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THE PHILOSOPHICAL LOGIC OF STÉPHANE LUPASCO (1900–1988)

Abstract. The advent of quantum mechanics in the early 20th Century had profound consequences for science and mathematics, for philosophy (Schrödinger), and for logic (von Neumann). In 1968, Putnam wrote that quantum mechanics required a revolution in our understanding of logic *per se*. However, applications of quantum logics have been little explored outside the quantum domain. Dummett saw some implications of quantum logic for truth, but few philosophers applied similar intuitions to epistemology or ontology. Logic remained a truth-functional 'science' of correct propositional reasoning.

Starting in 1935, the Franco-Romanian thinker Stéphane Lupasco described a logical system based on the inherent dialectics of energy and accordingly expressed in and applicable to complex real processes at higher levels of reality. Unfortunately, Lupasco's fifteen major publications in French went unrecognized by mainstream logic and philosophy, and unnoticed outside a Francophone intellectual community, albeit with some translations into other Romance languages. In English, summaries of Lupasco's logic appeared *ca.* 2000, but the first major treatment and extension of his system was published in 2008 (see Brenner 2008). This paper is a further attempt to establish Lupasco's concepts as significant contributions to the history and philosophy of logic, in line with the work of Gödel, general relativity, and the ontological turn in philosophy.

Keywords: actualization, contradiction, dialectics, energy, implication, information, logic, potentialization, process, reality.



1. Introduction

1.1. Logic, quantum mechanics and reality

Logic, broadly defined as the science of correct reasoning, is today a linguistic discipline, constituted by axioms and rules for determining the truth of propositions and the validity of inferences about them. Standard bivalent and multi-valent propositional logics, including their most recent modal, deontic and epistemic versions, have provided a powerful system for support of the development of science and technology. The principles of bivalent logic underlie standard set and category theory, computational theories of mind and the universe, and so on. Further, they correspond to part of our everyday experience and reasoning, *e.g.*, of identity, consistency and stability, and the ontological value we ascribe to these properties.

On the other hand, many aspects of existence, beginning with inconsistencies and change — growth and life and the emergence of new kinds, most generally speaking non-identities — cannot be handled by standard logics, and are often relegated to second-order ontological status, or are considered the exclusive purview of experimental science.

The advent of quantum mechanics in the early 20th Century had profound consequences for science and mathematics, for philosophy (Schrödinger), and for logic (von Neumann). In 1968, Putnam wrote that quantum mechanics required a revolution in our understanding of logic *per se*. However, applications of quantum logics were not explored outside the quantum domain. Dummett saw implications of quantum logic for truth, but few philosophers or logicians applied similar intuitions to real aspects of epistemology or ontology.

1.2. Rationale and objective

As early as 1935, however, a first and as far I have been able to determine the only significant challenge to the received limitation of logic to propositions or their mathematical equivalents was made by the Franco-Romanian thinker Stéphane Lupasco. The purpose of this article is to provide access, for English-language readers, to this novel philosophical logic and to position it in the history and philosophy of logic. A brief biographical note is essential to its understanding.



Lupasco was born in Bucharest in 1900 in a family of the old Moldavian aristocracy, a source of many writers, scientists and musicians. His father was a lawyer and politician; his mother, a pianist and student of César Franck, established the family in Paris in 1916. Lupasco studied philosophy, biology and physics at the Sorbonne and, briefly, law, and defended his State Doctoral Thesis in 1935 (see Lupasco 1935). First outlined in this Thesis, republished in 1973, Lupasco proposed a new form of logical system, grounded in the physics and cosmology of Planck, Pauli and Heisenberg, which was based on a principle of dualistic, dynamic opposition in energy, and characterized by a law of the *included* middle. In 1946, he was named Research Assistant at the French National Science Research Center, a post he was obliged to leave ten years later because of the inability of the Center to decide in which faculty his work belonged!

In a total of 15 books, Lupasco provided applications of his theory to physical, biological, psychological and social phenomena. His *Trois Matières* (see Lupasco 1960), published in 1960 was a bestseller, and the public, including artists such as Breton and Dali (but not mainstream philosophers and logicians) began calling Lupasco the Descartes, the Leibniz, the Hegel of the 20th Century, a new Claude Bernard, a new Bergson, etc. His last book, *L'Homme et ses Trois Ethiques* (see Lupasco 1986a), was published two years before his death in 1988 in Paris. His critics included the French philosophers Jean-Jacques Wunenberger, the well-known Gaston Bachelard and the Swiss Ferdinand Gonseth. Several contemporaries, e.g. the sociologist Yves Barel, plagiarized his ideas freely. However, his detractors and plagiarists, as well as his admirers, in my view, lacked the scientific perspective necessary to comprehend and appreciate the grounding of a system in physics, while maintaining the advantages of a formal logical structure. Basarab Nicolescu, Professor (em.) of Theoretical Physics at the University of Paris VI, a friend and collaborator of Lupasco, has recently summarized critical encounters of Lupasco in this period, for example with the philosopher Raymond Abelio among many others (see Nicolescu 2009).

Lupasco presented only a very limited formal treatment of his work, one of the possible reasons for its lack of acceptance, or even of discussion, by philosophers and logicians. Lupasco obviously did not find the didactic approach congenial; he made some reference to contemporary science, especially developmental biology, but not to contemporary logic or epistemology. In the 1970's, encounters with Nicolescu led Lupasco



to accept the former's more rigorous formulation of the included middle in terms of levels of reality. Together with Nicolescu, Edgar Morin and other key figures of the French *intelligentsia*, Lupasco founded the International Center for Transdisciplinary Research (*Centre International de Recherches et Etudes Transdisciplinaires, CIRET*) in Paris in 1987.

An Award of the American Academy of Arts and Sciences in 1984 was among the few honors that came to Lupasco during his lifetime. As Nicolescu has recalled, Lupasco was deeply affected by the stubborn resistance of the academic community to fair debate and discussion of his new conception of logic, and it is with an understandable bitterness that Lupasco saw in this resistance another example of the operation of its principles.

1.3. Bibliography

Lupasco was badly served by his few exegetes in his lifetime. Only one book, by the sociologist Marc Beigbeder (see Beigbeder 1972), presents a substantial description of Lupasco's theory and development of it as a "logic of society". A brief monograph by the philosopher Benjamin Fondane, dating from 1944 and published in 1998 (see Fondane 1998.), discusses the limitations of Lupasco's view of affectivity and ontology. An obscure English artist, George Melhuish (see Melhuish 1959), used Lupasco's ideas to develop a cosmology, a sympathetic but not very rigorous reading of them. Detailed lists of references to other books and articles by and about Lupasco can be found in Badescu and Ioan (see Badescu 1999 and Ioan 2000).

1.4. Outline

In the next Section 2, I recall the *non*-linguistic origins of logic as the context for the discussion of Lupasco. Section 3 summarizes Lupasco's Thesis and the main lines of development of his theory. In Section 4, an overview of the Lupasco logic is provided. In Section 5, I compare his system with several major innovations in logic in the last Century: abductive, paracomplete (intuitionist), paraconsistent and quantum logics. Section 6 indicates some specific issues in science and philosophy to which the Lupasco approach can be applied. Sections 7 and 8 discuss some philosophers and other precursors to Lupasco in two groups, those



for whom he provided a critique himself, and those, more recent, whom I have found most relevant in positioning his work. I conclude with some suggestions of possible directions of development of Lupasco's ideas.

2. The origins of logic

Logic and metaphysics began, in antiquity, as ways of reasoning about nature, or reality. However, relatively early, logic developed into simply a tool for determining the truth or falsity of propositions. Deductive reasoning *per se* was disconnected both from processes of scientific inference and from ordinary experience. The most common current definition of logic is that it is an analytical theory intended to formalize principles of valid reasoning as well as a theory of valid inference that provides insight into the foundations of mathematics. Logical relations, it is alleged, can obtain only between propositions, not between concrete entities, nor between abstract entities that are not propositional in nature. Examples of standard logics are classical term or syllogistic logics — “Aristotelian” logics. Their recent modifications include, among others, first and higher order predicate logics, modal logics and ampliative adaptive logics. Most such propositional logics are based on the principles of bivalence, absolute non-contradiction and the law of the excluded middle.

The logic proposed by N. A. Vasilyev (see Poli 1993) in the 20s brings into relief the unique position of Lupasco. Vasilyev proposed a “universal”, “non-Aristotelian” logical system, universal because it was in part more general than standard classical and neo-classical logics, non-Aristotelian because it rejected in part the axiom of non-contradiction (referred to by Vasilyev as the law of contradiction). Vasilyev tried to break the stranglehold of classical Aristotelian logic with an imaginary logic that has several aspects of interest, not because it provides a logic of reality, but because but it *refers* indirectly to such a possibility. He said that all contemporary movements in logic are a rebellion against Aristotle. “This rebellion progresses slowly, step by step, now here, now there. It is difficult to foretell the future.” “[...] future generations will decide whether this contemporary movement in logic was a riot against Aristotle or a scientific revolution.” I will leave it to the reader to position Lupasco's work on this scale.



3. Lupasco's thesis and major lines of argument

A somewhat broader recent conception of logic as the study of the most general features or forms of thoughts and judgments was proposed by Hofweber (see Hofweber 2005). One can assume, further, that 'forms' are concerned with what a judgment is about, rather than the judgmental proposition itself, and one can associate it (form) with the reality that is being judged, including the real mental process that making a judgment involves. On this basis, reality itself, including cognitive processes, has a logical form or structure, which implies a basis for logic in real-world phenomena, and its use for their description.

