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Ilie Pârvu
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Part I
Scientific Practices and Philosophical Traditions

Chapter 1
The Tradition of Scientific Philosophy in Romania

Ilie Pârvu

1.1 Introduction

In a rather schematic way, one can distinguish three main directions in the development of Romanian philosophy:

(a) a systematic-theoretic one, having as its model of excellence the great European tradition in metaphysics and logic, and aiming to build general ontological world-views. This direction was represented by Titu Maiorescu, Vasile Conta, Constantin Rădulescu-Motru, P. P. Negulescu, Ion Petrovici and Mircea Florian.
(b) an essayistic philosophy, inspired mainly by the works of Romanian historian Vasile Pârvan and by the ideas of the controversial philosopher Nae Ionescu, centered on the particularities of national culture, on the mode of representing the world as expressed in Romanian language. The main representatives have been Emil Cioran, Mircea Eliade, Mircea Vulcănescu and Constantin Noica.
(c) a scientific philosophy, correlated with the new theoretical and methodological developments of contemporary science. This kind of philosophy was promoted, with few exceptions, by very important philosophically minded scientists, actively involved in the practices of the real science.

There is, however, a singular figure among Romanian philosophers who seems to defy the above distinction: Lucian Blaga was the author of an original philosophical system based on a philosophical cosmology, a brilliant essayist and a major poet. Also, his posthumously published book, "*The Experiment and the Mathematical*

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Spirit" (1969), shows him a prescient advocate of historically based epistemology, anticipating the historical turn in philosophy of science.

Despite the fact that the "scientific philosophy" of the philosophers-scientists produced many of the most original, profound and enduring works, some of them internationally recognized as genuine paradigms, inspiring new ways of philosophical thinking, in the common histories of Romanian philosophy and of Romanian culture in general, this is typically understated, if not completely ignored. But this is not a "local fact", peculiar only to Romanian intellectual history. Rather, this seems to be a quasi-general perspective of the historians of philosophy: it is enough to observe the attitude in the standard philosophical histories towards such great philosophers as Whitehead, Husserl, Peirce, Einstein, Hilbert, Bohr, Heisenberg, Brouwer, and Gödel, as compared with the attention conferred to more "popular" philosophers, such as Nietzsche, Wittgenstein, Heidegger and Derrida.

The prevalence of essayistic philosophy in Romania, not only in the general cultural milieu but also in the professional philosophical discourse, can be explained by the dominance of the cultural model of belles-lettres and the role of literary critics as the main exponents of critical and reflexive thinking. It was an empirical fact that "in Romanian intellectual life after 1848 literary critics played an exceptional role. In every generation, one or two literary critics emerged who acquired an enormous prestige and whose directives on literary orientations were widely seen as judgments on society's value choices and even authoritative commentaries on the rhythms and models of its development" (Nemoianu 1990: 591). The best known examples of such "public intellectuals" are Titu Maiorescu, Garabet Ibrăileanu, Bogdan Petriceicu Hasdeu, Eugen Lovinescu, George Călinescu et al. The reason for this fact is, according to Virgil Nemoianu, that "inside Romanian culture, aesthetic values preserved a rank and prestige superior to political or ethical values" (Ibidem: 592).

The present study can be considered as a first attempt towards a more balanced perspective on Romanian philosophical history and contemporaneity. In my survey of the main components of the "theoretical corpus" of Romanian scientific philosophy, I intend to present two very important complementary "moments", or two kinds of philosophical thinking, conceived of as intrinsic parts of scientific construction. One is represented by various theoretical programs and methodological models in the new domains of "concrete" sciences, the sciences of complex organized and historically evolving domains, the emergent sciences of history, sociology, geography, economics and linguistics. These new domains of organized complexity cannot be theoretically represented, in the view of some Romanian working scientists, without a clear epistemological insight and a new metaphysical world view, both of them conceived of as genuine components of theoretical structure and interpretation of the new sciences. In their endeavors to build new hypotheses, explanatory theories and fundamental programs in such "soft" sciences, the Romanian scientists were essentially involved in epistemological and methodological reflection, which resulted in philosophical treatises of great depth, originality and significance, transcending the boundaries of the "new sciences", some of them becoming standard works of theoretical and philosophical thinking in science.

The second main kind of philosophical contributions of Romanian scientists was centered on the "categorical change" (Moisil 1942: 145) that occurred in the first half of the last century in mathematics and in "classical", mature science, as a result and at the same time as a precondition of a series of theoretical and methodological revolutions, the most important being the structural construction and reconstruction of mathematics and of the exact sciences of nature. The structural (re)construction of mathematics and physics represented a deep transformation of the relation between science and philosophy, which led up to a possibility of a new "scientific philosophy", a philosophy not only inspired by fundamental scientific achievements, but also internally constituted with the help of scientific (mathematical) "technique of reason". This philosophy of science is not an armchair philosophizing about science, but a new sort of theoretical practice, a fundamental and foundational research developed in the frameworks of the new abstract-structural theories. Before the second world-war, a group of Romanian mathematicians and physicists from the University of Bucharest, known as the "Onicescu seminar in the philosophy of sciences", was a very productive center of philosophical thinking in science (which they also called "axiomatic philosophy" or "structural philosophy of science"). This can be regarded as an important center of "scientific philosophy" with contributions comparable with those of the Vienna Circle, the Berlin Group, the Lvov-Warsaw School, Uppsala or Prague centers. In the second part of my chapter, I will try to justify this bold assertion.

1.2 Epistemological Programs and Methodological Models for Emerging Sciences

In this chapter I will present, without any claim to completeness, some important philosophical theories and research programs formulated by Romanian scientists in the new fields of the emerging sciences. The starting point for the entire development of the philosophical thinking of Romanian working scientists was the big debate on the epistemological status of human and social disciplines, on the possibilities and limits of scientific explanation in hermeneutic disciplines, known as "die Methodenstreit". The first renowned Romanian historian, Alexandru D. Xenopol (1847–1920), a member of the French Academy of the Social and Political Sciences, the author of the first great treatise on Romanian history, was also an important participant in this debate, alongside with Dilthey, Rickert, Windelband, H. Berr, B. Croce, P. Lacombe, G. Gentile et al. Regarded by his contemporaries as "one of the renowned epistemologists of history" (B. Croce) and one of the "founders of the new critical historical theory" (E. Breisach), Xenopol took part in this debate at a very fundamental level: he introduced a new metaphysical horizon, subjacent to the methodological one, a realist, non-Kantian ontology of space and time (conceived of as "forms réelles et existantes; … sans cette conception fondamentale, l'histoire ne serait qu'une immense fantasmagorie" – Xenopol 1908:

90), and a new topology and architectonics of science. In his much discussed work, *Théorie de l'histoire* (reviewed by H. Rickert, H. Berr, G. Gentile, B. Croce, R. Aron, E. Troeltsch et al.), Xenopol launched a new conception of scientific explanation in historical sciences based not on causal deterministic laws, but on a special kind of historical dependencies termed "historical sequences", which was applied as an analytic and interpretive instrument in the reconstruction of some important periods of Romanian history. This conception was based on the distinction between two kinds of objects of science or "phenomena", classified from the spatial-temporal perspective: "La science universelle se partagera, donc, en deux branches: la première comprendra la science des phénomènes sur lesquels le temps n'exerce aucune influence = *les phénomènes de répétition*; La seconde, les sciences qui auront pour objet des forces agissant dans le temps = *les phénomènes successifs*" (Ibidem: 20).

