What is Metascientific Ontology?

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Abstract — Metascientific ontology differs from philosophical ontologies in its objectives, objects and methods. By an examination of the ontological theories of Mario Bunge, we will show their main objective is a unified representation of the world as known through the sciences that their objects of study are scientific constructs, and that their methods do not differ from those that one expects to find in any rational activity. Metascientific ontology is therefore not transcendent because it does not seek to represent objects alien to the world we inhabit and to the sciences that study it, and therefore does not need special faculties and methods to carry out its research.

Résumé — L'ontologie métascientifique se distingue des ontologies philosophiques par ses objectifs, ses objets et ses méthodes. Par un examen des théories ontologiques de Mario Bunge, nous montrerons que leur principal objectif est l'élaboration d'une représentation unifiée du monde tel que connu par les sciences, que leurs objets d'étude sont des construits scientifiques, et que leurs méthodes ne diffèrent pas de celles qu'on s'attend à trouver dans toute activité rationnelle. L'ontologie métascientifique n'est donc pas transcendante parce qu'elle ne cherche pas à représenter des objets étrangers au monde que nous habitons et aux sciences qui l'étudient, et par conséquent elle n'a pas besoin de facultés ni de méthodes spéciales pour mener à bien ses recherches.

We continue our characterization of metascience we have undertaken in our article "Metascience. For a General Scientific Discourse" (Maurice 2020). In order to better understand the nature of metascience, and thus better understand what distinguishes it from philosophy, we will compare metascientific ontology to philosophical ontology. Since we argue in the just-mentioned article that Bunge's philosophical theories are in fact

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metascientific theories, we will use Bunge's ontology to carry out this comparison.

We will therefore examine the ontological theories as set forth in Bunge's writings, particularly those found in volumes 3 and 4 of the *Treatise on Basic Philosophy*. This paper will make clear the non-philosophical nature of Bunge's theories, notably through his refusal to postulate the existence of entities other than those postulated and studied by the sciences as well as his rejection of philosophical methods.

In several texts, Bunge has endeavored to define or characterize metaphysics or scientific ontology[2]. In general, Bunge considers ontology and metaphysics to be synonymous, just as scientific ontology and scientific metaphysics are synonymous, although Bunge leans towards the use of the second expression before 1977 and the use of the former from 1977. Note that we should not confuse *scientific ontology,* as characterized by Bunge and other philosophers, with *metascientific ontology,* as we will characterize it from the way Bunge practices ontology, and not from what he says about it, although in the end, once we no longer refer to Bunge's conception or those of other philosophers, we consider the two expressions to be synonymous. In fact, if we are in a strictly metascientific framework, we can speak of ontology only. At the end of this study, what interests us is to show that the scientific or metascientific ontology as we conceive it is different from any *philosophical ontology*.

Like the expression scientific ontology, the expression *scientific metaphysics* is used not only by Bunge, but also by some philosophers[3]. For our purpose, let us note that we have redefined metaphysics as the metascience of physics, in the same way that there is metachemistry, metabiology and metapsychonology[4]. For us,

[2] The five main texts in Bunge that deal with the nature of scientific ontology are: an article with the explicit title, "Is Scientific Metaphysics Possible?" (1971), Chapter 2 of *Method, Model and Matter* entitled "Testability Today" (1973a), a text in French entitled "Les présupposés et les produits métaphysiques de la science et de la technique contemporaines" (1974), an article proposing a typology of scientific theories entitled "The GST Challenge to the Classical Philosophies of Science" (1977b), and the introduction of *Ontology: The Furniture of the World*, volume 3 of the *Treatise on Basic Philosophy* (1977a).

[3] See *Scientific Metaphysics* (Ross, Ladyman & Kincaid 2013).

[4] We group under psychonology all the disciplines that deal with the human based on the existence of a fourth level of organization of matter, the thinking matter, in the same way as there is a physical, chemical and living matter (Maurice 2020).

ontology and metaphysics are not synonymous, although for reasons different from those put forward by philosophers (Maurice 2020).

Finally, the expression *scientific philosophy*, used by Bunge to define his philosophy, is a contradiction in terms[5]. Our appreciation of philosophy as a *transcendent general discourse* does not allow it to be scientific (Maurice 2020)[6]. The non-scientificity of philosophy will become clear once Bunge's metascientific ontology is exposed as an illustration of a *scientific general discourse*.

We dwell in this article on the referents of the ontological theories exposed in volumes 3 and 4 of the *Treatise*. We therefore leave aside the form that these theories can take or their formalism, the use that can be made of them or their implementation, and the way in which these theories can be evaluated or their testability. We will also leave aside the Bungean thesis that abstract scientific theories, such as Lagrangian dynamics, as well as systems theories, such as cybernetics or automata theory, are ontological theories. Most notably, Bunge argues that there are no boundaries between factual science and ontology, but that there is a continuity that ranges from the most peculiar factual sciences to the most general ontologies: "A complete ontology must include both universal and regional ontological theories. The former serve as frames for the latter, who in turn will somehow illustrate and test the former" (Bunge 1977a, p. 11). Thus, in philosophical jargon, Bunge supports a form of naturalization of ontology, even if in practice, as we will see, Bunge

[5] Romero has published a book called *Scientific Philosophy* (2018) that follows the structure of Bunge's *Treatise* quite closely. Despite the small number of pages, about 200, Romero's work is not necessarily more accessible than the *Treatise* since Bunge comments at length on his formalism. The fastest and simplest introduction to the *Treatise* remains the *Philosophical Dictionary* (Bunge 2003). More demanding is *Philosophy of Science* (Bunge [1967a] 1998, [1967b] 1998), a reissue of *Scientific Research*. Several of the themes of the *Treatise* are addressed.