This was Lupasco's basic insight: logic not only should but can be extended to reality, provided one takes into account, and gives proper metaphysical weight to, some of its characteristics that have tended to be neglected. These include the concepts, present also since antiquity, of dialectics — conflict as well as change and alternation between the different but closely related, interactive elements of a phenomenon. Dialectics can be considered neither more, nor less, than the generalization and mental expression of conflicts in nature and civilization, and their resolution, that man has observed from time immemorial. "Beings and things seem to exist and are able to exist only in function of their successive and contradictory conflicts" (Lupasco 1979). For Heraclitus, conflict did not mean the splitting or destruction of the unity of reality, but its constitution. The *logos*, the only 'abiding thing' is the orderly principle according to which all change takes place, a "binding-together". Conflict (*polemos*) and *logos* are the same.

The demonstration of the possible importance, as partially distinct from the historical interest, of Lupasco's work requires, obviously and unavoidably, the parallel demonstration of its correctness or, better, the additional explanatory power that it might bring to philosophical and scientific debate. Clearly, this writer believes that it does possess such explanatory power. Let us now, accordingly, proceed with the joint demonstration by first following the chronological development of Lupasco's thought.



3.1. Lupasco's thesis

Lupasco's Thesis of 1935 *On Logical Becoming and Affectivity* is in two volumes: the sub-title of the first is *Antagonistic Dualism* and of the second *Essay on a New Theory of Knowledge*. He originally conceived his Thesis as a study of method, and wanted to give it the title *Sketch of a New Discourse on Method* (see Hofweber 2005). This new method "would consist in seeking, in the presence of any phenomenon, first, what is its contradictory phenomenon and second, to what extent it is potentializes (virtualizes) it or is potentialized by it." This key passage in Lupasco's writing continues:

In a general way, one must link the rational and the irrational, identity and non-identity, the invariant and the variant [...] by the constitutive relation of contradictory complementarity, of a duality of dynamic terms, with a principal double aspect, including, for each term, the passage from potential to actual and the passage from actual to potential, each of the terms acting on the other. One must avoid the sterile parallelist conception of contradictory orders, as well as a monism favoring one order, by applying the notion of error or appearance to the other.

Lupasco's work can be divided into the following three periods:

- 1935–1950: scientific and epistemological foundations of a logic of contradiction; formulation of the Principle of Dynamic Opposition.
- 1950–1980: formulation of the axiom of the included middle or T-state, emerging from the contradictory characteristics of energy, and its demonstration in the fields of biology, psychology, etc.;
- 1980–1988: collaboration with Basarab Nicolescu and the formulation of the principle of levels of reality. Nicolescu showed that the Lupasco logic of the included middle was not *itself* contradictory, although it "handles" contradiction.

Of Lupasco's three major lines of argument — the phenomenological, the epistemological and the logical — the first and second had their origins in the Thesis, and the third appears in detail in Lupasco's 1947 work *Logique et contradiction*. The latter was formalized in 1951, in his *Logique d'antagonisme* in which the included middle, "the keystone of Lupasco's philosophy" (see Badescu 1999, p. 114), appears for the first time.



The lines of inquiry converged in a 1962 work, *L'énergie et la matière vivante*, devoted to the application of the Lupasco logical system to developmental biology. Lupasco's subsequent key publications described the application of his logic to neuropsychical (or psychological) "matter", *L'énergie et la matière psychique* (Lupasco 1974), revised and developed further in *L'univers psychique* of 1979 (see Lupasco 1979). It is inherent in Lupasco's system, perhaps inevitably, that the corresponding lines of argument overlap to a substantial extent and finally converge, precisely because Lupasco saw all phenomena, including theory, as different instantiations of the energy common to all of them, *including the logical*.

3.2. Physical and philosophical dualities

Lupasco's entire *oeuvre* can be described as starting from epistemological, logical and phenomenological examples of antagonistic dualism in nature:

Fundamental Dualities

- Physical
 - Intensity and extensity in energy; self-duality (quantum field)
 - Attraction and repulsion (charge, spin, others)
 - Entropy: tendency toward homogeneity
 - Negentropy: tendency toward heterogeneity
- Metaphysical
 - Actuality and potentiality
 - Continuity and discontinuity
 - Identity and diversity
 - Internal and external
 - Local and global

The major new tool available to Lupasco for understanding these dualities was modern physics, both classical and quantum.

3.3. The alternation of actuality and potentiality

The German electrochemist Wilhelm Ostwald (1853–1932; Nobel Prize, 1909) pointed out that an intensity and an extensity could be both actual and potential, but not at the same time. Lupasco first saw here the philosophical basis for both the alternation of actualization and potentialization of the extensive and intensive properties of various forms



of energy, and their relation to the principle of what he would later call the relation of contradiction. Homogeneity, exteriority and objectivity characterize the process of extensity, and heterogeneity, interiority and subjectivity that of intensity, time intervening in the second due to the necessary aspect of succession, but not in the first.

3.4. Identity and diversity

Lupasco's system was further based on the characteristics of energy expressed by the dialectic between its entropic and negentropic properties. Energy has the property of moving from diverse (heterogeneous) high-level forms toward a single (homogeneous) low-level form (heat), governed by the 2nd Law of Thermodynamics. At the same time, energy, as initially indistinguishable electrons (homogeneity, identity), show the property of diversity, governed by the Pauli Principle of Exclusion, which permits the build-up of atoms, molecules and, ultimately, life and human beings (heterogeneity, non-identity, diversity). In addition, the smallest unit of energy, the Planck energy, has both continuous (frequency) and discontinuous (the Planck constant) aspects. By the Heisenberg uncertainty principle, the energy and position of a particle are both localized and non-localized.

Electrons are located in shells around the nucleus of an atom, but two electrons in the same shell cannot have the same quantum numbers for their property of spin. Build-up of a multiplicity of shells is possible, for atoms heavier than helium, in which the electrons will all have, as a consequence of their distance from the nucleus and the degree of completion of the shells, a different capacity (potential) for reacting with other atoms to form different molecules enabling the existence of, ultimately, life and human beings. All matter thus also shows a tendency to instantiate an opposing process of heterogeneity, or non-identity or diversity, a "heterogenizing" process, a diversification.

In any phenomenon, Lupasco said, one should always look at the respective tendencies toward homogeneity and heterogeneity, its identifying and diversifying aspects, in order to understand its structure, orientation and the applicable laws. The "coefficients" of homogenization and heterogenization define a relation of contradiction or opposition since they imply the coexistence, in the energetic constituents of the phenomenon, of identity and non-identity.



4. The Logic of Lupasco as a formal logic

Lupasco proposed that the above characteristics of matter-energy have the form, or can be formalized as, logical principles corresponding to its inherent structural antagonisms or contradictions. I cite here the key passage from his *Le principe d'antagonisme et la logique de l'énergie*:

Energy must possess a logic that is not a classic logic nor any other based on a principle of pure non-contradiction, since energy implies a contradictory duality in its own nature, structure and function. The contradictory logic of energy is a real logic, that is, a science of logical facts and operations, and not a psychology, phenomenology or epistemology. [Lupasco 1951]

4.1. Fundamental postulate

The key postulate, as formulated by Lupasco, is that every real phenomenon, element or event e is always associated with an anti-phenomenon, anti-element or anti-event $\text{non-}e$, such that the actualization of e entails the potentialization of $\text{non-}e$ and *vice versa*, alternatively, without either ever disappearing completely. The logic is a logic of an *included* middle, consisting of axioms and rules of inference for determining the state of the three dynamic elements involved in a phenomenon (“dynamic” in the physical sense, related to real rather than to formal change, e.g. of conclusions).

4.2. Axioms

The three fundamental axioms of classical logic, in one version, are the following:

1. The axiom of identity: A is (or $=$) A .
2. The axiom of non-contradiction: A is not (or \neq) $\text{non-}A$.
3. The axiom of the excluded middle: there exists no third term ‘T’ (‘T’ from third) that is at the same time A and $\text{non-}A$.

Based on his “antagonistic” worldview, according to Basarab Nicolescu (see Nicolescu 1996), Lupasco “rewrote” the three major axioms of classical logic as follows:



1. (*Physical Non-Identity*): There is no A at a given time that is identical to A at *another time*.
2. (*Conditional Contradiction*): A and non- A both exist at the same time, but only in the sense that when A is actual, non- A is potential, reciprocally and alternatively, but never to the limit of 100%.
3. (*Included Middle*): An included or additional third element or T-state ('T' for '*tiers inclus*', included third).

The evolution of real processes is therefore asymptotically toward a non-contradiction of identity or diversity, or toward contradiction. The mid-point of semi-actualization and semi-potentialization of both is a point of maximum contradiction, a "T-state" resolving the contradiction (or "counter-action") at a higher level of reality or complexity.

Lupasco deserves the historical credit for having shown that a logic of the included middle is a valid multivalent logic, with the indicated terms. At a single level of reality, the second and third axioms are essentially equivalent. In Nicolescu's extension of the logic, the T-state emerges from the point of maximum contradiction at which A and non- A are equally actualized and potentialized, but at a higher level of reality or complexity, at which the contradiction is resolved. His paradigm example is the unification in the quanton (T) of the apparently contradictory elements of particle (A) and wave (non- A). In contrast to the Hegelian triad, the three terms here coexist at the same moment of time. The logic of the included middle does not abolish that of the excluded middle, which remains valid for simple, consistent situations. However, the former is the privileged logic of complexity, of the real mental, social and political world.

The logic of the included middle is capable of describing the coherence between levels of reality. A given T-state (which operates the unification of A and non- A) is associated with another couple of contradictory terms at its higher level (A^1 , non- A^1), which are in turn resolved at another level by T^1 . According to Nicolescu, the action of the logic of the included middle induces an open structure of the set of all possible levels of reality, similar to that defined by Gödel for formal systems (see below, Section 8.3).

4.3. Logical operators: implication

Lupasco’s fundamental postulate and its formalism can also be applied to logical operations, answering a potential objection that the operations themselves would imply or lead to rigorous non-contradiction. The concept of real processes is that they are constituted by series of series of series, etc., of alternating actualizations and potentializations. These series are not finite, however, in reality, processes *do* stop, and they are thus not infinite. Following Lupasco, I will use the term transfinite for these series or chains, which are called ortho- or para-dialectics (see Lupasco 1951).