Alongside of many partisans of the irreducible nature of historical science, Xenopol argued for the autonomy of this science, based not on particular methodological reasons, but on a very general epistemological "fact": history is a unique and irreducible science, a "new mode of knowledge" in the first place, which studies the world of succession, ontologically different from the world of repetition. The former possesses a new kind of causality (an intrinsic one, peculiar to historical development) and consequently necessitates a new form of scientific explanation, based on the "sequence of historical facts", this "forme sérielle de causalité ... la seule forme que le temps lui permette d'embarasser" (71). The idea of an historical sequence, which represents a chain of the individual facts based on an original phenomenon (a *kern*) and on a particular kind of integration of individual phenomena, gives Xenopol the possibility to reject the most influential philosophical construal of the originality of *Geisteswissenschaften*, based exclusively on subjective, epistemological and axiological factors (i.e., on values and understanding, as formulated by Windelband and Rickert), and allows him to introduce a more general conception of the human and natural history: "L'élément de la série de development occupe tout la domaine de la succession. Du point de vue logique, cette circonstance rend la série très apte a constituer l'élément distinct de la succession ... Et si pour la science de la répétition on trouve un élément universel qui les caractérise, celui de la loi, pour science de la succession il en faut aussi un qui soit applicable à tous, condition que ne serrait remplir la notion morale de la valeur, qui ne peut convenir qu'au développement humain, pendant que nous avons vu que la série se trouve dans tout le courant de l'évolution" (125–126). Historical sequences are not isolated fragments of empirical reality; they are successively and hierarchically integrated in even more extended and complex units. Only the progressive integration confers signification and necessity to the evolution of human world, and in this sense the criterion for establishing the significance of particular phenomena can be offered in the last instance only by the integrated history of humankind.

Whereas the science of historical phenomena requires, according to Xenopol, a new theoretical perspective in order to reconstruct the peculiarities of the history conceived essentially as a new and irreducible modality of knowledge, for his

contemporary Spiru Haret (1851–1912), a brilliant mathematician and theoretical physicist, the modern ideal of a science constituted by mathematical methods represented the leading methodological instrument and theoretical framework for the new sciences of social phenomena. This was the central methodological point of his sociological treatise "*Mécanique sociale*" (Paris, 1910), conceived as an essay "d'exposer une méthode qui permettra … d'introduire peu à peu, dans l'étude des questions sociales cette rigueur du raisonnement qui donne de brillants résulté dans ce que l'on appelle 'les sciences exactes' " (Haret 1910: 1–2). Spiru Haret, a first rank mathematician, with important contributions to the study of the n-body problem in celestial mechanics, particularly of the problem of stability of the great semiaxes of orbital path of planets (considered by H. Poincaré as "a great surprise"), was one of the founders of mathematical modeling of social phenomena. In his now classical treatise *Méchanique sociale*, Haret constructed a mathematical model of social statics and dynamics in analogy with the basic categories and fundamental laws of rational mechanics. This analogy represented a starting point for the formulation of fundamental principles of social equilibrium and social dynamics, the law of minimal action, etc. As a mathematical theory of social phenomena, *Méchanique sociale* should be considered not as a mathematical rephrasing or a reconstruction of some pre-existent social theory, but rather as a rational instrument that can make possible a social science as a theoretical description of some domains of existence. This interpretation relies heavily on the role attributed by Haret to the social laws that are analogous to the principles of rational mechanics. These laws are, in Haret's conception, not merely mathematical expressions of some empirical regularities, but rather the main constraints, determinative for the inner structure and development of the social world, being essentially involved in the theoretical construction of the social phenomena as a unified genuine world.

The program of "social mechanics" (with its fundamental matrix: economic position/intellectual power/moral value) was important because the "mechanical analogy" was used by the author essentially as a leading thread for finding the right conditions for a conceptual construction in social theorizing. In this respect, Haret's idea of building an ideal theoretical model as the necessary precondition for the mathematical construction of theories in social disciplines remains a permanent achievement of the epistemology of these sciences, with great general philosophical significance. Haret's social mechanics can be considered an eminent methodological approach to the complexity of idealization in the emerging sciences. Furthermore, as has been remarked, Haret's analyses take into account actual sociological practices and manifest a deep understanding of the nature and requirements of idealization's procedures and of the role of the theoretical models in science. In the same direction, we can observe the following requirements (formulated explicitly by Haret) for the adequate mathematical-theoretical construction of social science: a set of preconditions for the mathematical treatment of social phenomena (including, for example a clear meaning of basic concepts), a hierarchically ordered set of idealizing steps, the possibility for new generalizations (Haret himself for example, introduced the concept of hyperspace in order to better represent the social complex systems and social evolution), etc.

In a very sophisticated manner, Haret extends to social phenomena the methodological "style" of his own researches in celestial mechanics. From this perspective, the main methodological peculiarity of Haret's mathematical modeling of social phenomena consists, in my opinion, in the architectonic manner in which he conceived of the function of mathematical-mechanical analogy in edifying a social theory. Every successful theoretical construction in this complex domain must also observe, on Haret's view, the hierarchical order of laws and the determinative role of the fundamental law(s) for the entire conceptual system. These contributions justify the appreciation of the first reviewer of Haret's treatise, the American sociologist Lesly Ward: "*Mécanique sociale*, the book we are to consider, may be characterized as the result of a keenly felt need for exact methods in the solution of social problems. The mathematical genius of the writer has made it possible for him to conceive of certain quantitative elements in social life as standing in exact relationships to each other, which may be traced to social processes determined by well-defined and mathematically measurable forces ... The conclusions reached by the author are as interesting as they are significant" (Ward 1913: 815). As an example of these significant results, the American sociologist noted Haret's endeavor to "demonstrate mathematically that democracy is an essential condition of civilization", the task being "well met by Haret" (Ibidem: 816).