[6] Even if we try to broaden our characterization of philosophy, even if we assume that there are non-transcendent doctrines, philosophy cannot be scientific. Once we have managed to convince ourselves that concrete objects exist beyond our senses, that these objects are knowable, that the best way to know them is to appeal to science, in other words, once we no longer question the world and the sciences that study it, we find ourselves outside philosophy, especially if our general discourse does not postulate any metaphysical entity, appeals only to natural faculties and uses only standard tools, procedures or methods.

does not naturalize in the same way as philosophers[7]. We will not examine this thesis of the continuity between factual science and ontology, but our results indicate a dichotomy between the two disciplinary fields. It should be noted that Bunge does not defend the idea of continuity between the factual sciences and mathematics. On the contrary, it postulates a dichotomy between factual and formal propositions. In addition to the referents of ontological theories, we will be interested in the methods, techniques and tools used by Bunge to construct these theories. We will then find that Bunge does not use any approach associated with philosophical doctrines. In short, we will follow Bunge's advice: "When in doubt about the authenticity of an intellectual endeavor, the right thing to do is to perform a candorous [*sic*] reexamination of its three components: subject matter, method, and goal." (Bunge 1973b, p. 1).

In the case at hand, i.e., the nature of Bungean ontology, we will examine the ontological theories set out in volumes 3 and 4 of the *Treatise* devoted to their elaboration: *Ontology I: The Furniture of the World* and *Ontology II: A World of Systems*. Specifically, for the task ahead, we must consider only chapters 3 through 6 of *Ontology I* and chapter 1 of *Ontology II*. Why this restriction of our field of investigation? Our goal is to show 1) that the Bungean ontology does not postulate the existence of any particular object, but takes for granted the existence of the objects studied by the factual sciences, and 2) that the methods, techniques and cognitive faculties used to achieve this are those expected to be found in all rational activities, be it scientific research, management, law, etc. The chapters mentioned above set out the fundamental concept of the Bungean ontology, the *concrete object*[8]. In fact, the Bungean system is designed to account for the concrete object in the light of science. Whether it is semantics, epistemology, methodology or ontology, it is always the concrete object that is at issue because the factual sciences only study concrete objects since the world is made up only of

[7] For more details, see our article "Bunge's Metascience and the Naturalization of the General Discourse" in this issue.

[8] See in this issue Orensanz's article, "Bunge and Harman on the General Theory of Objects", for the general notion of object, and not only that of concrete object. See also in this issue the article by Lukyanenko, Storey and Pastor, "Foundations of Information Technology Based on Bunge's Systemist Philosophy of Reality", for a defense of the idea that the notion of concrete system is gradually replacing that of concrete object in Bunge's writings after the *Treatise*.

concrete objects. Let us understand that these metascientific disciplines do not study the concrete objects of the world, which is the responsibility of the various factual disciplines, from physics to sociology, but rather that they elaborate a generalized notion of concrete object. If an examination of this central concept of Bungean thought reveals no transcendence, it is implausible to find it in other places in the work.

We can divide these two volumes into six distinct moments. Chapters 1 and 2 of *Ontology I* serve to introduce the concepts of *substantial individual* and *substantial property* respectively. These concepts are used in Chapter 3 to define the concepts of *concrete object* and *totality of concrete objects* (section 1.1). Chapter 3 also puts forward two postulates, the ontological one of the *existence of concrete objects* (section 1.2) and the methodological one of the *dichotomy between concrete and conceptual objects* (section 1.3). Once these two definitions and postulates are in place, Bunge is able to introduce a large number of ontological notions (while appealing to semantic, epistemological and methodological considerations), which ranges from section 1.4 of chapter 3 to chapter 6, the last chapter of *Ontology I*. In Chapter 1 of *Ontology II*, the very first definition is that of a *concrete system*, defined using the notion of concrete object, just as for the ontological concepts of *Ontology I*. Subsequently, and from the second definition, it is this notion of concrete system that takes the front of the stage and will play as important a role in *Ontology II* as the role played by the notion of concrete object in *Ontology I*. Chapters 2 to 5 of *Ontology II* are then devoted to the study of concrete chemical, biological, psychological and social systems[9]. Finally, Chapter 6, the last chapter of *Ontology II*, generalizes some results concerning concrete systems.

To assist us in our characterization of metascientific ontology, we will use Bunge's definition of science (2003, see entry "Science,

[9] In other words, Bunge offers some ontological elements of what we have called metachemistry, metabiology, metapsychology and metasociology (there is also a semantics, epistemology and methodology of metachemistry, etc.) (Maurice 2020). There is no chapter on physical systems (a chapter on metaphysics in the metascientific sense) in *Ontology II* because, according to Bunge, they are the best known of all and he dealt with these systems in *Ontology I* (Bunge 1977a, p. 45). Technically, Bunge's second claim is false since he dealt with the notion of concrete object in *Ontology I* and not that of a physical system.