The terms in thus develop into a transfinite series of disjunctions of implications:

$$(\supset_A \overline{\supset}_P \vee \overline{\supset}_A \supset_P) \vee (\supset_A \overline{\supset}_P \vee \supset_T \overline{\supset}_T) \vee (\overline{\supset}_A \supset_P \vee \supset_T \overline{\supset}_T) \\
 \text{etc, } \dots, \text{ etc, } \dots$$

Every implication implies a contradictory negative implication, such that the actualization of one entails the potentialization of the other and that the non-actualization non-potentialization of the one entails the non-potentialization non-actualization of the other. This leads to the tree-like development of chains of implications, of which one example is indicated in the following diagram: This development in chains of chains of impli-

$$(\supset_A) \supset (\overline{\supset}_P) \left\{ \begin{array}{l} [(\supset_A) \supset_A (\overline{\supset}_P)] \supset [(\supset_A) \overline{\supset}_P (\overline{\supset}_P)] \left\{ \begin{array}{l} \text{etc} \\ \dots\dots\dots \\ \dots\dots\dots \end{array} \right. \\ \dots\dots\dots \\ \dots\dots\dots \end{array} \right.$$

cations must be finite but unending, that is, transfinite, since it is easy to show that if the actualization of implication were infinite, one arrives at classical identity (tautology): $(e \supset e)$. Any phenomenon, insofar as it is empirical or diversity or negation, that is, not attached, no matter how little, to an identifying implication of some kind, $(\bar{e} \supset e)$ suppresses itself. It is a theorem of Lupasco that both identity and diversity must be present in existence, to the extent that they are opposing dynamic aspects of phenomena and consequently subject to its axioms.



4.4. Semantics

Lupasco never discussed his logical system in terms of semantics as such, although a kind of semantics of inference can be written for it. I consider that Lupasco's logic is semantically incomplete, but Gödel has shown in any case that logics higher than first order are incomplete, and Hintikka (see Hintikka 2000) suggests a genuine logic need not be semantically complete. Incompleteness means only that a Turing machine cannot exhaustively enumerate the valid patterns of inference. This is a limitation of a Turing machine (see Chaitin 1998), not of logic in the extended sense of Lupasco.

5. 20th Century logics

Of the new logics of the 20th Century, whether bivalent, trivalent, multivalent or fuzzy, all except quantum logics ultimately refer to the truth or falsity of propositions. Non-truth-functional logics are possible, as recently shown by João Marcos (see Marcos 2005) but they depend on non-truth-functional *semantics*. Not only do we not move outside the linguistic domain, but as shown by Jean-Yves Béziau (see Béziau 2010), non truth-functional many-valued semantics basically keep a bivalence feature through the distinction between designated and undesignated values. Since this is also the case of truth-functional many-valued semantics, it cannot be considered as an argument against them, unless it is also considered as an argument against standard many-valued logics. From the Lupasco standpoint, this recent work confirms his position that all standard logics were basically bivalent and hence incapable of describing or modeling complex energetic processes.

The objection can be and has been raised against Lupasco's system that it is not a logic, as it fails to have the required formal structure. However, Béziau has shown that the essence of logic is not its formality, mathematical or other, and one is best off in speaking about logic *tout court*. In the Lupasco logic, as in inductive and abductive logics, truth preservation is not guaranteed, but one must remember that Lupasco's logical elements are not propositions in the usual sense, but rather correspond to non-standard probabilities, points on a non-commutative, non-Boolean lattice as in quantum logics. Stable macrophysical objects and simple situations, which can be discussed within binary logic, are the re-



sult of processes of processes going in the direction of non-contradiction. Thus, the Lupasco logic should be seen as applying to processes, to trends and tendencies, rather than to “objects” or the steps in a state-transition picture of change.

5.1. Inference and abduction

One of the major recent advances in the application of standard logic was the recognition that human reasoning did not follow a pattern solely of deduction and induction, but that these were accompanied and preceded by a process of inferences and hypotheses designated by C. S. Peirce as abduction.

The term inference was used above without definition, but it is necessary to state what it could mean for real elements, especially as the notion of inference will be essential for the consideration of Lupasco’s logic as a formal logic. Inference is a process limited to human thought and reasoning. Usually, one looks at the structure and properties of mental states and their constituents, and at what the roles of those constituents are *qua* their reference to sentences. However, since I replace the referents of inference to sentences by aspects or models of real phenomena, what are the consequences? Can one still talk legitimately about inference and/or patterns of inference?

I claim that one can. The inferences that one makes are from the state of an entity that is primarily actualized to some estimate of its potentiality or forthcoming potentialization. The analysis involves looking at what interactive, antagonistic processes of attraction and repulsion or association and dissociation are involved, as well as the contradictory trends toward homogeneity or heterogeneity. Details of the structures and inferences from them depend on the level of reality under consideration, but the *pattern* of inference will be substantially the one indicated. In this, the Lupasco system resembles standard logics that are characterized by a limited number of patterns of inference.

The concept of abduction provides further support for this view. If induction is defined as a process of generation of new hypotheses, in most cases abduction is a process of evaluation, explanation and if possible quantification of hypotheses whose origin may well be induction. I will be inferring knowledge about properties that are not immediately observable, with the objective of explanation rather than prediction. The



reason for mentioning abduction here is that the reasoning process used by Lupasco to develop his theory was primarily abductive. Inductive explanations do not provide any insight as to *why* things are the way they are. Abduction provides explanations only relative to a given theory, but that is all I ask of it. Peirce's original conception of abduction emphasizes its non-algorithmic character. In addition, "[...] abduction is logical inference having a perfectly definite logical form." In my view, while not constituted by propositions, Lupasco's theory has a definite logical form, defined by the axiomatization above.

Abduction is like induction in that the results of the process, that is, its truth-values, are not guaranteed. As has been suggested by Wang, induction and abduction are dual. In the Lupasco terminology, the two systems resemble, for propositions, what one observes for real processes. They instantiate a "structure" of alternation of application, and indeed abduction often follows a "good" induction and *vice versa*, very much as the sequences of the kind implied by the 2nd axiom of Lupasco.

Peirce saw the origin of abduction in intuition, but this should not be viewed negatively. In the Lupasco epistemology, intuition is a process of thought related dialectically to knowledge, and has a non-trivial logical and ontological status.

5.2. Induction and deduction

Lupasco, who did not read English well, makes no reference to abduction; however, in 1947, roughly in the same period as Carnap, he formalized the difference between induction and deduction in his contradictorial language. He begins his analysis of the problem (see Lupasco 1947) with the standard view of deduction, including the well known argument that if the particular signifies the same reality as does the general, there is no knowledge, deduction discovers nothing but a tautology. In fact, the actualization of the general, at the limit of the process of deduction, is the inhibition, the potentialization of the principle of non-identity or diversity, of intrinsic variation. Deduction must involve a knower of identity and a known of diversity or contingency. Thus both deduction and induction are equally inherent in logical becoming, either in its material form or its inverse vital form respectively.

The result of this approach is to change the initial simplistic picture of particular to general and general to particular, static terms that seem

rather meaningless in the absence of Lupasco's reading, as follows: induction is not an ascent from particular to general, but inhibiting the general by the particular, being the locus of the actualization of the particular, as knower, and the locus of the potentialization of the general as the object of knowledge, the known. Deduction is not a descent from general to particular, nor the extraction of the particular from the general, going from implier to implied, but actualization of the general, which inhibits the particular whose consequent potentialization becomes a kind of cognitive conceptuality, but not a knowledge as such.

The question of how the particular can emerge from a substantial generality, or from where, the particular constituting the reality of things, a illusory general could come, remains unanswered. The only possible solution, for Lupasco, is that between the general and the particular, in both deduction and induction, there is an existential antagonism, causal and relative, such that the actualization of the general potentializes the particular and *vice versa*. In deduction, the particular becomes the object of knowledge and in induction, the general. The latter process tends to succeed, and the former is limited, in the human mind, to intuitions, or flashes of cognition.

5.3. Paracomplete (intuitionist) and paraconsistent logics

Logics in which the classical axiom of non-contradiction does not apply but that of the excluded middle does are called paraconsistent; in the opposite case they are paracomplete, and Béziau has described them as "duals". The most significant example of a paracomplete logic is intuitionist logic, proposed by Poli for example as a basis for category theory.

Brouwer (see Brouwer 1951) and Heyting were prompted to develop intuitionist logic as a basis for mathematical reasoning about infinite sets. Brouwer claimed that the law of the excluded middle cannot apply in mathematics, "once it has been recognized to be an autonomous interior constructional activity which, although it can be applied to an exterior world, neither in its origin nor in its methods depends on an exterior world". He thus rejected the application to mathematics of a classical binary logic of "truth" and "falsehood", and of the concept of truth as a relationship between language and an extra-linguistic reality. However, there is no indication in this work of a basis (or need) for applying such principles outside mathematics. He did not, appar-



ently, formulate or show the necessity of a law of the included middle. His formulations contain idealized distinctions and processes that apply only within mathematics. As the law of non-contradiction is maintained, however, intuitionist logic remains closely related to classical logic.

Paracompleteness implies a fundamental incompleteness in a logical system: neither of two elements is considered true by itself, and new concepts must be introduced to close the gap between them. This could be considered a form of an included middle, and the applicable logic could be Lupasco's, but the total rejection any contradiction renders intuitionist logic inapplicable to reality.

One might say today that Lupasco's axiom of Conditional Contradiction implies that his logic is also paraconsistent, but this is not correct: in paraconsistent logics propositions are "true" and "false" at the same time; in Lupasco, only in the sense that when one is actual, the other is potential.

Paraconsistent logic is defined such that contradiction does not entail triviality or explosion. In some paraconsistent logics, such as those of Priest (see Priest 1987), an ontological commitment is made and real contradictions are allowed. In others, such as the logics of formal inconsistency of Carnielli, Coniglio and Marcos (see Carnielli *et al* 2005), they are not. These authors have shown that Contradiction + Consistency = Triviality. For Lupasco, triviality is equal to zero: nothing real is "trivial". Accordingly, Contradiction is equal to Inconsistency.