Despite the fact that classical rational mechanics was substituted by relativity theory and quantum mechanics as fundamental and foundational theories of physical sciences, with new basic laws and ontological models, the principles of classical mechanics retain their "transcendental function and significance" (as the first expression and original model) for the process of physical theory-construction, and as a first formulation of the structural conditions, indefinitely generalizable, for the very idea of a natural world. The Newtonian laws (with their fundamental "moments" expressed by the principles of conservation, causality and interdependence) represented the first structural pattern of lawfulness, determinative for an *ontos* as a complex system of entities, endowed with stability, ontological dependence and integrality. We can understand and evaluate the modernity of Haret's approach along these lines. The analogy with rational mechanics, the theory-core for the entire classical mathematical science of nature, represented, for Haret, not simply a transposition of the physical laws into a new domain, but an attempt to imitate the classical mechanics at two levels: (i) the first level concerns the methodological strategy of mathematical modeling or of scientific idealization; in this sense, Haret extends to social phenomena his own type of scientific practice, as represented by this work in celestial mechanics; (ii) the second level concerns the epistemological and metaphysical dimensions of this procedure: the Newtonian laws of general mechanics constitute, for Haret, a model of the theoretical construction of a world, the first effective realization of the structural constraints necessarily involved in every "law-determined world", or "law-constituted world". In this epistemological sense, the general Newtonian laws retain their perennial significance not as a "foundational" basis for every theoretical development in physics or other natural and social sciences, but as a methodological paradigm (as structural principles of a world construction) for every law-like model of the universe.

The social mechanics constructed mathematically by Haret didn't solve all the problems of social theorizing (the problem of free choice, for example, or the nature of individuals and individuality of social events, etc.), but it produced the theoretical premises for solving them. As a general abstract theory, the social mechanics didn't produce by itself predictions of special phenomena. Haret was aware of this fact, and his predictions were presented explicitly as internal "theoretical possibilities": the necessity of a new kind of the representation space for social phenomena ("hyperspace"), the possibility to use the diffusion laws for explaining some social events, the idea of a future "integral civilization" etc. These, and other such ideas, give us some ground for understanding the modernity and profundity of Haret's pioneering work in the complex field of social disciplines.

While the works of Alexandru Xenopol and Spiru Haret were known and commented upon in the scientific and philosophical community during their time or later (for example in the works of H. Rickert, B. Croce, E. Troeltsch, P. A. Hiemstra, E. Breisach, A. Portado, L. Ward, T. Lalescu et al.), and they became standard works in the philosophy and methodology of social sciences, the program launched for the theoretical construction of "concrete sciences" by another Romanian scientist, Simion Mehedinți (1868–1962), was practically ignored by his contemporaries. He was a Romanian geographer and the author of a monumental theoretical and epistemological treatise on geography, conceived of as an original and genuine science, "*Terra. Introduction into Geography as a Science*" (two volumes), published in Romanian in 1931, and of some other books in which he developed and applied to various domains (anthropology, ethnography) the "architectonic model of science" introduced in his masterwork.

The great originality of Mehedinți consists in the fact that his work represents "a model of philosophical construction of a science" (Geană 2002–2003: 14). In this sense, Mehedinti explicitly assumed as the leading thread for his entire project of a new science the Kantian conception of the architectonic construction of science. The "Idea of a science", in one of its Kantian senses as the "reason's scientific concept", signifies in its reflective hypostasis the "reason's concept of the form of the whole insofar as this concept determines a priori both the range of the manifold and the relative position that the parts have among one another" (Immanuel Kant, *Critique of pure reason* A832/B860). This meaning corresponds to the philosophical well foundation of a pre-existing science. In another context, it can be endowed with a "positive" or active meaning. In this determination, it refers to the "schema, as the original germ" for a new system of knowledge. This meaning, presented by Mehedinți in the form in which it occurs in Kant's Preface to the *Physical Geography* ("The Idea is architectonic. It creates science"), was instrumental in the construction of the new theoretical model of the science of geography which represented the main objective of Mehedinți's *Terra*. It was assumed as a fundamental prerequisite of a geography constituted, in Kant's terms, in accordance with "the genuine Idea of science".

The architectonic ideal represented for Mehedinți not only a general constraint for a "pre-paradigmatic" discipline, but mainly a fundamental condition for an adequate answer to the challenge of complexity in the new domains of "concrete"

sciences. The modular-architectonic construction of science is a necessary condition for the theoretical construal of the "organicity" of the domain of research, of the interaction of its "levels of reality", each of them endowed with distinct types of causality and forms of lawfulness, and in the last instance for underlying the role of the so-called "centers" of scientific representation.

As a first example of a philosophically constructed science in this new domain, *Terra* effectively presented the science of geography as a theoretical program in the form of an architectonic system. This program itself is a theoretical complex, irreducible to the classical (axiomatic-deductive) model of science. It contains a general formal principle, or a new theoretical model of "organicity" (the "descendent subordination of planetary shelves on the basis of their progressive complexity" Mehedinți 1931, vol. 1: 24), a new "categorical scheme", some mediating models and hypotheses and, finally, specific laws or theories for concrete empirically determined domains. In the methodological perspective, Mehedinți stressed the integrality of the entire architectonics of science and the irreducibility of its different theoretical and empirical levels. In other words, he argued for the necessity of a new mode of theoretical articulation of this "concrete" science, with an immanent epistemology and a new, characteristic concept of method.

This concept of method, as it emerges from the real development of science, contains essentially the sum total of "directive ideas", which are involved in gathering the empirical data, in explaining their relatedness, and in the search for causal relations between facts, and which support, in the last instance, the entire architectonic of the system (Ibidem: 24n). Mehedinți's concept of method represents a rational generalization, at a new level of theoretical sophistication, of the Cartesian rule-centered idea of method. In this sense, the "concrete science" of geography demands a reconstruction of the classical model of the scientific method (centered on operations and rules) and the introduction of a new (system-oriented) meaning of method. Beside the new theoretical paradigm, Mehedinți introduced a new "elementary unit of scientific knowledge", required by its architectonic form, and a new internal logic.

The architectonic model of theory-construction is instantiated in *Terra* by the integrative function of the set of general constraints (or formal-methodological, interdependent principles) such as the progressive complexity of spheres, the causal subordination of planetary covers and causal subordination of geographical zones, of the matrix of static categories (form, dimension and position) and of dynamic categories (composition, density and color). This theory-core of the entire program also contains a general methodological requirement: the order of scientific description should follow the order of causality in natural phenomena.

