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THE COMPLEMENTARITY OF SCIENCE AND METAPHYSICS

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ABSTRACT

A renewed interest in the old problem of the relationship between science and metaphysics has been fuelled by the ongoing debate between naturalistic metaphysicians and non-naturalistic metaphysicians. However, I maintain that this debate is missing the mark because it is focused on the problem of the credibility (or lack of it) of a metaphysics that is not 'scientific', instead of focusing on the presence of metaphysics in science. In order to show that metaphysics pervades all stages of scientific inquiry, and after analysing the distinction between presuppositions and assumptions, I address the complex problem of the relation of metaphysics to truth and to experience. I advocate that there is an indirect relation of metaphysics to experience and that it is possible to choose between rival metaphysical theories. But metaphysics, according to my view, is not present in science merely as a background of presuppositions and assumptions. It is present at every step of the scientific inquiry and also in a later moment: the interpretation of the findings of science and the elaboration of unifying theories.

Keywords: science, metaphysics, presuppositions, truth, experience, unification

1 Introduction

The major players and rivals in the contemporary debate around metaphysics are naturalistic metaphysicians and non-naturalistic metaphysicians. At the same time that non-naturalistic metaphysics was flourishing (especially with the works of David Armstrong, David Lewis and DH Mellor on causation, laws of nature, time and mode), its rejection also increased, and many books condemning it have been published by its opponents, for instance, by J. Ladyman and D. Ross (2007), Tim Maudlin (2007) and P. Maddy (2007). A positive upshot of the so-called 'revival of metaphysics' is this lively debate on the relationship between metaphysics and science. Naturalism advocates the use of the method of natural sciences to all fields of knowledge, including metaphysics, and the restriction of metaphysics to natural beings, i.e., to the beings that populate the space-time continuum. Metaphysics must be informed by science. For this reason, naturalistic metaphysicians take as premises for their conclusions what they see as 'the results of science'. These dictate all their metaphysical beliefs. The theory of relativity dictates their belief about time; quantum physics dictates their belief on substance, etc. And they add that non-naturalistic metaphysical theories like those about properties or about causality are irrelevant, since they have no impact on science. Scientists study the properties of phenomena and study cause and effect without taking those theories into consideration: 'Our objection to non-naturalistic metaphysics (...) is that, as an intellectual endeavour, it can have no practical benefit to anybody.' (MacLaurin & Dyke 2012: 14)

Non-naturalistic metaphysicians (E. J. Lowe, Jaegwon Kim, Donald Davidson, Jerry Fodor, Crawford Elder, Trenton Merricks) are driven by the rejection of scientism. They produce a metaphysics that is quite independent from science. For this reason, their opponents accuse it of being the result of 'armchair speculation', i.e., the activity of supposedly

explaining the external world by means of 'mere intuitions' concerning concepts such as tropes, universals, identity or properties.

But though these two schools oppose each other as if a third alternative is not possible, it is actually possible to reject naturalistic metaphysics without being forced to adopt a non-naturalistic metaphysics; and endorse a metaphysics that, while rejecting the project of a so-called 'scientific' metaphysics, is aware of the fact that, as its name 'meta-physics' says, is defined by its close bond with science. That is exactly my position.

Therefore, while refraining from defending a non-naturalistic metaphysics, I shall not endorse a thoroughly naturalized metaphysics. I confess that non-naturalistic metaphysics does not worry me, while a so-called 'scientific' metaphysics does. Non-naturalistic metaphysics does not worry me because history has shown that we never know where good ideas may come from. Even ancient practices, now obsolete, like alchemy, paved the way to the emergence of new sciences; the lunar tides theory and Newton's attraction theory, as well as Kepler's mystical Pythagorism, all shared an astrological origin; and Copernicanism was inspired by the Neoplatonic cult of the Sun. I am sure that many good ideas can flourish in non-naturalistic metaphysics. We would better not plead for a standardization of the human thought, for the hegemony of the scientific mind, and try to wipe out from the face of Earth alternative ways of thinking. Even if some sort of standardization is desirable in philosophy, a critical mind, not specifically a scientific one, is preferable. The focus of the ongoing debate is placed on science: should we practice a metaphysics that is not 'scientific'? How relevant is science to metaphysics? Do scientific theories clarify metaphysical questions? Must metaphysics be informed by science? But I believe we must revert to the former tradition, embraced by classical philosophers of science like Popper, Kuhn, Lakatos and many others. They were concerned, not with scientificizing metaphysics, but with the presence of metaphysics in science: how