Paraconsistent logics do mirror some of the contradictory aspects of real phenomena. Priest has shown this in his work on inconsistency in the material sciences (see Priest 2002a). However Lupasco captured in addition the contradictorial structure of the dynamics involved in real processes, in particular of thought.

The authors cited above have made extensions of their paraconsistent logical systems to explore aspects of reality that involve key issues in the foundations of science. These include inter-theoretic relationships, complementarity, the individuality of quantum entities and reasoning, among others. However, they tend to share the problem of the restrictions imposed by the concept of logic as a class of mathematical systems and their related formal tools, especially, standard set theory.

Dialetheism and the Logic of Paradox (LP) proposed by Priest provide a solid basis for understanding set-theoretic and semantic contradictions in terms of the truth or falsity of certain sentences or formulas, and

a “nexus” (nodal point of transition) which is both true and false. Priest has analyzed some real changes in these terms, such as simple motion (to which the Eleatic paradoxes apply¹) and the apparent passage of time, in which the contradictions that appear are considered to be of this type. However, the concepts of truth and falsity as used by Priest do not differ fundamentally from those used by classical logicians.

5.4. Quantum logics

In his original Copenhagen interpretation, Niels Bohr saw that quantum entities had to be described as both continuous waves and discrete elementary particles at the same time. He avoided contradiction and paradox by defining a concept of complementarity, equivalent to ‘both (A and not- A) at once’. This interpretation is now generally conceded to be inadequate, but totally satisfactory replacements have not been developed. Bohr was apparently suspicious of the ability of the above modifications of classical logic, as it was understood in the mid-20th Century, to assist in the definition of quantum physics, although the failure of non-commutativity and non-distributivity of quantum variables, which suggest non-Boolean algebra and logics, were well known.

Quantum mechanics basically recognizes the existence of intermediary or “superposed” states whose properties are mutually dependent and cannot be measured to the same degree of accuracy at the same time. Quantum logic, the logic of these elements of reality provides a formal model of a non-classical physical system in non-classical logical terms. Due to operation of the uncertainty principle, the commutative law of arithmetic fails or requires massive reworking and the distributive law for conjunction and disjunction fails.

The Lupasco logic can be seen as a quantum-type logic (see Brenner 2008) with the quantum probabilities of the quantum logical structure replaced by the statistically determined and in principle measurable values A and P of the alternating actualization and potentialization of dynamically contradictory states. As in non-standard probabilistic logic, the values also do not include the limits 0 and 1, but are reciprocally determined between greater than 1 and less than 0 (limits are only approached, asymptotically).

¹ Lupasco discussed the Eleatic paradoxes in detail in Aerts *et al* 2000, but his argument would require a separate paper.



The logical formalism developed by Diederik Aerts (see Aerts *et al* 2000) converts quantum mechanics into a system that can be applied to macroscopic phenomena, including space-time and the emergence of biological form and human cognition. Situations or entities that are intermediate between pure classical and pure quantum are not only possible, but their combined quantum and classical aspects can be described by different types of generalized mathematical structures. In this relatively quite new form of quantum logic, standard connectives themselves take on new, non-classical meaning, suggesting that, as in Lupasco, there is a close relationship between logic and quantum physics.

One *caveat* here: nothing in the above should be taken to imply that quantum processes occur as such at macroscopic levels of reality, as in some proposed theories of consciousness. A major advantage of the Lupasco system is that offers a non-reductionist description of complex process phenomena without either going outside the laws of physics or postulating intermediate cognitive entities for which there is no physical evidence (see below, 6.5 Representations).

6. Issues in philosophy and science

The logic of Lupasco has profound implications for all of the metaphysical dichotomies as usually formulated, including the choice of which is the more fundamental: continuity or discontinuity, geometry or dynamics, time or space, efficient or final cause. For each of these, Lupasco gave a detailed analysis that refused any absolute separation or total independence of the pairs of concepts, which he always saw as manifestations of energy, evolving in tandem. In this section, I have summarized Lupasco's approach in five major areas of philosophy and science.

6.1. Causality

The difficulties associated with the problem of causality and finality², in Lupasco's conception, is the consequence of a world-view based on a classical logic of identity. For Kant and his followers, causality was nothing more than a rational synthetic order imposed *a priori* on the

² The problem of causality has been referred to by Schaffer as a "black hole at the center of our universe".

a-logical, noumenal givens of diversity, such that experience could be possible. Cause and effect became condition and conditioned, and his implied rigorous determinism was equivalent to a conception of a non-contradictory universe. No chance, then, since this would have to arise from some irrational principle of negation, destroying the logic of identity. No efficient cause since this would look too much like a mysterious agent or power. This would also be outside classical logic, and which might imply the notion of an adverse agent, and thus contradiction or some other kind of functional interaction between instances of identity and diversity! No final cause either, because a finality, an effect that has not yet been completed, that is still virtual or potential, implies the antagonistic forces that were preventing or would prevent that completion, present at the same time, in other words, another contradictory dualism that would be contrary to classical logic.

Without contradiction, if either affirmation and negation, or identity and non-identity were the absolute, non-developing bases for existence, one or the other always true and self-sufficient, there would be no place for change or cause. Self-causation would also be excluded, since this would also imply a change from an initial definitive state. A reality that is rigorously non-contradictory or rigorously contradictory in the physical/metaphysical sense I have proposed excludes both cause and effect, because it can only be a reality that is rigorously static.

The antagonistic structure of Lupasco's system not only implies cause, but that causality and finality themselves are logical processes. The results in the complexification of the notion of cause, as different species of causation correspond to the different logical elements in processes "in progress". The relativity of contradiction, the movement toward *both* limits of contradiction and non-contradiction, means that at the heart of logic in the expanded sense, there are two inverse and antagonistic causalities: any identity, for example, that is more or less an identity, is the *effect* of all the series of identities which "went" from potentiality to actuality, by the process of ortho-dialectics, and are, consequently, both effects and causes (see Lupasco 1951). The same scheme applies to a given non-identity (diversity), determined by the series of more or less actual diversities. This negative (diversifying, not negating) causality, like all negative logical functions, has been ignored for the usual reason of the general tendency to focus on positive identities as the only carriers of reality.



In addition to these two causalities, however, there exists an additional causality of antagonism that determines them, in which a given actualization is the cause of the contradictory potentialization. Thus, to the series of causes and effects, or cause-effects of the same order, of identity or non-identity, is added a series of contradictory cause-effects. A given identity or diversity causes, by its actualization, the potentialization of the given diversity or identity respectively, which becomes its contradictory effect. From this, it can be shown that each cause C is 1) the effect of (relatively) non-contradictory causes; and 2) causes non-contradictory effects of the same order, at the same time as it, C , is the cause of the contradictory effect and the effect of the contradictory cause.

No understanding of a dynamic view of phenomena can be had without following the implications of this form of argument, as can be seen in its application to necessity and universality, on the one hand, and contingency and particularity on the other. Both sets of terms are caused by themselves and, at the same time, each set is caused by the other. The series of relative necessities and contingencies are caused by the series itself, from the point of view of its being a dynamics going from actual to potential; at the same time, necessity is the cause of contingency and *vice versa*.

Lupasco wrote that the contradictory interaction of the two main causalities of non-contradiction generate by mutual inhibition (semi-actualization and semi-potentialization of both), a causality of contradiction, a series of logical values in the category of T-states. The causalities of non-contradiction are the cause of the causality of contradiction, and the latter is the cause of the former. One can then make a key link with the concepts of immanence and transcendence, since 1) the causalities of non-contradiction, of rationality and irrationality respectively can be called transcendent to the extent they transcend contradiction; but 2) these causalities are the cause of the causality of contradiction, that can be called the causality of immanence or immanent causality. Logical values that imply immanence and transcendence “cause” themselves reciprocally. An essential corollary of this point is that there are no “pure” immanent and transcendent phenomena. One cannot, therefore, separate completely immanent “real” events and transcendent “abstract” facts (statements, propositions, categories, etc.) *qua* their existence but only *qua* their meaning by abstraction and elimination of any dynamics, that is, as non-spatio-temporal entities.



Since all energetic phenomena imply antagonism or dynamic opposition, this in turn implies, at some point, a potentialization becoming actual and an actualization becoming potential. The latter, as an efficient cause, generates a final cause, the locus of which is in the antagonistic dynamism that it potentializes. An antagonistic efficient cause is thus the source of every final cause and thus of every consequent process of actualization that results from it, and a final cause is the source of every efficient cause, by the corresponding process.

This fundamental concept, that phenomena are their own causes and effects, or that some kind of reciprocal relation obtains between cause and effect is not novel. It is a commonplace that it may be difficult to decide whether *A* causes *B*, *B* causes *A* or both. Is a bad leader, for example, the result or cause of a bad social and political climate? What Lupasco did was to place this concept in a *logical* context, in which it can be related to the functioning of other phenomena, as another instance of a process of contradiction or counter-action.

In current discussions of the metaphysics of causation, the entities in the cause—effect relationship are called *relata*; they are considered to be in the categories of events (coarse-grained) or else facts, situations, tropes, states of affairs, etc. (fine-grained), and their number varies from two to four, when including causal alternatives (counterfactual events). Using this terminology, one can say that Lupasco focused on the *relata* that are processes involving dialectically or contradictorily related elements. Simple events and facts, also with two *relata*, including propositions *qua* their meaning, do not require the Lupasco logic; only the standard chain of simple proximate causes is involved.