Mehedinți was not only a scientist who discovered the philosophical significance of the science of earth, as an integrated, hierarchically ordered study of all the "spheres" which define the earth. For *Terra* contains not only a new and revolutionary "vision", or a new epistemological outlook, but develops a new analytical aparatus as well. In this sense, Mehedinti's paradigmatic work contains an exemplary monographic treatment of the most important research instrument of geography (explanatory, predictive and practical), namely the map. The cartographic

theory formulated by Mehedinți is conceived of in the same integrative, "organicist" manner as are the thematic structures of the general theory of earth.

An eminent, Romanian-American, mathematician was Nicholas Georgescu-Roegen (1906–1994). A statistician (he authored an important book in this field, *The Statistical Method*, published in Romanian in 1933) and economist (called by Paul Samuelson "a scholar's scholar and economist's economist"), Georgescu-Roegen was a very original and profound thinker, with seminal contributions in several fields of economic theory, and "one of the founders of the field of multidisciplinary studies known today as ecological economics, which he himself, however, defined as bioeconomics" (Bonaiuti 2011: x). He created a new conceptual framework for economic studies by "opening economics to natural science, especially to thermodynamics and biology, [which] led him towards the elaboration of a new economic approach, which was the first to point out, on a sound scientific basis, the biophysical limits to growth" (Ibidem: xi). Georgescu-Roegen not only questioned the theoretical and methodological fundamentals of the neoclassic, "standard" paradigm of contemporary economics, but he also formulated a new alternative research program, based on a new epistemological model with profound scientific and philosophical implications.

On this basis, he was also widely recognized as a revolutionary epistemologist. In his opus magnum, *The Entropy Law and the Economic Process* (1971), he formulated an alternative program to the contemporary mainstream economy, the neoclassical paradigm. In this book, Georgescu-Roegen introduced a new conceptual framework for understanding the economic processes in contemporary society and, for this purpose, he formulated a new epistemology of economics based on a very general conception on science. I attempt to describe, below, only some of his ideas that are significant from the perspective of a general philosophy of science.

The most important metascientific concept introduced by Georgescu-Roegen is the idea of a "determined system of knowledge production", which is able to provide an integrative conceptual model of cognitive activity and of social dimensions of science, including a new approach of the historiography of science. This thematic metatheoretical concept allows us to represent the multidimensional reality of science. As an example of this general idea, Georgescu-Roegen developed the concept of the so-called "arithmomorphic system of knowledge production", based on a particular type of scientific concepts (like the concepts of classical mathematics, well defined and with sharp conditions of applicability), involving specific methodological procedures and a determinate structure and evolution type. In this sense, the very idea of "arithmomorphic system of scientific growth" characterizes not only a complex type of scientific knowledge production or epistemic activity, defined by a specific internal logic and a particular dynamics and evaluation of knowledge, but it also determines a specific type of social integration of scientific results and some peculiar "ideological commitments".

This kind of concepts are among those "thematic ideas" or "*durchlaufender Kategorien*", as the anthropologist Arnold Gehlen called them, which can structure the problematic of vast and multi-level fields of study, by welding whole disciplines into one coherent system, or by defining the guidelines for developing a certain

discipline over a long period of time. On the metatheoretical level, these concepts can mediate between the "internalist" and "externalist" approaches of science, providing a framework or a basic interpretive scheme for examining an entire "system of scientific activity" that exists at some point in the historical development of science. By using the idea of an "arithmomorphic system of science", Georgescu-Roegen identified certain types of cognitive structures, defined up to concepts of internal logic (as "discretely distinct" concepts): a generalized ontological framework, a methodological ideal-type (dominated by formalism), a model that causes subtle ironies like the following: no doubt, formal considerations are often inspirational spring, but past that, we tend to forget that they are not actually grounded on anything, and this is their real danger. At the same time, the concept of "arithmomorphic system" includes an analytical scheme, a peculiar kind of evolution required by "theory-based-science", as well as a determinate kind of the "institutionalization" of the arithmetic ideal-type as a paradigm of professionalized science, containing a definite type of the "authority structure" of science, a certain hierarchy based on arithmetic "ideal types".

The major purpose of Georgescu-Roegen is not limited to criticizing the arithmomorphic methodologies, but rather it aims at exploring new modalities to overcome this socio-cognitive system based on "arithmomorphic cognitive structures" and to open new ways of scientific growth beyond those permitted by the arithmomorphic structures, starting from a new kind of concepts, called "dialectical concepts" (taking inspiration by A.N. Whitehead, who was also a philosophical source for the ecological reconstruction of economics). This kind of epistemology introduces a conceptual vocabulary that should allow a wider perspective on the development of knowledge. The main target of Georgescu-Roegen critique is the "mechanistic epistemology" (see Georgescu-Roegen 1974) and the inappropriate use of classical logic in scientific reasoning. In this sense, Georgescu-Roegen declared: "I believe that what social sciences, nay, all sciences need is not so much a new Galileo or a new Newton as a new Aristotle who would prescribe new rules for handling those notions that logic cannot deal with" (Georgescu-Roegen 1971: 41). In his new approach, theoretical science must be conceived as "a living organism precisely because it emerged from an amorphous structure – the taxonomic science – just as life emerged from inert matter" (Ibidem: 36).

The fruitfulness of the categorical system introduced by Georgescu-Roegen was revealed by a case study of the significance of J. von Neumann's famous theorem regarding the interdiction of "hidden variables" in quantum mechanics, which was instrumental in blocking alternative constructions and interpretations in quantum theory (Pinch 1977). In the same direction, we can explain some of the moments in the history of science in which the theoretical-methodological aspects were strongly "connected" to socio-political ones. Thus, a theorem like von Neumann's, which blocked for about two decades and a half any competent attempt to criticize the Copenhagen interpretation of quantum mechanics (the so-called "standard" interpretation), can be understood within the arithmomorphic pattern as being dominated by the ideal of a super-formalization of theories. This could be the only way to explain why, during this entire period, the physicists didn't

criticize its logical structure, or its semantic and methodological significance. Only in the context of increasing doubt among mathematicians about the high virtues of formalism and axiomatization were the subtle "dialectic" arguments successfully brought up among the "great priests of science" by David Bohm. By overcoming the "arithmomorphic rigidity", Bohm reopened the "case" of physical and ontological interpretation of quantum mechanics. This "historiographical experiment" proves the epistemological potential and effectiveness of the new general interpretive system proposed by Georgescu-Roegen for understanding and improving the actual development of knowledge, as an important model for a philosophy of real science.

In a certain sense, the works of Haret and Georgescu-Rogen in social sciences instantiate the methodological duality between "mechanistic" and "organicist" paradigms of theoretical construction in this field of science. It is important to underline the fact that both scientists attempted to build a non-exclusive, complementary approach of these two methodological strategies. This attitude can be exemplified by the Haret's laws-centered approach towards the mathematical modeling of social phenomena and, at the same time, by Georgescu-Roegen's acceptance of the organicist mode of thinking in economics, not as a local fact of a special domain of reality, but rather as one with general significance, founded on strict analogy between physical laws, such as the entropy law or the second law of thermodynamics, and the economic processes.