metaphysical is science? How relevant is metaphysics to science? Do metaphysical theories clarify scientific issues? Is science informed by metaphysics? There is an important asymmetry here: the question of how scientific should metaphysics be is prescriptive, while the problem of science being (also) metaphysical is not, since the claim that the sciences do incorporate metaphysical commitments as a prerequisite for generating knowledge is now hardly controversial. There are two opposing views on how metaphysics should face the so-called 'results of science'. One view is adopted by naturalistic metaphysicians: the estrangement of metaphysics from the 'results of science' is a risk. Metaphysical success can only be achieved by following the success of science. Metaphysicians have no authority to tell scientists that they are wrong. The other view, the one that I endorse, is that scientific theories are themselves imbued with metaphysics and are formulated according to metaphysical presuppositions and assumptions, for instance, about time and space, or about properties and causality. These are often implicit or even unconscious. Much of the criticism against non-naturalism coming from naturalistic metaphysicians feeds on the deafening silence about the metaphysics working at the very core of science. Some of them, though, to be fair, (Anjan Chakravartty 2013 and Craig Callender 2011 for instance) do stress the presence of metaphysical presuppositions in science. Chakravartty has even been expressing a deep concern with the dangers of a simplistic naturalized metaphysics (see his 2013).

Although recognizing the existence, along with naturalistic metaphysicians, of a close bond between metaphysics and science, I disagree with them about the nature of that bond. In spite of acknowledging the importance for metaphysics not to be estranged from science, I maintain that science should not be viewed as a source of authority. It seems a good strategy to start theorizing about the world after being well informed about the knowledge available in our time. But this should not entail a submissive attitude towards that

knowledge. Metaphysics, i. e., the investigation of the nature and structure of reality, cannot be reduced to the merely descriptive task of reproducing the so-called 'results of science'. There are at least three reasons for that. First, the so-called 'results of science' are not 'neutral', but subject to interpretations. Therefore, they are seldom consensual. Second, scientific knowledge is grounded on presuppositions and assumptions that are metaphysical. Those presuppositions and assumptions cannot be legitimized by science itself and should be subjected to critical analysis. And, third, scientific knowledge is subject to error and revision: the philosophies that see science as a source of certainty are obsolete.

And what exactly are 'the results of science'? What is the science of our time that metaphysics should follow, according to naturalistic metaphysicians? Here is what can be considered vague expressions: 'the results of science', 'the science of our time'... The quantum physics of our time, for example, is the Copenhagen interpretation, Louis de Broglie's interpretation or David Bohm's interpretation? Which one should follow a naturalistic metaphysician who is well informed about the quantum physics of our time? Should he or she follow the prevailing school? But what presuppositions lie behind that prescription?

Scientific 'results' or 'outputs' raise interpretation problems whose nature is metaphysical and require metaphysical answers. The following words by French philosopher Claudine Tiercelin stress the paramount importance of metaphysics for the interpretation of scientific theories:

> It is not just for aesthetic reasons of coherence that there is a place for metaphysics, nor, above all, because we aspire to systematic ambitions or because we can dream of unity or absolute position. We need it, in the strong sense and in the first place, to interpret our own scientific theories. There is

> therefore autonomy in metaphysics and, in some respects, irreducibility to what science does... (Tiercelin 2011: 176). [1]

The point to remember is that 'There is never a royal way that, from a physical theory, a mathematical theorem or the empirical results, leads directly to necessary and determined metaphysical consequences.' (Tiercelin 2011: 172) [2] I will return to this issue later.

Moreover, how can contemporary science, probably quite different from future science, (this means that science evolves and, if it evolves, we do not know everything now and we do not even know what we know in the best way possible), be authoritative? Metaphysics cannot be placed in the difficult position of relying on 'scientific results', when 'scientific results' are always tentative and subject to revision. Let us recall Kant who, relying on the science of his time, made up a whole philosophical system based on Euclidean geometry and Newtonian mechanics. Ironically, now he is often criticized precisely for doing that, for being unable to foresee a non-Euclidian geometry and a post-Newtonian mechanics.