6.2. Emergence

Emergence is another topic of critical current interest that, however, was not discussed by Lupasco as such. Nevertheless, his T-states are the consequence of the operation of the Principle of Dynamic Opposition and of levels of reality. Since the T-state resolves the contradiction between two antagonistic terms at another, “higher” level of reality, it seemed reasonable to suggest that the T-state emerges from them. Accordingly, one could consider the Lupasco logic as a “logic of emergence”. One can differentiate between processes, T-states and emergence as follows: emergence focuses on the process *qua* process, or rather, as is usually the



case, the transfinite series of processes of processes, while the T-state is the (temporary) end-point of this ortho-dialectic series tending toward contradiction, viewed as an (id)entity.

In one typical anti-emergentist position, emergence is reduced to a merely epistemic notion that is, describing formal relations between *statements* about some set of properties of processes, not the inherent properties or processes themselves. As we have seen, however, the relations involved in and between processes are grounded in the inherent properties of energy, and statements about the consequences for higher levels of reality do not have an *a priori* character.

Some early proponents of emergence believed that primitive features of matter could exert a primitive form of causality, involving fundamental “configurational forces”. This, in other terms, was Lupasco’s point: the “features” of phenomena can be described as involving “configurational forces”, in which significant energy is encoded in potential form. It is in configuration space that the actual and potential states of electrons are present, and it is both of these features that are the carriers of the upward causation necessary for emergence. To take the example of the calcium ion, the combination of its size and net positive charge results in different potentialities for interactions with, say, water molecules than that of a lithium ion, Li^+ (see Lupasco 1986a) and their biological activity, partly as a consequence of this, is quite different, for example, at the psycho-physical level.

6.3. Cosmology: time and space

In his Thesis, Lupasco made detailed analyses of the cosmologies of Lemaître, Einstein, De Sitter and Eddington. Very briefly, he concluded that not only were time and space inseparable, but that they were real process phenomena, dialectically related, that followed the Principle of Dynamic Opposition. In his terms, the actualization or potentialization of a logical event is not a function of time, A_t or P_t , but time that is a function of the dynamics of actualization and potentialization, t_A or t_P . I will give an extended outline of Lupasco’s view of time and space as it underlies many of the crucial differences between his approach and that of standard logics that are based on classical pictures.

For Lupasco, time is only possible due to the existence of contradictory dualities whose energetic antagonism is both the source and nec-

essary condition of partial, non-infinite actualizations and potentializations. Time is thus, like the dynamisms that generate it, neither finite nor infinite but transfinite. Again, reversing Kant, time is not a condition of phenomena, but conditioned by phenomena, due to their logical dynamic structure. The first “object” to instantiate both a time and a space would be, of course, the singularity of the Big Bang, or its latest cyclic, non-absolute replacement (see Steinhardt and Turok 2002). Time and space result from the development of a process that actualizes itself, the necessary consequence of the dynamic structure of an energetic world. This implies that objects and events do not exist or take place in time, but are the sources of, or “unroll”, (*déroulent*) their own time.

Classical logic is non-temporal, since its rigorous non-contradiction, pure identity and relations and implications are totally fixed, incompatible with time and change. Together with much else, time is relegated to the domain of the psychological and irrational. Temporal logics are modal logics that introduce operators for discussing propositions whose truth is different in an apparent, past, present and future, but these logics do not provide a model for the dynamics of change as such. Smooth Infinitesimal Analysis, which is based on standard logic, captures only temporal aspects of phenomena that are amenable to description by differential equations, but neither the realities of phenomenological time, nor physical realities that are discontinuous or continuous *and* discontinuous.

Lupasco showed that in contrast to the classical philosophical notion of time based on a classic logic of identity and homogeneity, time in the empirical philosophy of Bergson is a heterogeneous duration, psychological, biological, vital, etc. However, it was defined as being outside logic, involving another classical distinction that was simply opposite to that of Kant — what is heterogeneous in Bergson is logical; what is homogeneous is not.

Lupasco’s logic, in which all is process and energy, dynamically contradictory, is a logic par excellence of the a posteriori. Therefore, if space is a logical phenomenon, it is a posteriori, like time, not a Kantian condition of phenomenal actualizations but conditioned by them. Simultaneity requires space; if events do and do not succeed one another, a required notion of space can develop. The moment two elements exist at once, simultaneously, they imply, simply because they don’t coalesce, a space, a location with a distance between them. By the fundamental pos-



tulates of the logic of energetic phenomena, the generation of a transfinite series of dualities of dualities (systems of systems) necessarily generates the logical space for them, which Lupasco called configurations or logical forms. Lupasco identified this space with the configuration space of quantum physics.

The link between space and time derives from (see Lupasco 1986b) the structure of energy itself and its logical aspects. There are both spaces and times, which are proper to individual phenomena, functions of their actualization. Thus objects and events do not exist or take place in space, but are the sources of, or “unroll”, (*déroulent*) their own space.

Objects are not in space, but space is in objects; objects are not localized, but localize, create localizations. It is in this admittedly informal way that such a space has the same characteristics as a configuration space, that is, it is a function of the number of its elements and of their degrees of freedom; it is what links the elements, their relations, that permits their co-existence in a system and their simultaneity. There is no spatial location outside of what is inside it. Logical space and logical time constitute a space-time proper to each system, a configuration space-time. Time cannot be separated from space, and only space-time exists.

Lupasco’s simultaneity is similar to that in current relativity theory: simultaneity can not be considered absolute within one frame of reference. Simultaneity is a contradictory conjunction that requires the presence of elements that are both identical and diverse; otherwise, the simultaneity would tend to disappear. Simultaneity is spatializing in that it defines or is the locus of space and is, accordingly, an energetic operation, not a static given. An energetic simultaneity is thus a “simultaneization”. It implies a passage from a degree of potentialization to a degree of actualization, of a certain quantity of potential energy to a certain quantity of actualized energy, therefore movement, succession and time: “No space without passage from succession to simultaneity and thus without time, and no time without passage from simultaneity to succession, no time without space.”

The conclusion is the following: logical space, in the sense of simultaneity or conjunction is dynamically opposed (in a contradictory relation) to logical time as succession or disjunction. The simultaneity of elements in space is based on their succession of time, and vice versa. Neither of the contradictory relations being processes ever going to ab-



solute completion, each will always have an irreducible residue of the other; there will always be some space in time, some time in space. This picture is sufficiently novel to warrant a further formulation of the basic points. Very much in the spirit of Lupasco, Koichiro Matsuno (see Matsuno 2011) calls for the suspension of the principle of non-contradiction in concepts of time and space applicable in biosemiotics.

For succession to exist, temporality, there must also be simultaneity, spatiality, in which and by means of which succession can operate and develop. Inversely, for there to be space and contradictory conjunction, that which what constitutes disjunction and entails succession and temporality and coexists with space must be potentialized. Spaces and times develop dialectically, following the scheme of ortho-deductions, moving toward, but not reaching, the ideal non-contradictory limits of identity or diversity, or, alternatively, toward a limit of maximum contradiction.

The most important feature of the Lupasco view of space-time is that it is not primitive. The work of Carlo Rovelli (see Rovelli 2009) on quantum gravity includes a discussion of the way in which the time variable ‘*t*’ can be eliminated from the equations of basic physics.³ Not only is neither time nor space absolute, but “time does not exist”. Lupasco’s insights are compatible with new cosmologies involving quantum gravity, *e.g.*, that of Rovelli, in which no background space-time manifold is required for the description of entities at all levels of reality.

6.4. Consciousness and cognition

For Lupasco (see Lupasco 1979), the processes of consciousness start with the initial reception of external stimuli and the consequent successive alternations of actualization and potentialization leading to complex sequences of T-states, as follows:

- An initial internal state of excitation, involving afferent stimuli.
- An internal/external (subject-object) state in which afferent and efferent (motor) mechanisms interact.

³My interpretation of the situation is that quantum entities and the gravitational field or its particle equivalents are self-dual and hence that a paraconsistent description is possible and adequate. For all more complex entities that do not exhibit self-duality, that is, entities that have an internal dynamics and are subject to change and the principle of dynamic opposition and the Lupasco logic apply.



- The above states interacting in the brain to produce higher level T-states: ideas, images and concepts.
- Further interactions leading to consciousness and unconsciousness (the unconscious) as T-states, memory and forgetting.
- At the highest level, the emergence of consciousness of consciousness, knowledge, intuition and overall psychic structure.

The originality of this picture does not reside in its identification of a consciousness, a consciousness of consciousness (sometimes designated as awareness) and an unconscious. Rather, it is in its emphasis on the logical origin of these higher-level dynamic structures in a principle of opposition at the level of basic physics that provides the mechanism for their emergence and the subsequent complexification of their interactions. Lupasco defined, in addition and as a consequence, the higher-level types of mental processes of memory, forgetting, imagination and creativity as emerging from these interactions.

Lupasco suggested, as have many others, that what distinguishes individual human awareness from animal or primitive consciousness is consciousness of consciousness. The best-known formulation of self-awareness is Descartes' *cogito, ergo sum*. But Descartes did not realize that he was conscious that he thought and therefore conscious of his consciousness, without seeing that he had arrived at the *cogito* by doubting. Doubting implies being aware of oneself as the locus of the contradictory consciousnesses referred to above, and of their T-states of the semi-actualization and semi-potentialization of each, which also includes the corresponding processes in the subconscious. One then possesses, in effect, two consciousnesses each of which is aware of the other, of their contradiction, of their antagonism and accordingly of themselves, through a consciousness of consciousness, via an internal dialectics. This dialectic of dialectics is thus at the same time a dialectic of consciousness of consciousness and consciousness of subconsciousness, and constitutes what is generally called the mind or psyche as such.

The Lupasco picture of the dynamic structure of consciousness that I have summarized obviously requires much additional development, but it can address processes at the neurophysiological, mental and philosophical levels. It is way of making a realist but non-reductionist approach to problems of intentionality, knowledge, such as that of the infinite regress,

and moral responsibility. Finally, is the basis of the Lupasco epistemology, about which the most significant point is its *non*-separability from the non-standard categorial ontology that Lupasco's work implied, but he did not develop as such (see Brenner 2009).