Basic")[10]. A factual science is characterized using ten criteria, to which we add an eleventh criterion, E. All of these criteria can be represented by $\mathcal{R} = \langle C, S, E, D, G, F, B, P, K, A, M \rangle$, where each component is detailed as follows:

(1) C, the *research community* of $\mathcal{R}$, is a social system composed of persons who have received a specialized training, hold strong communication links among themselves, share their knowledge with anyone who wishes to learn, and initiate or continue a tradition of inquiry (not just of belief) aiming at finding true representations of facts;

(2) S is the *society* (complete with its culture, economy, and polity) that hosts C and encourages or at least tolerates the specific activities of the components of C;

(3) the *domain* or *universe of discourse* D of $\mathcal{R}$ is composed exclusively of (actual or possible) real entities (rather than, say, freely floating ideas) past, present, or future;

(4) the *ethos* E of members of C characterize by the free search for truth, depth, understanding, and system (rather than, say, the ethos of faith or that of the quest for sheer information, utility, profit, power, consensus, or good)[11];

(5) the *general outlook*[12] G of $\mathcal{R}$ consists of (a) the ontological principle that the world is composed of concrete things that change lawfully and exist independently of the researcher (rather than, say, ghostly or unchanging or invented or miraculous entities); (b) the epistemological principle that the world can be known objectively, at least partially and gradually;

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[10] The definition of science is based on the more general notion of epistemic or cognitive field. Using this notion, Bunge deals with several other notions, such as paradigm, epistemic revolution, field of research, research project, etc. (Bunge 1982, sections 2 and 3, 1983a, pp. 90-93, 1983b, chaps. 13 and 14, 1984, 1985a, pp. 21-28, 1985b, pp. 242-252, 1989, pp. 296-300, 1996, chaps. 7, 2001, sections 8.3 and 8.4, Bunge & Ardila 1987, sect. 3.5). Bunge's attempt to demarcate science from pseudoscience based on the notion of epistemic field would seem ineffective (Mahner 2021).

[11] Our component E is for Bunge a subcomponent of G. But for us ethics does not belong to a scientific general discourse, but rather to a general discourse of convivence independent of metascience, philosophy and religion, even if there are philosophical and religious ethics (Maurice 2020).

[12] Bunge also uses as a synonym the expression "philosophical background", which we can dispense with since for us philosophy is not mistaken for a scientific general discourse or a metascience.

(6) the *formal background F* of $\mathcal{R}$ is the collection of up-to-date logical and mathematical theories (rather than being empty or formed by obsolete formal theories);

(7) the *specific background B* of $\mathcal{R}$ is a collection of up-to-date and reasonably well confirmed (yet corrigible) data, hypotheses, and theories, and of reasonably effective research methods, obtained in other fields relevant to $\mathcal{R}$*;*

(8) the *problematics P* of $\mathcal{R}$ consists exclusively of cognitive problems concerning the nature (in particular the regularities) of the members of *D***,** as well as problems concerning other components of $\mathcal{R}$;

(9) the *fund of knowledge K* of $\mathcal{R}$ is a collection of up-to-date and testable (though rarely final) theories, hypotheses, and data compatible with those in *B,* and obtained by members of *C* at previous times;

(10) the *aims A* of the members of *C* include discovering or using the regularities (in particular laws) and circumstances of the *D*s, systematizing (into theories) general hypotheses about *D*s, and refining methods in *M;*

(11) the *methodics M* of $\mathcal{R}$ consists exclusively of scrutable (checkable, analyzable, criticizable) and justifiable (explainable) procedures, in the first place the general scientific method**.**

From this characterization, Bunge defines the *material framework* and the *conceptual framework* of any factual science. The material framework consists of the first three components, *C*, *S* and *D*, while the conceptual framework consists of the last seven components, *G*, *F*, *B*, *P*, *K*, *A* and *M*. Between these two frameworks, we insert the *conventional framework*, component *E*. If we reason in terms of objects of study, that is to say the referents of a discipline, the concrete objects of component *D* are the objects of study of a particular factual science, whether it is physics, chemistry, biology, psychology, sociology, etc., while the concrete objects of components *C* and *S*, that is, scientists, scientific communities and the societies that host them are the objects of study of the history, sociology and psychology of science. Now, conceptual objects, or scientific constructs from components *G*, *F*, *B*, *P*, *K*, *A*, and *M* are the objects of study of the metasciences, that is, metascientific semantics, ontology, epistemology, and methodology. Thus, some of the scientific constructs lend themselves to either semantic, ontological,

epistemological, or methodological research, and other constructs, perhaps the majority, are studied using two or more of those metascientific disciplines. In other words, the same scientific construct can be studied from several angles, not to mention that it can be the subject of logical analysis and mathematical synthesis if it is incorporated into a mathematized metascientific theory. Finally, component *E* has as its object the conventions necessary for the smooth running of scientific activity. Thus, the factual sciences study the material objects of the *C*, *S* and *D* components, the metasciences study the conceptual objects of the *G*, *F*, *B*, *P*, *K*, *A* and *M* components, and the convivence disciplines study the conventional objects of the component *E*.