Admittedly, naturalistic metaphysicians may argue that, though subject to revision, 'the results of today's science' are nevertheless the most advantageous point of departure to acquire new knowledge. Science should be metaphysics' source of inspiration: 'Naturalized metaphysics is metaphysics that is inspired and constrained by the

[1] 'Ce n'est donc pas seulement pour des raisons esthéthiques de cohérence qu'il y a place pour la métaphysique, ni davantage parce qu'on aspirerait à des ambitions systématiques ou que l'on rêverait d'unité ou de position absolue. On en a besoin, au sens fort et tout en premier lieu, pour interpreter les theories scientifiques elles-mêmes. Il y a donc une autonomie de la métaphysique et une irréductabilité, à certains égards, à ce qui se fait en science...'

[2] 'Il n'y a jamis un chemin royal qui, d'une théorie physique, d'un théorème mathématique ou de résultats d'expérience, mène directement à des conséquences métaphysiques déterminés e nécéssaires.'

output of our best science.' (Chakravartty 2013: 33) Therefore, all the metaphysical theories of Newton's time should have been Newtonian metaphysics... The upshot being that when Newton physics became outdated, as it did, all of them would become outdated as well.

Contrary to what naturalistic metaphysicians maintain, I believe that, though metaphysics should take into account the findings of science, and should not go against these findings deliberately, its goal has always been to go *beyond them* (meta-physics). Only this way can metaphysics retain its inspiring character, be a source of inspiration for science. A metaphysics that is incapable of going beyond science, simply does not take risks. It makes us doubt of its ability to inspire, and even of its relevance.

2 Metaphysical presuppositions and assumptions

The description and explanation of the general features of reality, or of an aspect of reality, are grounded on certain basic presuppositions. These are a *condiciones sine quibus non* for a rational interpretation. As the philosopher and historian of science Alfred Tauber writes,

> (...) presuppositions are, as R. G. Collingwood described them, the assumptions and guiding precepts that are closed to further analysis or revision (Collingwood 1940). They are the bedrock of the conceptual apparatus they support. Start with different presuppositions and logical progression will bring the disputants to very different ends. (...) So the public drama is not about science per se, but about the metaphysics in which science functions. (Tauber 2009: 28)

I prefer the term 'presuppositions' to 'axioms' or 'postulates' due to the purely formal connotations of the latter and to 'hypotheses' because presuppositions are implicit, while hypotheses are not, though presuppositions should be regarded as hypotheses. The problem of metaphysical presuppositions in science has been discussed at length. It is extremely difficult to argue for the possibility of building knowledge free from presuppositions.

Collingwood (1940) made a distinction between presuppositions and assumptions. Presuppositions are non-justified implicit implications. They differ from assumptions because the latter are stated openly, are explicit, not implicit. We assume by an act of free will: 'To assume is to suppose by an act of free will. A person who 'makes an assumption' is making a supposition about which he is aware that he might if he chose make not that but another. (...)' (Collingwood 1940: 27) Presuppositions, however, work in the darkness. But they establish logical connections with the statements formulated in our explicit thought. Examples of presuppositions are the unity or diversity of the ultimate constituents of matter or the nature of causality and its prevalence in the spatial-temporality of nature (every occurrence takes place in space and time), determinism or indeterminism, or the existence of a fundamental level of reality. Errol E. Harris also made a similar distinction:

> (...) hypotheses are of two kinds, both in some measure relative to the limitation in scope of a science. There are working hypotheses, which scientists adopt consciously and deliberately, and which direct and canalize their researches; and there are more fundamental presuppositions, often made as a matter of custom or tradition and without explicit reflection: such, for instance, as that every event has a cause or that all causation is efficient. For metaphysics all such hypotheses are contraband and the critical examination of them is consequently part of the metaphysician's business. (Harris 1967: 200-1)

But, after examining a long list of debates that revolved around ontological questions concerning physics and mathematics, French philosopher Frédéric Nef arrived to the conclusion that 'ontological questions are more than just presupposed in the development of the physical sciences, they are often explicitly implied.' (Nef 2009: 35)[3] When a research programme is undertaken, a number of metaphysical ideas are clearly assumed. But it should be added, I think, that these assumptions, deliberately adopted at first, may become unconscious, become presupposed, as the programme is developed. What happens is that trust in them, over time, becomes uncritical. At first they are implicitly conveyed in the education of scientists in a way similar to Kuhn's description in *The Structure...* (1962). Moreover, some presuppositions never get recognized as such, due to the mistaken belief that the adopted theory is empirical, free from any trace of metaphysics. However, no scientific research or philosophical inquiry, including empiricism, is free from metaphysics. Part of the inability of empiricism to reject metaphysics lies precisely in the fact that empiricism is itself based on metaphysical presuppositions. E. A. Burtt understood this well in his pioneering work (1932):