The last Romanian scientist-philosopher to be discussed here is Eugenio Coseriu (1921–2002), a leading theoretical linguist of the last century and a philosopher of language trained in phenomenology. My reasons for presenting his ideas in linguistic theory are related not only to their innovative character and their potential for further generalization, but also to their relevance for the general philosophical significance of contemporary linguistics, which has become, after the successive structuralist and cognitive paradigmatic changes, a "pilot discipline" (R. Thom) for many emerging sciences.

Eugenio Coseriu was the proponent of a new type of theory-construction in linguistics, called "integral linguistics", and the founder of a new school in the contemporary science of language. The theory-core or the theoretical framework of his scientific program, known as "Coseriu's matrix", is determined by the "intersection of three levels of language and three 'points of view' on linguistic (and cognitive) reality, giving (at least) nine different ways in which the phenomenon of language can appear for us, and in which it can be systematically studied" (Zlatev, 2011: 132). In this sense, Coseriu's matrix is a scientific model which has at the same time an intrinsic philosophical significance, being "a helpful epistemological frame of reference for the interpretation not only of the various linguistic problems ranging from the linguistic change to that of translation and of linguistic correctness, but also of the structure of the linguistic disciplines themselves and of recent developments in linguistics" (Coseriu 1985: xxv).

This theoretical framework, which represents for Coseriu his "permanent frame of reference", is based on an implicit fundamental principle "underlying [his] treatment of the different, general, or particular, linguistic problems" (Idem), and which concerns the levels of language (universal, historical and individual), and

what has lately been called "linguistic competence" or, as Coseriu has called it, "linguistic knowledge" (*saber linguistico*). The distinction between different levels of language is instrumental in determining the theoretical topos of different linguistic problems and of the different theoretical perspectives in the study of language. The second "dimension" of the theory matrix is represented by the three "points of view" or perspectives in approaching the phenomenon of language, respectively, as activity (*energeia*), knowledge (*dynamis*) or product (*ergon*).

In his "Presidential Address" to the *Modern Humanities Research Association* at University College, London (on January 11, 1985), Coseriu presented what he considers his "main contribution to the study of language and consequently to the foundation of linguistics or, to put it in another words, what constitutes my permanent frame of reference" (Ibidem: xxv), namely the conceptual matrix generated by crossing the points of view with the levels of language (representing a sui generis "categorical scheme" for the study of language with a duality of functions: theoretical/ metatheoretical or fundamental/foundational):

Coseriu's matrix is represented in the following way:

		Points of view	
Levels	*energeia*	*dynamis*	*ergon*
	Activity	Knowledge	Product
Universal	Speaking in general	Elocutional knowledge	Totality of utterances
Historical	Concrete particular language	Idiomatic knowledge	(Abstracted particular language)
Individual	Discourse	Expressive knowledge	Text

The most important distinction in this complex matrix, indispensable, in Coseriu's view, for the understanding of the very structure of language, is that between activity, knowledge and product. This tripartite distinction, operative at all levels of language, and the essential emphasis put on *energeia* (activity), are the basis for a new understanding of the nature and function of the much discussed linguistic competence. For Coseriu, the primary distinction between activity and cognition, which is missing in the great majority of contemporary theories of language, enables us to better understand the multifarious problems of linguistic competence, as well as equally important problems of linguistic change, translation and language learning. For Coseriu, linguistic competence, which is the basis or the medium for the creativity of human language, must be placed at another level of the language structure, and consequently, must be conceived of in a different theoretical manner than, for example, in Chomsky's conception of linguistic competence. In contradistinction to the latter, which locates this essential capacity of language nature and functioning at the level of the "knowledge of language", Coseriu considers that linguistic competence is thereby "under-theorized" and its main characteristic – creativity – is "mistaken for productivity, for the production of infinitely many 'correct' sentences by means of the application of a fixed and finite system of rules" (Ibidem: xxix).

Coseriu's new theory of linguistic competence conceives of its proper dimension – creativity – as irreducible to something else, to something not creative, but regards it rather as a "primary *Faktum*" of human language, which corresponds to the special constitution of human beings (Coseriu 1988: 202). On Coseriu's view, Chomsky and his followers "are not prepared to establish and to accept creativity as a *Faktum*, but they try to reduce it to another thing which is not more creativity, namely the facts of the same kind" (Ibidem: 201). In the best case, they try to reduce creativity to some aspects of experience. This reduction is contradicted by the impossibility to derive from a particular combination of the items of experience the abstract (a priori, for Kant) structure of linguistic competence. In fact, in the case of the constitution of concepts, we find a permanent overcoming of experience and a creation of universals. In the case of a "positivistic thinking", the linguistic competence in general "is not founded on a special possibility of humans to create linguistic knowledge, but it is reduced again to knowledge (*Wissen*)" (Ibidem: 202). As a new kind of competence, the linguistic competence is conceived by Coseriu as a "capacity to create projects of the possible", as is the case, for example, with the construction of concepts. This particular situation is informative for the general idea of linguistic competence, because it proves the impossibility to represent this type of human capacity according to the Aristotelian kind of abstraction.

When applied to explaining language meanings, Coseriu's conception is completely opposed to a current view, shared among philosophers, which considers that "the meanings are deduced from contexts"; this perspective has nothing to do, in Coseriu's conception, with the nature of language meanings, but only with the modality in which they are learned (It is possible that this opinion has been one of the reasons for a non-sympathetic attitude of the neo-wittgensteinians towards Coseriu's philosophy of language). At the same time, the learning of language represents itself "a continuous creation of meanings, i.e., a creation of projects and systems", having the same internal structure with the language competence in general. In the most positive perspective, the creativity of language represents for Coseriu "a capacity to dispose on a system of possibilities", which is not reducible to a system of predetermined rules, but represents a second order capacity, which designates the determinative matrix for the generation or production of different systems of rules: "Es geht nicht darum," Coseriu said in an interview, "dass man unendliche Fakten realisiert aufgrund eines System von Regeln, sondern darum dass man neue Regeln enstehen lässt und neue Regeln schafft" (Kabatek and Murguia 1997: 162). Creativity of language, as a construction of new rules or systems of rules, and not as a repeated application of already given rules, can define a new paradigm for many humanities and social sciences. The theoretical and philosophical potential of Coseriu's matrix and of his conception of an "integral linguistics" can justify the following claim: "it is possible to surmise that linguistics would not have been in its present fragmented state if, sometime half a century ago, it had followed the lead of thinkers such as Coseriu rather than Chomsky" (Zlatev 2011: 132).