As fields of research, the metasciences can be characterized in a similar way to the factual sciences. At this point, the constructs or conceptual objects of the *G*, *F*, *B*, *P*, *K*, *A* and *M* components of the factual sciences are found as elements of *D* of the metasciences, that is, the objects of study of a scientific general discourse. In this article, among the components *D*, *G*, *F*, *B*, *P*, *K*, *A* and *M* of a metascientific ontology, we will therefore focus on the next section on component *A*, the objectives of such an ontology, and then in section 2, we will examine component *D*, the objects of study of this ontology, and, finally, in section 3, we will look at the *M* component, the methodic of the metascientific ontology. We will use the Bungean ontology to illustrate our point.

1] Goals of Ontology

Bunge has stated the objectives of his ontology in several places and these objectives are diverse, as they are related to certain theses as to the nature of ontology which we discussed briefly in the introduction[13]. Bunge's characterization of ontology and the goals he assigns to it are ambiguous and inconsistent with the way he practices his ontology.

If we stick to the introduction of *Ontology I* of the *Treatise*, we find the following characterizations and objectives:

> Metaphysics is *general cosmology or general science:* it is the science concerned with the whole of reality—which is not the same as reality as a whole. "Its business is to study the most general features of

[13] See note 2 for a list of Bunge's texts on the nature of ontology.

> reality and real objects" (Peirce). It "is concerned with all questions of a general and fundamental character as to the nature of the real" (Montagu). In other words, metaphysics studies the generic (nonspecific) traits of every mode of being and becoming, as well as the peculiar features of the major genera of existents. […] We adopt the latter position: we maintain that the ontologist should stake out the main traits of the real world as known through science, and that he should proceed in a clear and systematic way. He should recognize, analyze and interrelate those concepts enabling him to produce a unified picture of reality. (The word "reality" is here understood in a strict and non-Platonic sense, namely as the concrete world.) (Bunge 1977a, p. 5, italics and quotations in the original text)

It is not clear, for example, what the study of the "most general features of reality and real objects" can mean, since for Bunge there are only concrete objects, endowed with concrete properties, and in interaction with each other. For example, Bunge does not believe in the existence of general properties in nature. What are these "generic (nonspecific) traits of every mode of being and becoming"? If the features and traits in question are those of real or concrete objects, then they cannot be general or generic.

The interpretation we give of them is to say that it's not "general characteristics" or "generic features" of concrete objects which ontology studies, but rather scientific constructs that refer to reality. In other words, an ontology proposes generalized constructs based on the constructs used and produced by the factual sciences. For example, the sciences study concrete properties, while the metasciences study a generalized notion of property. These constructs used and produced by the factual sciences are of various kinds. Let us think, among other things, of general postulates such as the existence of the external world, of certain concepts called constitutive by Bunge such as that of association, of certain other more well-known concepts that scientists spontaneously use such as those of property, of fact, of event, of processes, of system, and of others less known as those of emergence and level of organization.

The passage quoted above is quite complex, but the characterization that seems to us the most accurate is that which specifies that ontology must "*recognize, analyze and interrelate those concepts* enabling him to produce a unified picture of reality". Here, we approach a conception of ontology whose task is to study implicit or

explicit scientific and metascientific constructs[14]. However, the idea of a factual ontology that would study concrete objects is reaffirmed a few paragraphs later:

> We take factual (natural or social) science and ontology to be the only disciplines concerned with concrete objects. And we assign ontology the task of constructing the most general theories concerning such and only such objects. (Bunge 1977a, p. 6)

We find this ambiguity concerning generality, but here from the angle of a very general theorization of concrete objects. Do such general theories, such ontologies, have the same status as the general theories of certain factual sciences, such as quantum mechanics or the theory of evolution? Finally, in another place, Bunge clearly announces what ontology does not study:

> Ontology does not study constructs, i.e., ideas in themselves. These are studied by the formal sciences and epistemology. (Bunge 2003, p. 201)

The statement is surprising when one considers the way Bunge constructs these ontological theories in volumes 3 and 4 of the *Treatise*. For example, he analyzes how scientists represent concrete properties by asking what this construct is, not by studying a general property in nature, a property that does not exist, but by studying certain concepts of property such as mass, the latter representing a concrete property studied by physicists. So, there is an ambiguity in Bunge's characterization of his research. He conceives ontology in a vague and general way and then practices it in a precise and rigorous way. His characterization of ontology is not interesting since it is not distinguishable from several characterizations found in philosophy. On the other hand, his metascientific practice of ontology deviates radically from the philosophical practice of ontology. He studies and tries to theorize certain scientific constructs, including general postulates often implicitly used by scientists, but he

[14] *Implicit metascientific constructs* are essentially general unformulated postulates, traditionally associated with philosophy, such that the objects of the world interact. *Explicit metascientific constructs* are those used by scientists to communicate, such as the use of the notion of property, but without specifying or formalizing them. *Explicit scientific constructs* are those produced by any science, such as a concept, a proposal, a classification, a theory, etc., and the *implicit scientific constructs* are those borrowed from other disciplines, and even from other research projects of the same discipline, without formulating them.

does not postulate the existence of any object, takes for granted the existence of objects studied by the factual sciences, uses methods, techniques and cognitive faculties used in all rational activities. There are no metaphysical objects that a first philosophy could study. There is no more philosophy.