> (...) even the attempt to escape metaphysics is no sooner put in the form of a proposition than it is seen to involve highly significant metaphysical postulates. (...) If you cannot avoid metaphysics, what kind of metaphysics are you likely to cherish when you sturdily suppose yourself to be free from the abomination? (...) your metaphysics will be held uncritically because it is unconscious. (...) it will be propagated by insinuation rather than by direct argument. (...) he will be under a strong and constant temptation to make a metaphysics

[3] '(...) les questions ontologiques sont plus que présupposées par le développement des sciences physiques; eles sont même souvent explicitement impliquées.'

> out of his method, that is, to suppose the universe ultimately of such a sort that his method must be appropriate and successful. (Burtt 1932: 228-30)

What is important to retain is that presuppositions guide the scientific inquiry and play a heuristic role; and the recognition that metaphysics is an integral part of science, its ground. Metaphysical presuppositions act as a group of regulative ideas that decide what the adopted ontology will be. For observation and experience to take place it is necessary that scientists know what they should be looking for in the jungle of complexity and populations of the world. These regulative ideas guide the scientist in that jungle, showing them a path through which to tread upon; they also show them which aims should be achieved and which problems should be solved, as well as what kind of solutions will be deemed acceptable and what can be considered a true discovery. Metaphysical presuppositions are neither arbitrary nor subjective criteria; nor can they be reduced to social, material or ideological bases. They are true intellectual strategies, heuristic hypotheses that create the conditions for an investigation to take place. Mark W. Wartofsky sums up this point well when he writes that metaphysics is

> that part which serves as the most general conceptual framework within which scientific hypothesis and theories come to be formulated. Metaphysics serves therefore as a source of ideas, as a guide to the systematization of different parts of scientific thought. Such pervasive characteristics of the scientist's commitment as the notion that nature is uniform, that scientific laws are nonlocal or hold equally in all parts of the universe, that nothing comes into being out of nothing (the earliest formulation of so-called conservation principles), or that nothing happens without a cause – all these, although they are not themselves the sort of things whose truth can be tested by experiment, are nevertheless underlying regulative, or heuristic, ideas in science. That is, they form the basic world view of the scientist, the deep structure of his way of thinking,

> and constitute his (perhaps unstated) beliefs about the nature of things. As such, these metaphysical ideas regulate or guide the scientist with respect to the kinds of things he will regard as important or plausible. (Wartofsky 1968: 11)

At first glance, science's metaphysical presuppositions may come up as uninteresting, since presuppositions like 'every event is an instance of some universal law' or that 'all events have at least one sufficient cause' or that 'something remains unchanged through change', are too abstract; nothing is said about particular situations. But while this is true, it does not make those presuppositions empty. They suggest that there are laws that govern each type of phenomenon, that there are causes behind the phenomena, and that therefore it is worth trying to discover these laws and these causes. Beliefs in the existence of universal laws, the law of causality and quantitative conservation put modern science on its path.

Presuppositions are not merely methodological; they rather determine which methodology will be adopted. They try to describe the fundamental nature of the world. Metaphysics is something constitutive; it establishes sets of statements or principles. Methodology is regulative, it establishes sets of rules. Research rules stem from metaphysics. As Haig Khatchadourian wrote,

> there may be metaphysical principles (such as perhaps the law of causality) which cannot be theoretically justified in this way [verifiable by reference to facts and logical principles], but which are logically presupposed by scientific method, practice, etc. It is obvious that in such a case these principles cannot be consistently rejected without at the same time abandoning scientific method, practice, etc. – unless we shun altogether the problem of the theoretical justification of scientific method, practice, and so on, as pedantic, useless or purely academic! (Khatchadourian 1955: 195)

Nowadays, presuppositions are not regarded as apodictic truths. They may not be true, though they are often regarded as such, due to their implicit nature. They form a hypothetical and conceptual sketch of reality. By adopting this conceptual sketch, science develops it in detail through investigation, as if reality is the way described by that sketch. After being empirically tested, however, the sketch may eventually be corrected or modified.