6.5. Representations

By now, we have become accustomed to talking about mental phenomena in terms of representations whose existence as real entities is taken for granted. In representationalist theories dealing with cognition, internal entities of some sort stand for or correspond in some way to external processes and events. These mental representations explain or are explanatory devices for cognition in that they are, or correspond to intentional states, instances of intentionality considered as embodying the irreducible first-person properties that are alleged to characterize consciousness, reasoning and qualia. (I will not reproduce the relevant theories, many of which are derived from Husserl and more recently from the intentional realism of Fodor.)

However, as M. R. Bennett, a neuroscientist, and P. M. S. Hacker, a philosopher show in their recent massive document — *Philosophical Foundations of Neuroscience* — representations are among a group of concepts for which no empirical evidence exists (see Bennett and Hacker 2003). These authors show how virtually *all* of the standard modern approaches to mental entities involve some form of confusion, to use their word. For example, in the computational form of representationalism of Dretske and others, there is a symbolic entity between neurobiological and phenomenological data, and a host of secondary problems arise as to the properties and relations of the symbols involved.

From a Lupascian perspective, such confusions are the consequence of the separations which have been the unavoidable consequence of standard logics. Existing accounts of mental processes suffer from the need to introduce additional entities due to the lack of a principled method of relating their critical concepts contradictorily. A mental phenomenon, which is not something other than the physical processes with emergent properties “displays” its contradictorial origins in appearing to have symbolic and non-symbolic aspects, and being closer or farther from the center of attention at a particular time. Bennett and Hacker essentially deconstruct the concept of any mental entities including representations,



qualia, models and concepts of self and free will — that are a substitute for, or an addition to, the mental processes themselves.

A further difficulty with the standard picture of representations is the difference in treatment of mental states *vs.* intuition, which some people might consider a fiction. In the Lupasco's view, intuitions, as diversities, and more permanent or salient mental states, as identities, are related contradictorily. The real existence of intuitive processes provides an argument against Fodor and against the introduction of what in my view is an unnecessary additional entity into the causal chain.

My interim conclusion will I hope be clear. The Lupasco logic is a real logic of processes, a logic of real phenomenal processes, applicable in many fields of philosophy and science, that can be used to make valuable inferences about their evolution. As discussed in this Section, the Lupasco dialectical approach that distinguishes without separating mental entities enables one to avoid falling back into an identity theory of mind. Metalogical arguments to the effect that this schema is not a logic are untenable, since it requires the limited definition of a logic that is exactly the contested issue. Let us now position the principles of the Lupasco system *vis à vis* some of his major historical and more modern precursors.

7. Major Precursors (1): Lupasco's critique

Lupasco devoted a significant portion of his Thesis to a novel critique of some major predecessors — Kant, Hegel, Schopenhauer and Bergson. Lupasco was able to show that each philosopher was able to maintain the coherency of his system only by ignoring or relegating to an inferior ontological status one or the other of the two essential aspects of existence, identity or diversity. The diametrically opposed approaches to time and space by Kant and Bergson could be read as an example of the way in which dialectics “plays out” at the level of individual psychologies.

Lupasco has certainly not been the only author to have pointed out the weaknesses that accompany the strengths of these major philosophers, but may be the only one to have shown the contradictory relation of their theories as a consequence of contradictory aspects of their logical assumptions. This alone could provide a basis for consideration of his own work as a major contribution to 20th Century thought. I have



summarized Lupasco's critique of Kant and Hegel for the insight they give into his own processes of logical reasoning.

7.1. Kant

Lupasco suggested that Kant, due to a tendency to actualize identity, was able to see only the form and the framework of the "one", rejecting the diversity of experience into the mystery of the noumenon. For Kant, the logical act of understanding involves synthetic extensive and *a priori* judgments. Finding the connection or link between a concept *A* and an external predicate *B*, "two heterogeneous entities", constitutes the process of knowing. Non-identity was a fact, something static, a-rational and external. Analytic judgments were possible, but far from creating "real" heterogeneity, could only go over the ground of the synthesis, backwards.

Lupasco asked, with all due respect to Kant, how such synthetic judgments could be possible, since *a posteriori*, any link between the two entities could also only participate in the contingency of all existence. The first part of Lupasco's answer, not Kant's, was to consider that a real analytical judgment was possible, one that would "un-link" two homogeneous concepts; unlinking should be as acceptable a process as linking, especially if the link were somehow imposed from outside. Lupasco saw the source of Kant's metaphysical postulates in the idea of sensible reality being an empirical heterogeneity in which logic was absent, and the existence of a rationality based essentially on logical non-contradiction. Lupasco then showed, in his terms, the reality of diversity and heterogeneity that he wished Kant had pursued. Even in the simplest logical act, the affirmation of the identity *A* is *A*, one must address the possibility that *A* might not be *A*; the affirmation of identity is made against a potential non-identity, conceived of as possible. The same thing is true for *A* affirmed as not-*A*.

Lupasco's basic dialectical concept is that, as in Kant, the connection between *A* and *B* is a phenomenon, but so is the *non*-connection:

A phenomenon is something which contains in itself, coming from nowhere else, its life and its death at the same time, its affirmation and negation of itself, without one being able to annihilate the other, because their existence is a function of their coexistence. This belief is behind all the examples we have discussed previously



of the relations of contradictory terms. No thing has an absolute value. Nothing is not the absence of something but a logical quantity a positive absence of link, a contradiction of a thing by itself, a non-identity, but existential and constitutive of an analytical factor having the same value as the synthetic factor responsible for the link. [Lupasco 1935]

For Lupasco, the only solution is to focus on the relation, and see that when one “goes” from one concept to the other, one has in hand a basis for their difference, the potentiality of a link or a non-link, that enables one to carry out the synthesis. The synthetic approach takes place on top of the differentiating approach that evolves *between* A and B , and does not exist *in* A or B . Thus, both the synthesis and the discovery of difference, the true analysis, only exist in the relation between A and B taken as the field of investigation. Differentiation, in the case of real phenomena, like identity, is to be found only in the passage from A to B , and both have, and should be stated as having, the same existential value.

7.2. Hegel

Both Hegel and Lupasco started from a vision of the contradictory or antagonistic nature of reality; developed elaborate logical systems that dealt with contradiction and went far beyond formal propositional logic; and applied these notions to the individual and society, consciousness, art, history, ethics, and politics. Parallels to Hegel’s dialectics, logic and ontology may thus suggest themselves to the reader, and so I first note that Lupasco considered that his system included and extended that of Hegel. However, one cannot consider Lupasco a Hegelian or neo-Hegelian without specifying the fundamental difference between Hegel’s idealism and Lupasco’s realism.

Hegel incorporated contradiction in logic and rejected the idea of a classical “formal” logic that claimed to be a study of the form of thought in abstraction from content.⁴ He proposed three axioms to describe reality that differ from the classic axioms: A is A ; A is non- A ; non- A is A after all, or else they are all together. They imply a primarily diachronic sequence of A , non- A , and A as thesis, anti-thesis, and synthesis,

⁴In a paper for publication, “What is formal logic?”, Jean-Yves Béziau shows, from the standpoint of contemporary logic, that the notion of “formal” is neither essential nor useful to characterize it.



whereas Lupasco proposed both a synchronic and diachronic existence of A , non- A and T-state as an included third term, with the understanding that “inclusion” refers to its location between the first two terms but at another level of reality or complexity. At first sight, Hegel seems to have accepted contradiction as fundamental, until one realizes that, although the most ontologically significant relation is one of opposition between two things that mutually define each other, what is essential is their inner identity. In fact, if an element is in contradiction with itself as its negation, it disappears. This argument suits only Hegel’s ontological conclusion that finite things disappear or die because they are failed attempts to “embody the infinite” and makes it clear that Hegel lacked a physical/metaphysical basis for life, form and diversity of equal ontological value.

Hegel’s logic is integrated into a “metaphysical dialectic”, in which the contradictory duality he introduced was continually abolished by successively purer and broader syntheses of antithetical terms, finally reaching the *Aufhebung*. Lupasco’s system, however, involves *two* dialectics, ascending and descending (*diverging*) toward the non-contradictions of identity and diversity and a *third* dialectics *converging* toward contradiction. As above, the source of contradiction is inherent in energy and is the only existent reality. To say that material-energetic reality was the result or emanation of some other necessity as the foundation of the real amounts to tautology or mysticism, and Hegel’s “obscure logical descriptions remained without a future for logic and science”. As Lupasco expressed it, Hegel’s system was “only half of a dialectics” (see Lupasco 1947). The affirmative value of identification always transcends the negative value of diversification. In Lupasco, contradiction is established at the basic physical level.

As pointed out by Taylor (see Taylor 1975), Hegel’s thesis depends on a premise of ontological necessity that in turn depends on the contradiction of the finite. Hegel established or expounded his ontological structure at “high” levels, but his project required demonstration of his ontology at the lowest level of simply determinate beings, and his attempted proof of contradiction failed. I suggest that Lupasco’s realism successfully answers this major objection to the coherence of Hegel’s system, without requiring a commitment to his basic thesis, the idealist part of his doctrine. In my view, Lupasco’s view of contradiction founded a dynamics, whereas Hegel’s did not, precisely because his system is not



metaphysically and physically grounded at the “lowest level of simply determinate beings” that is, microphysical entities. Lupasco (see Lupasco 1951) showed that there is no *deductive* necessity in Hegel for thesis generating anti-thesis, let alone any subsequent fusion. My view is that Lupasco can be considered as Hegel *naturalized*, since a physical basis in reality for Hegelian change has been defined.

