, albeit in a generalized form. Although the experiments dismissed the empty wave of Selleri, the reality of the state of the so-called no-photon could represent a contribution against the antirealist interpretation of quantum mechanics, strongly criticized by Waves[29].

Conclusion

In the preceding sections, we have attempted to show how the foundations of the philosophy of science in Italy were made possible by the overcoming of idealist philosophy–a philosophy grounded in the devaluation of the cognitive significance of science–which had dominated Italian culture into the second half of the past century. This shift occurred through a distinctive process, one that did not simply involve the reception of the anti-metaphysical stance of neopositivism, which had revaluated science as the sole legitimate form of knowledge and dismissed the idealism-realism controversy as a meaningless pseudo problem. Both Geymonat and Agazzi, as we have seen, adopt key neopositivist insights by affirming the centrality of science as the most advanced, though not exclusive, form of knowledge. At the same time, they acknowledge the value of philosophical knowledge without depriving it of meaning, as the neopositivists had done with most philosophical theses. In doing so, they propose a resolution to the idealism-realism controversy in favor of a non-metaphysical form of realism–a possibility that had not been excluded by Moritz Schlick, in contrast to the majority of the members of the Vienna Circle, particularly Carnap, who famously dismissed both realism and idealism in his *Aufbau*[30]. The path followed by Geymonat was that of a critical realism rooted in experimental practice, developed within a reformulation of dialectical materialism that, like neopositivism, emphasized the representational power of scientific theories in their depiction of reality. As we have seen, Agazzi's version of scientific realism is instead based on the concept of scientific objectivity, according to which the object is understood as a structured set of properties that can be operationally defined through their relationship with empirical procedures. Although they arrived at different conclusions, both approaches have in common three crucial points: the contextual relativity of scientific truth, the centrality of the interplay between theoretical concepts and observational procedures, and, as we have seen, the need to reinterpret quantum mechanics in terms that integrate ontic and pragmatic considerations. The important result that we can apply to Geymonat's proposal is the attempt to bridge the philosophical discussion with the interpretation of quantum mechanics, even if his interpretation of complementarity is now untenable. As we have seen, Agazzi's realism, based on scientific objectivity, assumes that the objects of science are relational structures of operationally definable properties, interpreted by measuring procedures according to the logical empiricist view, but at variance with it, he maintains that they cannot be completely reduced to such properties. Moreover, it is precisely this structure that makes the world as it is. This conception of the structural nature of theoretical entities appears crucial in our attempts to understand what kind of reality can be attributed to the wave function of quantum mechanics. Agazzi's idea that a physical concept does not denote a single operation but a set of operations, "which originates from an operation but cannot be identified with it," allows the overcoming of the complementary interpretation based on the opposition of the two classical concepts of wave and particle. He pointed out, the need to introduce in microphysics concepts which are new not only because they represent a new combination of classical concepts, but also because they are able to replace their classical components with something new: "Only by inventing some new concepts, that is, new in this fundamental sense, we could possibly overcome the present uneasy state of affairs, which is not related to the regret of losing old concepts, but to the slack of new concepts capable of adequately replace them"[30]. This seminal idea of Agazzi opened a new fruitful perspective in the search for a realist interpretation of quantum mechanics, which is still the subject of ongoing research[31]. This work of the two philosophers and their schools marked the beginning of the studies on the philosophical foundations and epistemological implications of scientific theories in conjunction with a decline of the humanistic primacy in the debate on philosophy in the Italian academy. From the contributions given by Geymonat and Agazzi, 20th-century Italian philosophy began to recognize the primary role of empirical and formal sciences, and in particular of logic and physics, whose concepts and principles cannot be no longer considered as pseudo-concepts and meaningless statements, but as central elements in the philosophical inquiry.

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