If we summarize, the goal of metascientific ontology is to study scientific constructs to produce an abstract, generalized, unified picture of the world[15]. If we return to the definition of a factual science, these constructs are to be found among the objects that are found in the components of the conceptual framework of the factual sciences: *G*, *F*, *B*, *P*, *K*, *A* and *M*. Other constructs of a conceptual framework may be the objects of study of semantics, epistemology, methodology, and some constructs may require the contribution of several metasciences. The study of scientific constructs justifies conceiving the metascience as conceptual sciences, forming a triad with factual sciences and formal sciences (Maurice 2020).

2] Objects of Ontology

The notion of concrete object is at the heart of the Bungean ontology. It is this notion that is the subject of a theorization elaborated in *Ontology I*. Virtually all the ontological notions discussed are related to the concrete object. But the definitions and postulates concerning the notion of concrete object and the associated notions are nourished by the knowledge of the concrete objects studied by the physical, chemical, biological, psychological, and sociological sciences, more precisely by the constructs used, implicitly or explicitly, by scientists to represent concrete objects. There is therefore a back and forth between scientific constructs, which must be analyzed and interpreted, and the construction or synthesis of an abstract notion of concrete object and associated notions.

The notion of concrete or material object in Chapter 3 of *Ontology I* is defined in a formal and complex way. Bunge needs a theory of substance (Chapter 1) and another of form (Chapter 2) to arrive at a definition of concrete object. We will not examine these two

[15] Even if for Bunge, the ultimate in the outcome of all research is a theory, a hypothetical-deductive system, he is aware that several results exposed in *Ontology I* and *II* are not strictly speaking theories. He thus introduces the notion of *ontological framework*, a construct that lies between a set of ideas that are closely related to each other and a hypothetical-deductive system or a theory (Bunge 1977a, pp. 11-12).

theories and will adopt a more intuitive characterization of the concrete object proposed by Bunge himself, which will suffice for our purpose (Bunge 1977a, pp. 240, 2000)[16]. The concrete object is the object that is subject to change. But since change is impossible without energy or without any energy transfer, the concrete object is the object endowed with energy. This definition justifies the postulate, again in chapter 3 of *Ontology I*, of the dichotomy between concrete objects (things) and conceptual objects (constructs). The concepts, propositions, theories and formal objects of logic and mathematics are not endowed with energy, are therefore not susceptible to change, and consequently have no concrete, material, or real existence. Concrete objects change and conceptual objects are replaced.

Note that the definition of a concept is not proof of the existence of the object to which the concept refers. Thus, in chapter 3 of *Ontology I*, we have seen that there is a definition of the concrete object, but also the postulate of existence of concrete objects[17]. Thus, Bunge takes for granted the existence of concrete objects although he theorizes the notion. Moreover, for Bunge, the criteria and demonstrations of the existence of particular concrete objects such as atoms, living cells or social groups do not belong to ontology, but to the factual sciences (we will come back to this). Bunge does not attempt, therefore, in *Ontology I: The Furniture of the World*, to determine the "furniture of the world" if by furniture of the world we mean the concrete objects studied by the factual sciences:

> What is there?—we shall abstain from answering it. That is, we shall not list the kinds of constituent of the world but shall leave the task to the special sciences. For, no sooner does the metaphysician pronounce the world to be "made of" such and such kinds, than the scientist discovers either that some of the alleged species are empty or that others are missing in the metaphysician's list. (Bunge 1977a, p. 153)

So, there is no metaphysics in the philosophical sense for Bunge. We can, however, understand "furniture of the world" in a general sense. In this case, the conceptual objects to which the ontological

[16] It is not clear to us that the developments in chapters 1 and 2 in *Ontology I* are necessary for the development of a metascientific ontology.

[17] Similarly, change (Bunge 1977a, p. 261) and energy (Bunge 1977a, p. 240) as phenomena are taken for granted, although these notions are theorized in Chapter 5 of *Ontology I*.

concepts refer are seen as the "furniture of the world". But there are no general concrete objects in the world, nor general properties or laws, nor general states or events, nor general processes or changes. All that exists are particular objects, endowed with their particular properties, in particular nomic interaction: "The real thing is the substantial individual with all its intrinsic and mutual properties. Everything else is fiction." (*ibid.*, p. 101). Or, in a pithy way: "To be, to really exist, is to be a thing"[18] (*ibid.*, p. 158). Or:

> […] *all* things, and *only* things, possess the property of existing really—a property represented by E_θ. This vindicates Aristotle's principle that *real existence is singular*. There are no general things: every real existent is an individual. (ibid., p. 157; italics in the original text)

We construct a general concept of concrete object, property, state, event, process, and change. Without these general concepts, often used only implicitly, all theorization and communication, even in the factual sciences, would be impossible. It is for this reason that there are metascientific concepts, inherent in science, wrongly assimilated to philosophical concepts. In other words, we need general concepts to represent the world and to communicate, but these concepts do not refer to particular real objects and even less to metaphysical objects; they are the result of an abstraction and a generalization on the basis of a study of scientific constructs. For example, concrete properties are conceptualized in certain ways by the factual sciences, and it is the way of conceptualizing them that interests the Bungean ontology and not the properties themselves. Thus, Bunge analyzes the way scientists represent concrete properties by asking what is this construct that is called property, not by studying a general property that would be found in nature or in a metaphysical reality, but by studying certain concepts of property such as that of mass, the latter concept representing the concrete property of mass with which certain objects of the world are endowed, each individually. In the strict sense, in fact, concretely, massive objects do not share or do not have in common a general mass property; each of them has its own mass by the nature of the objects that compose them and the relationships they maintain.