3 Choosing metaphysical theories

a) In philosophical contexts

Naturalism aims at solving the problem of the independence of metaphysics from experience by avoid thinking independently of 'experimental science'; by sticking as close as possible to 'scientific results'. How can metaphysics be justified if it is not sanctioned by scientific experiments in one way or the other? Naturalistic metaphysicians are suspicious of what they call a 'non-scientific' metaphysics because they believe one cannot chose between competing metaphysical theories. How can we know which metaphysical theories are true if no empirical test can decide it? It amounts to nothing but 'armchair speculation', they say...

For example, anything that exists or happens is compatible with both the metaphysical theses that assert the reality or the unreality of space-time. Both theories are consistent with the empirical data and none of them can be tested by that data. Thus, metaphysical theories are underdetermined by empirical evidence. It is always possible to create, for each of them, a contradictory theory that is also consistent with the empirical data. As Claudine Tiercelin stresses, the results of science are not verdicts or refutations for metaphysical theses. Consistency with empirical experience cannot decide the debate, i.e.,

cannot prove that, in face of two or more incompatible metaphysical theses, only one of them is true. And why is that so?

> Because the properly scientific or empirical parts of the theories in question are compatible with a whole set of different metaphysical theses and they do not point in one direction more than in another. Would it not be naive to suppose, as Peirce reminded us, that scientists do their research on the world without metaphysical prejudices and that their findings can act as impartial referees between rival metaphysical conceptions? (Tiercelin 2011: 185) [4]

It would be naive, indeed. It is hard to believe that science can solve metaphysical problems in a definitive way. Asserting that quantum physics *proves* that is wrong to believe that all events have a cause, or that relativity *proves* that the nature of space is so and so is an illusion. First, because scientific theories are based on presuppositions that are metaphysical and that determine, for example, the kind of questions and answers seen as acceptable in science at a given period of time. Second, because the degree of generality of metaphysical presuppositions prevents us from obtaining clear evidence from experience, as experience is inherently limited and localized. Scientific statements, *stricto sensu*, are not completely general. Their generality is either spatial, temporal, or the quantifier 'all' is followed by a specification, such as 'all planets', 'all molecules', 'all viruses', i.e., generality is limited to the list of objects within a collection. Therefore,

[4] 'les parties proprement scientifiques ou empiriques des théories en question sont compatibles avec toute une série de theses métaphysiques différentes et ne pointent pas plus en direction de l'une qu'en direction de l'autre. N'est-il pas naïf de supposer, comme le rappelait Peirce, que les scientifiques font leurs recherches sur le monde sans préjugés métaphysiques et que leurs découvertes peuvent fonctionner comme des arbitres non biaisés entre des conceptions métaphysiques rivales?'

scientific statements can be refuted, though not verified. But the idea of 'totality' or ‘whole’ of the metaphysicians, like in the statement 'the universe is a unified whole', differs from the idea of 'all' of the scientists. As Kit Fine says, metaphysicians do not talk of dogs and cats or electrons and protons, but of material particulars; they do not talk of thunder and lightning or wars and battles but of events (Fine 2012: 16). Nonetheless, I will argue that even though it cannot be proved that our favourite metaphysical theory is true, nor that the ‘results of science’ may be considered as verdicts or refutations for metaphysical theories, it is possible to choose rationally between rival metaphysical theories.

But before doing that, let us recall that scientific theories are also underdetermined by empirical evidence. Accepted scientific theories are somewhat corroborated but not fully verified by empirical experiments; otherwise they would not be theories. All theories are theories, precisely, because theorizing is the attempt to see beyond what can be literally seen. Furthermore, the empirical evidence that would decide the choice is theory laden. There is no 'pure' empirical evidence. What is considered to be reliable empirical evidence at a given time, and the nature of that evidence, depends on metaphysical presuppositions. Therefore, if the impossibility of knowing 'for sure' the truth value of philosophical and metaphysical theories is a problem, the so called ‘court of experience’, often invoked to decide the truth value of scientific theories, is certainly also a problem.