I have dedicated a little more space to the exposition of Coseriu's fundamental ideas in linguistics and philosophy of language not only because I think that it

has an important epistemological potential for generalization, but also because his conception can contribute essentially towards fulfilling the desideratum of a "theoretical contemporaneity" of the human disciplines with the most developed classical sciences, dominated by the so-called abstract structural mode of theory-construction. This kind of scientific theorizing (as "epistemologically projected" by some Romanian scientists) is the subject matter of the next section of my chapter.

1.3 The "Categorical Change" in the Exact Sciences and the Project of an "Axiomatic Philosophy of Science"

In this section, I will concentrate on a very important project of philosophical construction developed in the 1930s and 1940s by a group of philosophically minded scientists from the University of Bucharest, led by the mathematician Octav Onicescu. This kind of contribution of Romanian scientists to the philosophy of science centered on the "categorical change" (Gr. C. Moisil) in mathematics and physical science in the first part of the last century, a change determined by the structural (re)construction of mathematical sciences, which involved a deep transformation of the relation between science and philosophy and opened the possibility of a new scientific philosophy, a philosophy not only inspired by the new fundamental scientific achievements, but also internally consolidated with the help of scientific concepts and methodological procedures.

In what follows, I will try to present briefly some of the philosophical ideas and metatheoretical concepts formulated by members of the Onicescu seminar. This seminar was attended by some well-established scientists, as well as by a series of young scholars in mathematics, physics, linguistics and philosophy: Grigore C. Moisil, Dan Barbilian, Şerban Ţiteica, Nicolae Teodorescu, Gheorghe Vrănceanu, Alexandru Ghika, Petre Sergescu, Mihai Neculcea, Nicolae Georgescu-Roegen, Alice Botez, et al. Their works were published in a great variety of forms: as monographs or thematic collective volumes (e.g., O. Onicescu, ed*., The Problem of Determinism*, 1940; O. Onicescu, *Principles of Scientific Knowledge*), but also as research papers in scientific and philosophical journals from Romania, France, Germany, Italy, USA, and as academic treatises, university or popular lectures, etc. Many of these works were reviewed by A. Church, E. Nagel, G. Birkhoff, R. Feys, C.H. Langford, P. Henle, A. Turquette, etc.

The Onicescu seminar was organized each year around a fundamental theme, such as the ideas of determinism, space, time, infinity, the object of scientific theory, the problem of language in contemporary science, etc. The "scientific philosophy" of the Onicescu group (alternatively termed, "axiomatic philosophy", "mathematical epistemology" or "the philosophy of structural science") can be characterized by the following important traits:

(i) The philosophical reflection of the Romanian scientists represented in an essential way a product of the critical examination of *abstract-structural theories* in

mathematics and physics. The conceptual framework for philosophical analysis was provided by the probabilistic and structuralist revolutions that have occurred in the first half of the last century and produced a sort of "categorical change" in the exact disciplines (Moisil 1942). This "new kind of science", stylistically dominated by the structural research and the construction of abstract theories, offered the methodological instruments, fundamental principles, and patterns of explanation for the philosophical programs or for the new interpretive frameworks.

In this direction, very significant were Onicescu's efforts to build a general philosophy of structural science, in which the most fundamental, thematic ideas of science like object, causality and determinism, time and space, etc., can be creatively re-interpreted. At a time in which the philosophical field was dominated by logical empiricist conception on science, Onicescu rejected the "nominalist" or formalist reduction of science (and especially of mathematics) to language, the instrumentalist interpretation of the relation between mathematics and reality, and the general anti-metaphysical outlook characteristic for many new schools in the philosophical interpretation of science. He also formulated a realist conception about the nature and function of theoretical concepts and laws of science. In his sense, we must note his remarkable analysis of the most complex concept, theoretical *par excellence*, which was operative in science and philosophy: the concept of infinite. Onicescu extended Hilbert's program, launched in the latter's famous 1926 lecture "On the Infinite", to a solution of the problem of the infinite at the logical level, and explained the essential role of the infinite in the constitution of abstract concepts and of new levels of theoretical architectonics of science.

Throughout his research, Onicescu was inspired by the change of perspective produced in science by the two fundamental theories of the last century, Relativity Theory and Quantum Mechanics. For Onicescu (as well as for Dan Barbilian), the main transformation produced by these two theories consists in the introduction of the invariant-theoretical approach, which must be continued at the epistemological and ontological levels of the philosophical reflection on science. The new "science of structures" opened, on Onicescu's view, not only new theoretical perspectives, but it produced also important changes in the "technique of reason", improving at the same time the analytical apparatus of the scientific methodology.

Starting from the same structural construction of mathematical sciences, Grigore C. Moisil launched the program of a rigorous formal "mathematical epistemology", having as central themes the ideas of truth, objectivity, and stability of knowledge (In connection with this last concept, we must note the fact that Moisil was one of the first scientists and philosophers of science who emphasized the epistemological significance of theoretical stability of mature science, especially in understanding the role and function of theoretical laws). Moisil proposed to avoid the traditional empiricist concerns with epistemic certainty of beliefs and the refutation of skepticism, and to redirect the epistemological research to the more fundamental problem of the objectivity of knowledge. In his project for a new "mathematical epistemology", Moisil indicated the possibility and necessity to use

the new formal instruments offered by the concepts and theoretical procedures of structural mathematics in order to rend intelligible the problem of knowledge. The new mathematical analysis of the problem of knowledge can reveal "the very formal acts of thought" and the rational connections between thought and reality. Moisil considered his project of a mathematical epistemology as an extension of Poincaré's reflections concerning the role of the idea of group as a "form of the understanding" to all structural concepts and abstract theories of contemporary mathematics.

(ii) Most Romanian scientists benefited from their mastery of mathematics in developing many of the scientific and meta-theoretical instruments for the analysis and theoretical reconstruction of science and philosophy. Thus, for example, Gr. C. Moisil, in a very influential, paradigmatic study, "Determinism and enchainment", applied and further developed the new ideas from the probability theory formulated by O. Onicescu and Gh. Mihoc, in order to reconstruct the internal forms of the principle of determinism as theoretical constraints on the physical laws, characteristic for every type of deterministic theories. The great significance of the new concepts and methodological approaches formulated by Onicescu and Mihoc in probability theory is testified by the fact that Onicescu was invited in 1937 to present the new concept of a statistical chain with complete connections to the international congress on probability at the University of Geneva (where among the invited guests were W. Heisenberg, A. Kolmogorov, B. de Finetti, R. von Misess, J. Nyman etc.).