[18] For Bunge, "concrete object" and "thing" are synonymous.

Thus, Bunge postulates the existence of concrete objects and puts forward several reasons to justify such an assumption, including this one, the most important:

> Another reason for having to postulate the existence of things is that, if we want to prove anything about existents, we must posit them. *We cannot prove the existence of concrete things any more than we can prove the existence of deities or of disembodied minds*. What can be proved is that, unless there were things, other items—such as acting on them and investigating them—would be impossible. (*ibid.*, p. 112, our italics)

A demonstration or logical proof of existence is impossible. It is through reflection, through our experience and through our acquired knowledge that we can convince ourselves of the existence of the world and the concrete objects that compose it. And much of that thinking, experience, and knowledge is fueled by science. More specifically, we cannot demonstrate the existence of the general concrete object because it does not exist. Only the existence of a particular concrete object postulated by the factual sciences can be the subject of empirical proof (in fact, it is enough to find only one):

> Our theory of things supplies no criterion for either establishing or refuting any hypothesis to the effect that such and such an object really exists. It is not the business of metaphysics to offer existence criteria […] (*ibid.*, p. 160).

Or:

> Metaphysics, on the other hand, is hardly in a position to admit or rule out any fact. What metaphysics can do is to clarify some of the concepts involved in scientific judgments of possibility or impossibility. (*ibid.*, p. 178)

So, an essential notion for Bunge is that of a *concrete object* or *thing*. Concrete objects are objects that are subject to change because they are endowed with energy. In contrast, we find *conceptual objects* or *constructs*. They are not subject to change because they do not have energy. Are we then in the presence of an ontological duality? No, since one of the axioms of the Bungean system is that only concrete objects exist. Duality is therefore methodological. It is also necessary to allow us to treat fictions or constructions of the mind *as if* these constructs were autonomous. But this necessary

methodological duality is often perceived by the mind as an ontological duality (Maurice 2020).

Among the concrete objects, we have, for example, the objects immediately considered concrete by most people, such as a stone or a table, but also objects whose concreteness is not immediately apparent, such as a quantum object, a physical field, a chemical compound, a living organism, a family, a company, etc. Thus, the meaning of "concrete" for Bunge has a much broader scope than that of common sense or even that of philosophy. The concrete objects of the world are mostly of a different type from the billiard balls hitting each other. This type of object forms only a small set of all concrete objects. Again, everything that is endowed with energy, and therefore susceptible to change, is a concrete object.

Among conceptual objects, there are objects of logic and mathematics, but also any construct that refers to concrete objects or that represents them, whether or not this construct has a well-defined logical or mathematical form. Thus, functions and mathematical sets are constructs, but also the concept of metabolism, which should not be confused with the concrete metabolism to which it refers. Metasciences study the concepts of metabolism and not concrete metabolisms, as Bunge points out in the last quote above by assigning to metaphysics the role of conceptual clarification. Again, you have to pay attention to the words. A conceptual clarification or conceptual analysis for Bunge has nothing to do with their philosophical equivalent. Bunge uses standard methods widely used in logic (formal logic, not philosophical logic), mathematics, and science. It does not postulate the existence of any reality other than concrete reality and distinguishes this reality from the fictions we use to represent it.

This dichotomy between the factual and the formal led Bunge to propose a metascientific theory of factual properties and another of natural classes because the predicates of logic cannot be equated with concrete properties and mathematical sets cannot be confused with natural classes:

> We now have a theory of properties, distinct from the theory of predicates, and a theory of kinds, different from the algebra of sets. We can therefore use without qualms the concepts of a property and a kind. The differences between predicates and properties, and between sets and kinds, suffice to ruin the ontological interpretations

> of logic and of set theory. There is no reason to expect that pure mathematics is capable of disclosing, without further ado, the structure of reality. (Bunge 1977a, p. 150)

In the same way that a mathematized physical theory is not assimilated to a mathematical theory, a mathematized ontological theory *à la* Bunge is not assimilated to a logical or mathematical theory. Logic and mathematics have no ontological significance in metascience. Only certain philosophical, religious, and mystical doctrines grant the formal sciences the power to account for the world without concern for the factual sciences.