The problem of truth value does not concern only metaphysical theories. As Peter van Inwagen points out, it concerns all and every philosophical theory:

> No doubt a significant proportion of the metaphysical theories on offer are, as Pauli once said of a fellow physicist’s conjecture ‘not even false’. And falsehood that is never going to be conclusively demonstrated to be such. If a metaphysical theory is false, its falsity is in every case like the identity of the Unknown Soldier: Known but to God. But this serious and

> entirely apposite charge seems to me to be applicable throughout philosophy, applicable to the whole of it – including van Fraassen's own contributions to the subject. (...) This charge against analytical metaphysics, if applied without prejudice, represents a serious challenge to philosophy itself, a challenge to which philosophers have never properly responded. (Van Inwagen 2007: 68-9)

Van Inwagen argues ironically that, due to the impossibility of refutation, the falsity of metaphysical theories, as of philosophical theories, is unknown. And this ignorance is a challenge that philosophers have not yet responded to. It is the value of philosophy that is at stake. What is the usefulness of philosophical theories if one cannot even figure out if they are false?

I do not know if van Inwagen considers Popper's response to his challenge a 'proper' one, but it fully satisfies me. In his own way, Popper asked the same question in the "Metaphysical Epilogue" of his (1982): how can an irrefutable theory be assessed? Why should we rationally criticize a theory when we know beforehand that it cannot be tested? His answer is as follows: if what is at stake is an isolated metaphysical proposition, or a product of a sudden 'intuition' or 'revelation' that implies acceptation or refusal without further ado, then it may be impossible to discuss it rationally. But the same happens with scientific propositions: why should we accept the equations of classical mechanics if no one explained to us the problems underlying them and the issues to be solved?

But if what is at stake are theses or theories, metaphysical or scientific, then they are rational as long as they are part of a chain of problems they are trying to solve; and it is by taking those problems into consideration that they can be rationally discussed. The aim of a critical discussion is precisely to assess the quality of the presented solution: whether it is superior to the solutions presented by other theories or not, and if it is inspiring and fruitful; whether it has the

ability to suggest new problems and new solutions or not; and, finally, if it can be empirically tested. If the theory is scientific, the answer to this last question is positive. If the theory is philosophical or metaphysical, the answer to the same question is negative. All the others, however, do apply. With this in mind, I conclude that what really matters is not to know at once if metaphysical theses and theories are true or false. What really matters is to find out whether and how they can make a contribution to the search for truth.

b) In scientific contexts

Therefore, and even though metaphysical theories are underdetermined by experience and cannot, strictly speaking, be proved wrong, it is possible to choose between competing metaphysical theories. Moreover, outside the philosophical context, such a choice has been constantly at play precisely within the scientific context. Many metaphysical theories have been abandoned because they were too difficult to sustain; they eventually ended up being debunked in favour of some other. Let us recall Descartes' theory of 'vortices'. The atomistic metaphysics proved to be much more manageable and fertile when transferred to the language of science; the hypothesis of the vortices did not succeed. Also, the philosophies of a universe free from generation and corruption were abandoned by science in favour of theories of the universe as an evolutionary and corruptible system. And Einstein's special theory of relativity led to the abandonment of Newtonian metaphysics of absolute space as a container for material objects.

While metaphysical theories are not directly refutable, since it is impossible to conceive a crucial experiment for them, they do seem to have an indirect relationship with an empirical basis. As Errol E. Harris states, not only science is speculative, but metaphysics is indeed related to an empirical basis through scientific experiments. Even though natural sciences relate to experience in a direct way, and metaphysics

relates to experience indirectly through the sciences, both science and metaphysics are theoretical-empirical activities:

> (...) in the special sciences, theory is more directly related to observation, whereas metaphysical theory is related to the empirical evidence indirectly through the special sciences. This, to the casual observer, may give the impression that metaphysics is purely speculative and 'deductive' in its method, 'scorning the base degrees by which it did ascend' and producing empirically unverifiable theses. But this impression is false. All science is speculative. (...) In this respect metaphysics does not differ from science, nor does it differ in its manner of verification. (Harris 1970: 200-1)

The vision of theories as fully scientific or fully metaphysical is unsophisticated. Typically, both of them have metaphysical parts and testable parts, though they come in different proportions. As Craig Callender points out, beyond their properly scientific parts, it is typical of scientific theories to have parts that are more abstract and distant from experience; they may be classified as metaphysical (Callender 2011: 35-54). Presuppositions, like, for instance, spatiotemporal continuity, remain immune to empirical trial: 'Through experiment, confirmation and disconfirmation seeps upward through theory, but some bits – such as spatiotemporal continuity – are fairly well insulated.' (Callender 2011: 47) It is a metaphysical part of the theory. Only the empirical parts of scientific theories, though theory-laden, can be directly tested.