Hegel did distinguish between dialectics and formal logic — which was for him the Aristotelian logic of his day. The subsequent developments of formal logic, starting with Frege and Russell, have forced Hegel’s conception of contradiction to be rejected or interpreted non-literally. Neo-Hegelians have attempted to conserve *this* principle of contradiction by emphasizing the factor of time: *A* is not identical to *A*, because time has passed in which changes have occurred; contradictions take place one after the other, etc. Articles purporting to describe dialectical logics still appear. In one example, a relation is proposed with non-linear dynamics in which dialectical logic is enhanced by mathematical logic. These and other moves, however, do not address, any more than Hegel did, the question of what drives the change from thesis to antithesis to synthesis, that is, how any term cannot “stand on its own” but “goes over” into its opposite or contradiction. Russell demonstrated, before Lupasco, that Hegel’s logic could be deconstructed because it still presupposed traditional Aristotelian logic, but not for this more important reason.

The standard Hegelian form of Marxist dialectical materialism correctly accords a central role to conflict and contradiction in the transformation of social realities. However, as Priest showed subsequently (Priest 1989), Marxist dialectics fail to give an adequate account of the true contradictions involved in society: an inconsistent or paraconsistent logic is necessary for such an account, albeit in my view not sufficient. A logic of the Lupasco form seems required to characterize the emergence of new structures, including social structures, from real contradictions.

8. Major Precursors (2): recent and contemporary

In this section, I have indicated a relationship of Lupasco’s basic ideas to those of a few other thinkers, recognizing, while trying to avoid it as much as possible, the inevitable component of projection such an enterprise involves. Elsewhere (see Brenner 2005), I have discussed the



relation of Lupasco's work to the critical aspects of the philosophical system of A. N. Whitehead.

8.1. Peirce

In his summary of Lupasco's ternary system, Nicolescu (see Badescu 1999) pointed to the similarities between it and Peirce's triadic semiotics. Peirce's system can be summarized as a combination of semiotic monism, conjoined with an ontological category theory. Peirce based his theory on categories of Firstness (possibility), Secondness (existence) and Thirdness (reality), without the requirement for radically different ontological domains. The "First" is a "Sign" or "Representamen" which is in a genuine triadic relation to a "Second", called its "Object" so as to be capable of determining a "Third", its "Interpretant" to assume the same triadic relation to its Object in which it stands itself to the same "Object". The term 'Sign' was used by Peirce to designate the irreducible relation between the three terms, irreducible in the sense that it is not decomposable into any simpler relation, such as some form of part-whole relation. The common interpretation is that the relation is dynamic because it leads to "chains of triads". I consider this theory insufficiently dynamic because there is no energy that can be assigned to the triadic relation that would give it a basis in reality (physics).

Despite his deep and anticipatory intuitions, Peirce made no ontological commitment regarding his concepts, especially in his early work. He wrote specifically that his "phaneroscopy" (phenomenology) had nothing at all to do with the question of how far the "phanerons" it studied correspond to any realities. I see the problem with Peirce's categories as being like that with the Hegelian triad of thesis, antithesis and synthesis: there is no deductive basis for the movement from one term to the other or a description of any physical interaction between them. If the argument is made that nothing of the sort is required, my response is that is exactly the problem — the terms are not physically grounded and hence have limited explanatory value other than perhaps as a heuristic device for keeping track of the entities involved in, for example, biological processes; its use should not make one neglect the real properties of the system. It is clear that if semiosis is a process of meaning making, of construing a material entity or phenomenon as a Sign, then semiotic interpretation differs from simple physical interaction. It is, nevertheless,



a physical as well as an epistemological process, a process of knowing involving emergence of a more complex process that constitutes meaning. It should not and does not have to be cut off from its physical base since cognitive processes also follow the Lupasco Principle of Dynamic Opposition.

The Peircean semiotic concept of information has been summarized by as a “triadic dependent” process where a form is communicated from an Object to an Interpretant through the mediation of a Sign. My critique of this approach is that as stated by Peirce himself, it is derived from a *formal* science of signs that provides an *analytical* framework. Information as process is constrained by the abstract characteristics of the Peircean categories, that is, their abstraction from dynamic aspects of real physical phenomena.

I present this critique of Peirce primarily to stimulate debate in the face of the tendency, also noted by Short (see Short 2007), to take much of Peirce at face value, a current uncritical acceptance of Peirce’s categories that has become counterproductive. There is evidence in his later writings that he moved towards a more dynamic or energetic viewpoint that is closer to Lupasco, if one selects from among the many available interpretations. Thus in contrast to an essentially static linguistic definition of form in terms of “conditional propositions” stating that certain things happen under certain circumstances, Peirce said that “*Form can also be defined as potentiality* (‘*real potential*’) (emphasis mine). For Lupasco (see Lupasco 1967), structure and form are also physical processes, including the physical processes of their conceptualizations. Form is characterized not as “potential” only, but as a process whose elements are both actual and potential at the same time.

8.2. Von Bertalanffy

In a Theoretical Appendix to to his major work on living systems (see Lupasco 1962) entitled “Notions of General Systemology”, and sub-titled “The place and role of living matter in cosmogony”, Lupasco set forth the principles underlying all of his work in terms of systems. It is interesting to compare Lupasco’s approach to systems with that of his contemporary Ludwig von Bertalanffy, the author of *General Systems Theory (GST)*.

Ludwig von Bertalanffy took various global theories, involving physical, biological and social sciences and proposed something that was in-

tended to go radically beyond them. In his *GST*, based on his fundamental research in biology and embryology, he proposed that the only meaningful way to study organization was to study it as a system. The necessity and potential feasibility of the systems approach was recognized only after the developments in theoretical physics and mathematics of the mid-20th Century, despite the fact that they cannot be fully formulated mathematically.

Problems with the logic of *GST*, however, emerged very early in von Bertalanffy's treatment: he stated that his "science of wholeness" should be a formal logico-mathematical discipline based essentially on the equations of differential calculus. But what logic does he have in mind? Where is the system of logico-mathematical laws he would like to apply, and what is his guarantee that differential calculus can apply to real phenomena? True, he did say that the "all-or-none" concepts of traditional logic fall short of continuity concepts basic for mathematical analysis, but he saw their origin in the structure of our central nervous system as a digital computer. This is the origin of our bivalent yes-or-no logic, thinking in terms of opposites and why "our mental representation of the universe always mirrors only certain aspects or perspectives of reality. He saw that this way of thinking, of occidental physics, could not handle problems of wholeness or form and thus, especially in biology, was a "tremendous embarrassment" to physics. In general, von Bertalanffy used the terms logic and logical relations in a way that indicates the tension between standard bivalent or multivalent linguistic logics and the dynamic vision he wanted to express. He wanted to use a logico-mathematics as an "instrument of holism", but what logic and what mathematics are appropriate?

Both von Bertalanffy and Lupasco worked to oppose dogmatic physicalism but Lupasco described in addition the critical dynamic logical relation between real processes, not only between conceptual constructions. Von Bertalanffy did not provide an axiomatic theory of systems as such, but this is exactly what Lupasco did do, starting from the simplest case of two elements and the requirement that they 1) neither coalesce nor fly apart and 2) cannot instantiate both identity and non-identity. Where von Bertalanffy said "the structure of reality is such that it corresponds to the logical structure of our conceptual schemes", I believe that Lupasco would have inverted this phrase to "the logical structure of our conceptual schemes is such that they correspond to the structure of reality".



8.3. Gödel

In the absence of any perceived need or reason in science to extend Gödel's principles outside mathematics, the extensions made or proposed have been largely informal. For example, in his definitive presentation of Lupasco's contribution to logic and metaphysics, Nicolescu (see Nicolescu 2002) states that physicists have neglected Gödel's theorems and they have been without impact on science despite the fact that physical theories use mathematics and therefore are subject to the conclusions of those theorems. The relation between consistency (or absence of internal contradiction) and completeness, in mathematics, is between two abstract entities. For any application in physics or other science, what might be recognized is that a *similar* relation of opposition or dynamic interaction exists in the physical domain between real elements, which can in addition have emergence of new phenomena as a consequence.

Lupasco's system is a logical model of reality grounded in experience. It is consistent with Gödel's philosophical position that, as described by Hintikka (see Hintikka 2000), was one of actualism, referring to the actual world as the locus of phenomena, including the existence of non-physical "Platonic" objects of mathematics. "All crucial concepts, whose source is a "non-sensible" intuition, require reference to the actual world."

Lupasco is relevant to an understanding of Gödel's views by providing a metaphysical but also logical structure of the properties and relations of things existing independently of our definitions and constructions, also in its naturalization of intuition. Lupasco gave ontological value to both knowledge and intuition, and provides an explanation for the termination of infinite regress in practice, for example, in dealing with "Gödelian" questions.

A major difference between the Lupasco logical view of real systems and whether a Gödelian logical system is incomplete or inconsistent is that the latter are maximally indeterminate; there is no external "driving force" for them to be one or another. One can "oscillate" between the two alternatives of the same ontological value as in the Liar or other paradoxes. In the Lupasco description of real phenomena, for example choice, systems display the same duality, but the outcome, including the probability of emergence, is determined within the essential determinacy of the universe.

The Gödel theorems and logic — as written — do not apply to physical or mental emergent phenomena, but the principle involved, the duality of consistency and completeness, can be seen axiomatically as another instantiation of the fundamental duality of the universe. This is a leap that Gödel, who was fundamentally conservative, certainly did not make. He rejected, correctly in my view, the more idealist implications of many-world pictures of reality, but did not make the extension of his own ideas to it. The ontological development of logic undertaken by Lupasco can illuminate Gödelian dualism as another expression of the fundamental dynamic opposition at the heart of energy and phenomena.

8.4. The ontological turn

Briefly, the “ontological turn” in philosophy is a term of art that designates dissatisfaction with descriptions of reality based on analytical, semantic criteria of truth. Starting with Heidegger’s critique of hermeneutics and the basing of philosophy on human life, the ontological turn is a challenge to neo-Kantian epistemologies, and looks to what the structure of the world might be like to enable scientific, that is, non-absolute knowledge. Unfortunately, ontological theories have been hobbled by the retention of static terms whose characteristics are determined by bivalent logic.