In the same direction, the extension of the "Erlangen program" in geometry and physics proposed by D. Barbilian (a forerunner of contemporary invariantist approaches to articulating a fundamental theory) resulted in a new axiomatization of classical mechanics (Barbilian 1937). He explicitly formulated the fundamental role in this theoretical construction of science of the fundamental group of a theory, as the key instrument for attaining the objectivity of knowledge at the abstract-structural level of scientific theorizing (Barbilian 1940). The new axiomatization of classical mechanics formulated by Barbilian, as an extension in physics of the group-theoretical reconstruction of mathematical theories (proposed initially by Felix Klein for geometric theories), can also be considered as a step in the realization of the second Hilbert's program – the mathematical axiomatization of physical theories (Hilbert's 6th problem), and in this sense, as a partial fulfillment of Hilbert's scientific-epistemological ideal expressed in his famous lecture "Axiomatical Thinking" (1917): "Alles, was Gegenstand des wissenschaftlichen Denken überhaupt sein kann, verfält, sobald es zur Bildung einer Theorie reif ist, der axiomatischen Methode und damit mittelbar der Mathematik". Along the same lines, Barbilian emphasized the epistemological significance of his axiomatization of classical mechanics: "Jetzt, wo die klassische Mechanik von den Physikern den Geometern überlassen wurde, war es vielleicht nicht unnötig zu zeigen, dass man mit ihr noch etwas machen kann, sie nämlich mit einer durchsichtigen Struktur ausstatten, die an ihr Urbild, die bewegliche Himmelsphäre, erinnert" (Barbilian 1937, in *Opera matematica*, vol. 1: 210).

We should also note that, at about the same time, Alexandru Froda, who was considered in the 1950s one of the most eminent philosophers of physics (according to Suppes 1994), anticipated the new forms of physical axiomatics, developed from an algebraic point of view, as well as their meta-theoretical requirements.

(iii) Conceptual analyses and theoretical reconstructions were performed by Onicescu, Moisil, Barbilian, Țiteica et al. in the field of real science as an internal aspect of the "*theoretical practice*" of articulating and developing a complex research program, and not as a series of "nominal definitions" or "elucidations" of the meta-scientific concepts or of the principles and methodological procedures considered *in abstracto*, as elements of "rarefied", simplified "models" of scientific activity. The main intention of the Onicescu group was the reinvestment of the analytical results of the metatheoretical studies into the fundamental research in order to open new horizons for the constructive extension of science and philosophy. We can illustrate this approach to the analytical research of these Romanian scientists with Barbilian's idea of the role of the fundamental group of a theory, which was remarkably suited, by its capacity to bring into prominence the general features of the structural type of theory-construction, to represent the main instrument for the mathematical generalization of an abstract theory and for generating new alternative research directions by the different modes of the "paradigm's articulation".

The metascientific results of the Onicescu group were not so much logical elucidations of the concepts, arguments and interpretive principles of a general character, but rather new theorems and theories with a genuine creative potential for the extension of exact science and at the same time for "deepening the foundations" and enhancing philosophical understanding, the essential task for axiomatic thinking as defined by David Hilbert.

The constructive nature of the conceptual analyses characteristic of the Bucharest school in scientific philosophy, was, in part, determined by the very essence of the science that constituted the field of metascientific research: the structural-abstract mathematics and natural science, that kind of science for which the axiomatic analysis represented not so much a matter of logical systematization of pre-existing empirical science, but rather a *sui generis* mathematical construction by which a general structure with multiple possible realizations was determined for the first time. In this sense, on the one hand, Moisil understood philosophical analysis as a part of fundamental research in science. The philosophical principles of determinism, for example, were projected as internal constraints, mathematically defined, on the theoretical articulation of science. On the other hand, it is this kind of science, best represented by structural mathematics, which makes it possible to employ the technical instruments, concepts, and constructive methods of science for philosophical reflection, in order to obtain new ways of presenting and solving epistemological problems. In Moisil's own words, "if mathematics of quantity was a wonderful instrument for the knowledge of physical world", structural mathematics "opens the possibility to organize a mathematical epistemology" (Moisil 1937, in Ath. Joja et al (eds) 1971: 144).

(iv) The same invariant-theoretical approach in fundamental research can explain the "mathematical way" (as distinct from the proof-theoretical one) of conceiving the main *metatheoretical constraints* of axiomatic theories. The Romanian scientists intended to bring forth, by means of mathematical concepts, a deeper level of the "logical structure" of a scientific theory, one revealed not by the deductive organization of its set of statements (as in the case of the standard formalization of theories), but rather by the formative and determinative mathematical substructures of the theory. This logical structure or internal logic can be revealed by the axiomatic conceived by Barbilian, for example, as a general and formal theory of "scientific doctrines" (very similar to Carnap's "*allgemeine Axiomatik*"). Consequently, they were interested in exploring other kinds of metatheoretical conditions, all of them strongly related to the internal constructive function of the fundamental group of a structural theory (Thus we can explain their alleged insensitivity to the famous metatheoretical results concerning the deductive completeness of first order axiomatization).

On the group-theoretic or invariantive approach, the operations presented by the abstract theory are, in the axiomatic philosophy of Dan Barbilian, of a cardinal significance from the metatheoretical point of view. The fundamental group, as a formal matrix determinative for an entire research program, is at the same time responsible for the new kind of the metatheoretical conditions of "axiomatic doctrines" (completeness, categoricity, axiomatizability), which constrain essentially the relation between theory and reality, not only the deductive closure of a set of sentences that represents only possible formulations of the theory. In this sense, in the case of axiomatic doctrines, as interpreted by Dan Barbilian, we can speak of an "immanent approach" in the metatheory of exact sciences: constraints of this kind are imposed not by some external, logical conditions, but by the very formal structural core of the theory – the fundamental group. At the same time, given the fact that the fundamental group of a theory is essentially involved in all possible extensions of the general theory, the explicit formulation of the subsidiary mathematical structure of a scientific theory constitutes not only an analytic but also a constructive, "creative" procedure (Barbilian 1940). This methodological procedure can be exemplified by the case of classical mechanics: after being included by Einstein and Poincaré in the "Erlangen Program", the "absolute" character of this doctrine (univalent theory) was abandoned in favor of a general spectrum of theoretical alternatives.