As a Popperian, Joseph Agassi described the indirect relationship of metaphysics to experience through science by appealing to the notion of 'research programme'. A research programme is the adoption of a metaphysical programme by science. A research programme is launched because a metaphysical theory somehow raises questions which science believes can be answered: '(...) a metaphysical theory can raise questions some of which are answerable by scientific theories. In a

sense, then, a metaphysics may generate problems whose solutions are at times scientific. The way it does so is by generating a research programme.' (Agassi 1981: 250) Metaphysics is thus indirectly subjected to the empirical methods of science.

Again, as a Popperian, instead of Callender's term 'unverified', Agassi uses the terms 'rebutted' and 'abandoned' to describe the possible outcome of confronting metaphysics with an empirical basis. A metaphysical hypothesis cannot be refuted in the sense of being subject to a crucial experiment; it is merely abandoned when incorporated into a scientific theory that is defeated by experience. And this is what paves the way for the possibility of choosing between competing metaphysical theories within a scientific context:

> Metaphysical doctrines are not normally as criticizeable as are scientific theories; there is usually no refutation, and hence no crucial experiment, in metaphysics. But something like a crucial experiment may occur in the following process. Two different metaphysical views offer two different interpretations of a body of known facts. Each of these interpretations is developed into a scientific theory, and one of the two scientific theories is defeated in a crucial experiment. The metaphysics behind the defeated scientific theory loses its interpretative power and is then abandoned. This is how some scientific problems are relevant to metaphysics; and as a rule it is the class of scientific problems that exhibit this relevance which is chosen to be studied. (Agassi 1964: 191-2)

There are therefore indirect ways by which theories that are not testable relate to scientific experience. This happens when a specific testable hypothesis based on these non-testable theories is applied to empirical facts. Non-testable theories become more or less plausible depending on their indirect relationship with empirical facts, i.e., on the corroboration or refutation of the specific scientific hypothesis they inspired. They do not become scientific though, because they are not

established or abandoned in the same way as specific scientific hypotheses are established and abandoned (through direct confrontation with experience). Nevertheless, they play a very important role in the scientific enterprise.

That is how some metaphysical theories that inspired research programmes have become partly empirically tractable. 'Partly' empirically tractable because metaphysical statements cannot be the subject of a direct empirical study. However, they become more accessible to science. That everything is energy, that all there is are forces or atoms and void, that in nature determinism or indeterminism reigns, that something remains unchanged through change, that the whole equals the sum of its parts, these are all beliefs that are so general that remain metaphysical even if the science of an era adopts them and acts according to what they stipulate, and even if experiments do corroborate them to some extent. Many metaphysical theories exhibit this kind of indirect relevance to empirical findings, as long as their propositions are not taken in isolation. Sure, metaphysics is also a speech and therefore it is conveyed through sets of propositions, but a metaphysical theory cannot be evaluated by isolating its propositions, the way logical positivists used to do. Metaphysical theories must be taken in their entirety, and subject to the evaluation of their fruitfulness for research programmes.

It is interesting that Joseph Agassi argued that, as Popper once said, safe theories do not attract scientists. But Agassi offered a different reason for it than Popper (Agassi 1964: 189-211); in my view, a much more interesting one. Agassi maintained that what attracts scientists to certain theories is not the ability to predict novelties, but the fact that they are *metaphysically relevant*, that they address great metaphysical problems, such as space and time or the ultimate constitution of the universe. And this despite of the fact that these theories are not the boldest, in the Popperian sense of boldness: a high degree of exposure to empirical testing. For Agassi, scientists are primarily interested in

metaphysically relevant theories and prefer to start their research by them; they make great efforts to test those theories empirically, though they are barely testable:

> (...) I must contradict Popper here. He would say that research is conducted toward the finding and testing of highly testable hypothesis, whereas I say that it is very often conducted toward the finding and the testing of highly metaphysically relevant hypothesis. And as a rule, (...) research tends to begin with which hypothesis have a low degree of testability or are not testable at all. Consequently investigators often have to use great ingenuity to test a barely testable hypothesis, and even first improve a hypothesis to the point of rendering it testable to some degree. (...) I shall argue that the study of a hypothesis of a low degree of testability is often conducted with a view to criticizing some metaphysical theory upon which it may have some bearing. (Agassi 1964: 199)