In 2002, Priest called attention to a generalized ontological turn in philosophy, away from language and toward *what is* — the nature of reality, and suggested that that nature is contradictory. However, Priest made no detailed analysis of what this might imply other than the validity of paraconsistent logic. As I have tried to show, Lupasco anticipated this ontological turn by some sixty years.

9. Conclusion and outlook

In this overview of the “life and work of Stéphane Lupasco”, I have tried to give some sense of the intellectual achievement it represents. I have discussed the formulation by Lupasco of the physical, dynamic opposition in energy as the basis of a logic and of a metalogical general principle of opposition related to issues in philosophy, logic and science. Many aspects which it has not been possible to cover deserve attention, for example, Lupasco’s extensive application of his system to biology in



general and embryology in particular. His concept of the information present as potential in at the level of both genes and cells finds echoes in new approaches to non-Shannon-Weaver “biotic” information (see Kauffmann et al. 2007). In general, Lupasco’s work can be seen as a bridge or intermediate explanatory structure between the disciplines and the realities they discuss.

However, I am aware that its more general acceptance and application requires a shift from focus on the axioms and formalism of classical and neo-classical propositional or mathematical logic as the criteria of a valid logical system. People who refuse the principle that logic need not be limited to propositions but can describe certain important and interesting aspects of complex processes will not be convinced by my multiplying examples. Nevertheless, I feel that Lupasco effected a return, which one might call a metalogical “rejunction”⁵, of logic with its original sense of a global science of nature. No diminishing of the value of standard logic in its appropriate domain is intended or implied.⁶

In my view, Lupasco’s logical theory is at the same time a scientific theory and, to the extent that its physical postulates or underpinnings could be disproved, it could meet Popper’s criterion of falsifiability. In another sense, however, it is a metatheory that proposes analyzing the extent to which other theories adequately represent the non-separable properties of real phenomena. Thus, there is in Lupasco’s work a possible new criterion of falsifiability as *partial* falsehood. Any theory whose argument depends on the absolute independence of the entities or interpretations under discussion may be biased in favor of one or the other, resulting in errors or omissions. (I have tried to avoid this trap by *assuming* the existence of a counter-theory with which Lupasco’s is necessarily in a dialectical relationship.)

Students of Popper may wish to compare Lupasco’s conception of potential properties with propensities, but in my view Lupasco’s dialectics ground propensities at a more fundamental physical level. Thus,

⁵I suggested this term in a paper presented at a Symposium on Lupasco under the auspices of CIRET and the Romanian Delegation to U.N.E.S.C.O., Paris, March 24, 2010.

⁶Readers familiar with the Universal Logic of Jean-Yves Béziau, Huacan He and others may wonder if it includes the Lupasco logic. As I have discussed with these authors, Universal Logic is a method for systematizing and mathematizing propositional logics and does not apply to the Lupasco system.



potentialities do not “bestow” powers on particulars: they *are* powers. As Shoemaker (see Shoemaker 1982) said, “What makes a property the property it is, what determines its identity, is its potential for contributing to the causal powers of the things that have it.”

At the current stage of the rediscovery of Lupasco’s work, it is far too early to tell whether it will have an impact on thought in the 21st Century or remain an intellectual curiosity. Given the volume of Peircean studies today, for example, one tends to forget that his work also traversed a period of relative occultation, which, however, was diminished by its accessibility in English and its codification at Harvard University. In my opinion, the demands of deeper understanding in both science and philosophy will render standard propositional logics obsolete as a limit is reached in the acceptance of tautologies as adequate to a satisfactory world-view. However, the inertia represented by existing logic and philosophy is enormous, and change, if it comes at all, will come slowly. This article, my *Logic in Reality* and *Nicolescu’s Qu’est-ce que la réalité?* now exist, together with other work by associates of Nicolescu in France, Romania and Brazil, as a basis for change. However, as Lupasco might say, any tendency toward their acceptance and application exists, for the time being, primarily in potential form.

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References

- Aerts, D., E. D’Hondt and L. Gabora, 2000. “Why the logical disjunction in quantum logic is not classical”, *Foundations of Physics* 30: 1473–1480.
- Badescu, H. and B. Nicolescu (eds.), 1999, *Stéphane Lupasco; L’homme et l’œuvre*, Monaco: Éditions du Rocher.



- Beigbeder, M., 1972, *Contradiction et nouvel entendement*, Paris: Bordas.
- Béziau, J.-Y., 2010, “Non truth-functional many-valuedness. <http://www.unine.ch/unilog/jyb/nottmany.pdf> .
- Bennett, M. R., and P. M. S. Hacker, 2003, *Philosophical Foundations of Neuroscience*, Massachusetts: Blackwell Publishing.
- Brenner, J. E., 2005, “Process in reality: A logical offering”, *Logic and Logical Philosophy* 14: 165–189.
- Brenner, J. E., 2008, *Logic in Reality*, Dordrecht: Springer.
- Brenner, J. E., 2009. “Consciousness as process: A logical perspective”, unpublished manuscript. Presented at the Symposium on Consciousness, International Conference on Computing Anticipatory Systems, Liège, August.
- Brouwer, L. E. J., 1951, *Cambridge Lectures on Intuitionism*. <http://home.mira.net/~gaffcam/phil/brouwer.htm>
- Chaitin, G., 1998, *The Limits of Mathematics*, Singapore: Springer-Verlag Singapore.
- Carnielli, W., M. E. Coniglio, and J. Marcos, 2005, “Logics of formal inconsistency”, pp. 15–107 in: *Handbook of Philosophical Logic*, 2nd edition, Dordrecht: Springer, 14. Available at http://www.cle.unicamp.br/e-prints/vol_5,n_1,2005.html
- Fondane, B., 1998, *L'être et la connaissance; essai sur Lupasco*, Paris: Éditions Paris-Méditerranée.
- Hintikka, J., 2000, *On Gödel*, Belmont, California: Wadsworth.
- Hofweber, T. 2005, “Logic and ontology”, in: *The Stanford Encyclopedia of Philosophy*, Summer 2005 Edition), editor E. N. Zalta. <http://plato.stanford.edu/archives/sum2005/entries/logic-ontology/>
- Ioan, P., 2000, *Stefan Lupascu si cele trei logici ale sale*, Iasi Editura “Stefan Lupascu”.
- Kauffman, S., R. Logan *et al.*, “Propagating organization: An enquiry”, *Biology and Philosophy* 23: 27–45.
- Lupasco, S., 1935, *Du devenir logique et de l'affectivité*; Vol. 1: *Le dualisme antagoniste*; Vol. 2: *Essai d'une nouvelle théorie de la connaissance*, Paris: Vrin; 2nd edition 1973.
- Lupasco, S., 1947, *Logique et contradiction*, Paris: Presses Universitaires de France.
- Lupasco, S., 1951, *Le principe d'antagonisme et la logique de l'énergie*, Paris: Éditions Hermann. 2nd edition Paris: Éditions du Rocher, 1987.



- Lupasco, S., 1960, *Les trois matières*, Paris: Julliard.
- Lupasco, S., 1962, *L'énergie et la matière vivante*, Paris: Julliard. 3rd Edition, Monaco: Éditions du Rocher, 1986.
- Lupasco, S., 1967, *Qu'est-ce qu'une structure?*, Paris: Christian Bourgois.
- Lupasco, S., 1974, *L'énergie et a matière psychique*, Paris: Julliard. 2nd Edition, Monaco: Éditions du Rocher, 1987.
- Lupasco, S., 1979, *L'Univers Psychique*, Paris: Denoël-Gonthier.
- Lupasco, S., 1986a, *L'homme et ses trois éthiques*, Paris: Éditions du Rocher.
- Lupasco, S., 1986b, "La topologie énergétique", pp. 11–28 in: *Pensées hors du Rond, La Liberté de l'esprit*, Paris: Hachette.
- Marcos, J., 2005, *Logics of Formal Inconsistency*. <http://www.math.ist.utl.pt/~jmarcos/Thesis/>
- Nicolescu, B., 1996, *La transdisciplinarité. Manifeste*, Paris: Éditions du Rocher, p. 9. Reedited 2001: *Manifesto of Transdisciplinarity*, Albany: State University of New York Press. Cf. <http://perso.club-internet.fr/nico1/ciret>
- Nicolescu, B., 2002, *Nous la particule et le monde*, Paris: Éditions du Rocher.
- Nicolescu, B., 2009, *Qu'est-ce que la réalité?*, Montreal: Liber.
- Melhuish, G., 1959, *The paradoxical universe*, Bristol: Rankin Bros.
- Matsuno, K., 2011, "Framework of space and time from the proto-semiotic perspective"; for publication in *Biosemiotics*.
- Poli, R., 1993, "Vasil'ev, Nicholas A. Logic and metalogic. Imaginary (non-Aristotelian) logic", *Axiomathes* 3: 325; 329; 351–353.
- Priest, G., 1987, *In Contradiction*, Dordrecht: Martinus Nijhoff.
- Priest, G., 1989, "Dialectic and dialethic", *Science & Society* 53: 388–415.
- Priest, G., 2002a, "Inconsistency in the empirical sciences", pp 1–11 in: *Inconsistency in Science*, J. Meheus (ed.), Dordrecht: Kluwer Academic.
- Priest, G., 2002b, *Beyond the Limits of Thought*, Oxford: Clarendon Press.
- Revardel, J.-L., 2003, *L'univers affectif*, Paris: Presses Universitaires de France.
- Rovelli, C., 2009, "Forget time", *arXiv: 0903.3832v3 [gr-qc] 27 Mar.*
- Shoemaker, S., 1982, "Causality and properties", in: *Identity, Cause and Mind*, Cambridge, U.K.: Cambridge University Press.
- Short, T. L., 2007, *Peirce's Theory of Signs*, Cambridge: Cambridge University Press.



Steinhardt, P. J., and N. Turok, 2002, “A cyclic model of the universe”, *Science* 296, 1436.

Taylor, C., 1975, *Hegel*, Cambridge: Cambridge University Press.

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