(v) This "*mathematical way*" of the philosophical analysis of science represented, for the Bucharest group, the most suitable possibility for building a new "*scientific philosophy*". It constituted the common core of all three projects of the theoretical reconstruction of philosophy, respectively, "mathematical epistemology" (Moisil), "structural philosophy of science" (Onicescu) and the mathematical meta-mathematics with its "inseparable" structural ontology (Barbilian). The technical results and the philosophical significance of the invariantive perspective in foundational research, as a genuine form of the "logical analysis of science", can be better understood in the light of the

recent reevaluations of the instruments of metatheoretical investigation that appeal essentially to the most advanced theories of the structural mathematics, especially to category theory, sometimes considered as the contemporary form of the "Erlangen Program". From this perspective, we have now a better reference frame for evaluating the insistent critique by the Romanian scientists of the formalist approach in the philosophical analysis of science and their project to re-think the whole task of such an analysis as a constitutive part of, and a fundamental/foundational investigation in, the real science, and as an original form of the scientific philosophy.

The Onicescu group was enlarged in the years 1940–1945, when other scientists and philosophers (Simion Stoilow, Anton Dumitriu, Alexandru Mironescu, Constantin Noica, et al.) joined in, forming the "Science and Knowledge Group" and becoming thus the most active center of research in philosophy of science in Romania. It was continued after the Second World War, at the University of Bucharest, mainly through the studies and university lectures by O. Onicescu, Gr. C. Moisil, Al. Froda and M. Neculcea. At other Romanian universities, this kind of foundational, philosophically informed research in science was undertaken by Remus Răduleț, at the Polytechnic University of Bucharest and by Emil Tocaci, at the University of Ploiești.

If we consider the whole development of the ideas described above, we can distinguish in the works of members of the Onicescu seminar and of their followers some common, integrative traits: a set of thematic concepts and methodological principles, some paradigmatic studies that served as models of scientific philosophy, a new technique of philosophical analysis, and some new metatheoretical requirements. All these features represent the most important traits of the constitution of a genuine school in philosophy of science, which further develops at a higher level the individual efforts of such great forerunners. Due to all its achievements and projects, this philosophical school has been appreciated as "the most important philosophical fact in Romanian culture" (Dumitriu 1942: 113).

Bibliography

Albrecht J (ed) (1988) Energeia und Ergon, Sprachliche Variationen– Sprachgeschichte– Sprachtypology: Studia in Honorem Eugenio Coserio, 3 Bde. Gunter Narr, Tubingen

Albrecht J (2003) El paradigm Incompleto de Eugenio Coseriu: Tares Pendiente para la Tercera Generation. Odissea 3:41–54

Barbilian D (1937) Eine Axiomatisierung der klassischen Mechanik. Comptes Rendus de l'Inst Des Sc De Roum II(2):1–7

Barbilian D (1940) Determinism and order. In: Onicescu O (ed) (1940)

Barbilian D (1942) The place of axiomatics (in Romanian). In: Barbilian D (ed) Opera didactică. Editura tehnică, Bucuresti

Beard TR, Gabriel LA (1999) Economics, entropy and the environment: the extraordinary economics of Nicholas Georgescu-Roegen. Edward Elgar, Cheltenham

Bernardo Paniagua JM (1995) La construccion de la linguistica. Un debate epistemologico. Ed. Universitat de Valencia
Berr H Sur Bernheim et Xenopol. Revue Synth Hist XVIII:354–358
Bonaiuti M (ed) (2011) From bioeconomics to degrowth: Georgescu-Roegen's "New Economics" in eight studies. Taylor & Francis, New York
Boutroux E (1908) La théorie de l'histoire par Alexandre D. Xenopol. Académie des sciences morale et politiques, Paris
Colvin P (1977) Ontological and epistemological commitment and social relations in science. The case of the Arithmomorphic System of Science Production. In: Mendelsohn E et al (eds) (1977)
Coseriu E (1955–1956) Determinacion y entorno. Dos problemas de una linguitica del hablar. Rom Jahrb 7:29–54
Coseriu E (1957) Sincronia, diacronia e historia. El problema del cambio linguistico. Rev Fac Humanidades y Cienc (Montevideo) 15:201–255
Coseriu E (1978) Les universaux linguistiques (et les autres). In: Proceedings of the eleventh international congress of Linguists, I, Bologna, pp 47–73 (trans: Linguistic (and other) Universals. In: Makkai A, Heilmann L (eds) (1977) Linguistics at the crossroads. Padua, pp 317–346)
Coseriu E (1985) Linguistic competence: what is it really? The presidential address of the Modern Humanities Research Association, read at University College, London, 11 Jan 1985
Coseriu E (1988) Sprachkompetenz. Grundzuge einer Theorie des Sprechens. Bearbeitet von Heinrich Weber, Franke Verlag, Tübingen
Coseriu E (2000a) The principles of linguistics as a cultural science. Transylvanian Rev (Cluj) IX(1):108–115
Coseriu E (2000b) Structural semantics and 'Cognitive' semantics. Logos Lang (Tübingen) I(1):19–42
Coseriu E (2003) Geschichte der Sprachphilosophie. Von dem Anfangen bis Rousseau. neu bearbeitet und erweitert von Jörn Albrecht, Tübingen
Croce B (1939) Conversazioni critiche. Bari (serie quinta)
Dumitriu A (ed) (1941–1945) Caiete de filosofie. Atelierul de Arte Grafice Independenta, Bucuresti
Dumitriu A (1942) Foreword. Caiete de filosofie 4:111–113
Froda A (1959) La finitude en mécanique classique, ses axiomes et leur implications. In: Henkin L, Suppes P, Tarski A (eds) The axiomatic method with special reference to geometry and physics. North-Holland, Amsterdam
Froda A (1960) Analyse du principe de continuité en physique. In: Suppes P et al (eds) Logic, methodology and philosophy of science. Stanford, North-Holland/Amsterdam
Froda A (1971) Error and paradox in mathematics (in Romanian). Editura enciclopedică română, Bucuresti
Geană G (2003–2004) The actuality of Simion Mehedinți's thought (in Romanian). Studii si cercetări de geografie xlix:13–18
Georgescu-Roegen N (1933) Statistical method (in Romanian). Institutul de statistică generală a statului, Bucuresti
Georgescu-Roegen N (1966) Analytical economics: issues and problems. Harvard University Press, Cambridge, MA
Georgescu-Roegen N (1967) An epistemological analysis of statistics as the science of rational guessing. Analele Universităţii din Bucureşti, Seria Acta Logica X:61–91
Georgescu-Roegen N (1971) The entropy law and the economic process. Harvard University Press, Cambridge, MA
Georgescu-Roegen N (1974) Mechanistic dogma and economics. Methodol Sci vii(3):178–184
Georgescu-Roegen N (1986) The entropy law and the economic process in retrospect. East Econ J 12:3–25
Haret S (1910) Mécanique sociale. Gauthier-Villars, Paris
Hiemstra P (1987) Alexandru D. Xenopol and the development of Romanian historiography. Taylor & Francis, New York
Itkonnen E (2011) On Coseriu's legacy. Energeia III:1–29