From the moment Bunge is in possession of the notion of concrete object, many of the postulates and definitions of his ontology are constructed using this notion. Here is a partial list of these concepts: state, space of states, nomic statement, natural class, population, communities and species, real existence, nothingness, real possibility and necessity, disposition and propensities, change, events, processes, space-time, concrete system, level of organization. Thus, all these ontological concepts are based on the notion of concrete object. For example, it is not uncommon for a definition to begin with "Let X be a thing…" or "If $T \subseteq \Theta$ is a set of concrete objects, then… ", Θ being the set of the totality of concrete objects. Take for example definition 4.3 of *fact*:

> Let X be a thing. Then f is a *fact* involving X iff either
>
> i) f is a *state* of X, i.e. there is a state space $S_{\mathbb{L}}(X)$ for X such that $f = s \in S_{\mathbb{L}}(X)$, or
>
> ii) f is a *change of state* of (or *event* in) X, i.e. there is an $S_{\mathbb{L}}(X)$ such that $f = e = \langle s, s' \rangle \in S_{\mathbb{L}}(X) \times S_{\mathbb{L}}(X)$ (Bunge 1977a, p. 169)

In other words, "*a (real) fact is either the being of a thing in a given state, or an event occurring in a thing*" (*ibid.*, p. 267; italics in original). The notions of state and change of state in points (i) and (ii) are defined in a similar way by appealing to the generalized notion of concrete thing or object. The examination of the other ontological notions on which Bunge dwells only confirms the interest of the latter for the concrete object, but not just any concrete object since the general notion of thing is supposed to conform to more particular notions produced by the sciences, such as those of physical field, atom, cell, person, society, etc. We can say that Bunge is interested in the *scientific object* if we understand that this

expression refers to the *scientific study of concrete objects*. Bunge is not interested in how one conceives of the concrete thing or object in everyday life, although some factual sciences such as psychology or sociology may be interested in it. Common sense does not have as its primary aim or its sole end the production of objective knowledge, whereas it is this objective knowledge, produced by the factual sciences, which deserves to be studied in a general way by the metasciences. In other words, common knowledge cannot be the subject of a general discourse because its concepts are not objective or coherent enough and therefore cannot be generalized, while the objectivity of scientific knowledge makes possible the existence of a scientific general discourse, a metascience.

When we examine the definitions and postulates of *Ontology I* and *II*, Bunge's ontology, unlike philosophical ontologies, is not intended to make us discover a reality to which the factual sciences would not have access. Not only does Bunge not posit the existence of conceptual, ideal, or spiritual objects, Bunge does not affirm the existence of particular concrete objects. It is the factual sciences that postulate the existence of concrete objects, establish criteria for their existence and elaborate the means of studying them.

3] Methods of Ontology

Bunge has had little discussion of his method of constructing semantic, ontological, and epistemological theories, perhaps because for the author of the *Treatise* it is obvious that there are no special faculties or tools for theorizing science. Bunge appeals to the entire arsenal of cognitive faculties, starting with reflection[19], and does not favor *a priori* any mathematical formalism based on a philosophical doctrine. Discussing the nature of the philosophy of science, or rather metascience, Bunge clarifies what its subject, method, and goal are:

> The object should be real science (both natural and social), and the method should be essentially the same as the method of science—since in either case one tries to know something given. The goal should be to dismount and then to reassemble the mechanism of

[19] Ordinary or natural reflection, which we are all endowed with, and not philosophical reflection. Thinking, even in general, does not prove that we philosophize (Maurice 2020).

> science in order to expose its structure, content, and functions. (Bunge 1973b, p. 21)

And more particularly in the case of ontology:

> Any means should be permitted in constructing a metaphysical theory as long as it leads to a good theory: pinching from another field, analogizing, extrapolating, looking for models of abstract theories, and of course inventing radically new ones. Here, as in science and in mathematics, there is no royal road, and theories are judged by their works not by their scaffoldings. (Bunge 1971, p. 509)

Thus, in terms of methods and techniques of analysis, Bunge practices a methodological conservatism and opportunism. Several philosophers, including Bunge, make little or no use of the tools or methods of reflection and analysis recognized by philosophers. These methods seem to cause more problems than they solve, which may explain why they are not used in the formal and factual sciences. Here is a non-exhaustive list of tools, methods and approaches, essentially associated with philosophy and which Bunge does not use[20]: transcendental argument, philosophical counterfactuality, philosophical thought experiment, philosophical logical analysis, philosophical conceptual analysis, philosophical linguistic analysis, philosophical necessity and possibility, philosophical conceivability, philosophical intuition, dialectics, *Epochè*, and analyses using possible worlds (modal techniques), etc.[21] Bunge also did not seek to develop a doctrinal method, a method associated with a philosophical doctrine, as is the case with several philosophers: Plato developed dialectics, Aristotle syllogistics, Descartes wrote the

[20] We must qualify as *philosophical* most of the approaches listed here because some of them also have a meaning and utility outside of philosophy, but without being used philosophically.

[21] For an overview of some philosophical methods, see the *Oxford Handbook of Philosophical Methodology* (Cappelen, Gendler & Hawthorne 2016) and the *Cambridge Companion to Philosophical Methodology* (Overgaard & D'Oro 2017). These two works, like similar works, appropriately use an encyclopedic style that does not account for the scope of philosophical methods. Only the reading of a few philosophical works makes it possible to understand that the ways of thinking of philosophers, on the one hand, differ radically from the ways of thinking of rational discourses, scientific or otherwise, on the other hand, that they are designed to differ radically since the objective is to know a reality that would escape the sciences.

Discourse on the Method, Husserl proposed phenomenological reduction, and the Vienna Circle, logical analysis.

Throughout his work, Bunge has consistently criticized these approaches or methods and has always denied the existence of any cognitive faculties necessary for philosophical practice. It would be futile to seek *the* Bungean method, as it is customary to do in the case of the great philosophers, the method then coming to characterize the philosopher. In this way, a Platonist cannot surpass Plato, a Cartesian cannot surpass Descartes, and a Kantian cannot surpass Kant. The method is inseparable from the philosopher. If you change the method a little too much, you develop another philosophical doctrine. In Bunge's case, a general discourse on the world does not require a particular approach different from what is practiced in any rational activity, whether in science, management, law, education, health, etc. Bunge can therefore be overtaken by anyone who has the capacity and who takes the trouble to do so. This is an important and even essential quality of the Bungean approach to a general discourse about the world that distinguishes it, again, from the philosophical approach.

So, for Bunge, for example, there is no distinction between what is ontologically, metaphysically, or philosophically possible and what is factually, concretely, materially, actually, or physically possible. Metaphysical necessity and possibility do not exist in Bunge, implying that he does not resort to philosophical methods to establish what would be philosophically or metaphysically necessary or possible[22]. This situation alone should convince anyone that Bunge's ontological theories are not philosophical, but metascientific.

Cordero pointed out the fundamental aspect of the Bungean approach: all rational activity uses experience, reason, imagination, and criticism. (Cordero 2019, pp. 94-96) Note that the experience, reason and imagination in question have no transcendent significance. In other words, it is the experience of the concrete world,

[22] Bunge distinguishes conceptual possibilities from real or factual possibilities, in accordance with his methodological postulate of the dichotomy between concrete and conceptual objects. These notions of possibility are discussed in Chapter 4 of *Ontology I*. Suffice it to mention here that the real possibilities depend on the laws of nature, that is, on the nomic relations that exist between concrete properties. That is, philosophical and metascientific possibility have only the name in common.

including and above all the concrete world revealed by the factual sciences, and the use of reason and imagination as natural faculties and not as faculties that would give us access to a philosophical reality. The cognitive psychology of science as well as the cognitive neuroscience of science, which studies cognition and cognitive processes in scientists, assume that these processes are of the same nature for all humans:

> […] scientific thinking involves the same general-purpose cognitive processes—such as induction, deduction, analogy, problem solving, and causal reasoning—that humans apply in non-scientific domains. (Dunbar & Klahr 2013. p. 702)

Bunge differs from philosophers because the latter believe that there are special faculties to bridge the "gap" between reality and appearances, or if these faculties do not exist, then reality is unknowable. But, from the start, this is a false problem[23].

4] Conclusion

To understand the distinction between metascience and philosophy, it is useful to remember that we do not have direct access to reality, that there is no proof or general demonstration of the existence of things, that we must then take for granted the existence of the "external world", that there is no possible answer to the question of the existence of one property rather than another. It is through reflection and our experience that we arrive at this observation (Maurice 2020).

Our representation of the world therefore passes through the study of scientific constructs, which is the task of metascientific ontology. If we also think that a general discourse on science is valid, useful for the advancement of knowledge, then we can study science itself, which is devoted to metascientific semantics, epistemology, and methodology.

The Bungean ontology therefore does not postulate the existence of any object and does not use any philosophical method, despite its desire to be part of the philosophical tradition: doing does not follow saying. If a discipline is characterized by its objects and methods,

[23] We examine the dichotomy established by philosophers between appearance and reality in section 3 of our article "Bunge's Metascience and the Naturalization of the General Discourse" in this issue.

then Bunge's scientific ontology bears little resemblance to philosophical ontologies. Bunge does not problematize science in the same way that philosophers do. In philosophical jargon, Bunge is a materialist, but his materialism is reduced to accepting the concrete objects studied by the physical, chemical, biological and psychonological sciences. He therefore relies on science to determine the furniture of the world. It is then abusive to reduce Bunge's thought to a materialist doctrine insofar as even these doctrines, because philosophical, postulate the existence of objects and processes alien to science and use methods unknown to scientists. We do not need materialist doctrines, we only need to adopt the same general postulates as the sciences, to analyze and interpret their constructs, and then to abstract and generalize, all with the help of our natural faculties. The role of Bungean ontology, but also of semantics, epistemology, and methodology, is similar to that of metalogic and metamathematics. And since the scientific beast is just as complex as the logical beast or the mathematical beast, it's no wonder that it took Bunge to compose a nearly 2,400-page treatise to lay the foundations of metascience[24].

Bunge tells us in his autobiography that he had set himself the goal of linking philosophy and science. In doing so, he annihilated philosophy to produce a scientific general discourse. This general discourse is designed for science and for scientists, more precisely for metascientists, that is, scientists interested in a general discourse about the world and science. It is easy for any scientist interested in a general discourse on science and the world to understand Bunge's thought. Nothing he says is extravagant and nothing he does go off the path of a normal research process. Because he was able to summarize the spirit of the Bungean approach so well, let us leave the last word to Joseph Agassi:

> The idea behind the program is as commonsense as could be. This may sound disappointing, as it lacks all extravagance, but then this is what the program is all about. The idea is to stay well within one world […]. (Agassi 1990, p. 117)

[24] We exclude here volume 8 of the *Treatise* on ethics because, for us, metascience, a scientific general discourse, is dissociated from a general discourse of convivence or living together. There is no metascientific imperialism as there is philosophical imperialism (Maurice 2020).

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