What makes science move are the big problems. These are very difficult problems for science to answer. But scientists are more interested in working with these difficult problems than with a highly testable problem with no metaphysical relevance that would lead to quick answers. Hardly testable problems with metaphysical relevance are much more inspiring and fruitful to science; the fight to find answers for them originates a much bigger progress than highly testable problems with no metaphysical relevance. The upshot, therefore, is that the aim of science is not the accumulation of trivial truths, for the mere attachment to empirical observation rarely leads to interesting scientific hypotheses. Nor is its aim to go after verifiable truths that calm down our thirst for certainty; nor to go after falsifiable hypotheses. It is rather the never ending quest for comprehensive and meaningful truths capable of answer relevant questions (though all the answers we can find are, of course, not eternal but sooner or later subject of revision). Science is, after all, something like 'experimental

philosophy', the term used by the pioneers of the 17th century 'scientific revolution'.

4 The omnipresence of metaphysics in science

However, I will argue that metaphysics is not present in science merely under the form of more or less explicit presuppositions and assumptions.

Craig Callender describes the presence of metaphysics in science as being from top to bottom: 'Indeed, I think that what we conventionally call science in ordinary affairs is inextricably infused with metaphysics from top (theory) to bottom (experiment).' (Callender 2011: 48) But, in my view, the presence of metaphysics in science is more pervasive and radical than that. It is not enough to say that metaphysical elements are implicated in scientific theories and scientific experience. I shall describe it as a triple presence instead:

as the background, i.e., metaphysical presuppositions and assumptions of science. This shows metaphysics' primordial nature, in a sense that is not merely temporal. The background is the core from which the following two stages emanate.

as the action ground, i.e., as the reflection of the metaphysical background on the specific activity of scientists. The action ground concerns the activity of the scientists within their research programmes, the way they deal with particular problems; for example, their interpretation and explanation of phenomena, their construction of theories, their choice between rival theories, their designing of instruments, their sometimes stubborn persistence in error, their surprising indifference to an interesting new theory, etc. All this action,

for good or bad, is highly dictated by the background. This stage shows that scientific work, even in its most local aspects, is always guided by metaphysical presuppositions and assumptions that greatly influence the choices of scientists and the direction of their action.

as the foreground; this concerns a) the interpretation of scientific theories and b) the development of theories of unification.

a) the interpretation of scientific theories

A scientific problem, when thoroughly analyzed, always leads to philosophical and metaphysical questions. A good example is the changes brought about by quantum physics. These were not interpreted in the same way by all the scientists involved. From the empiricist and idealistic viewpoints those changes were felt more radically than from the realistic point of view. From the empiricist point of view, the old ontology was showing its limits, and the unobservable, traditionally associated with metaphysics, was playing a new and very important role. But for the realists, to believe in the unobservable was not a problem. Realists believe unobservables to make a reference outside the theories which imply them, as long as these theories are considered reliable. But from an idealistic point of view, it seemed like man was doomed to ignorance: the wave-corpuscle dualism had no real existence; it was rather a necessity for the human mind to think. When referring to atoms, it was therefore better to confine ourselves to certain mathematical terms and avoid asserting their physical existence. However, according to the realists, it was the old epistemology that was showing its limits. The theory was regarded as inadequate; it was not reality that had become inadequate to human understanding.

But if interpretations of 'results' typically support a specific metaphysical viewpoint, it is because that metaphysical viewpoint has been there since the beginning. Those who endorsed the Copenhagen

interpretation were non-realists and interpreted the quantum phenomena in a non-realistic way; those who endorsed the hidden variables hypothesis were realists and interpreted the same phenomena realistically.

The interpretation of scientific theories is so important that it has given rise to a series of debates among scientists, some of them famous in the history of science. As Elie Zahar wrote, 'During periods of methodological uncertainty, metaphysics plays a dominant role in the development of the sciences.' (Zahar 2007: 218) Since the metaphysical presuppositions of their research programme are then under threat, i.e., there is a clash between different interpretations of phenomena, scientists feel the urge to debate ideas. And since in metaphysics there is no consensus, this means there is also room in science for quarrels, for those always heavily criticized quarrels when the stakeholders were philosophers. When scientists fully understand the fundamentals of their theories and their methodologies, as it often happens with the best of them, they invariably engage in debates of a philosophical and metaphysical nature.

b) theories of unification

There is a traditional and persistent belief that the task of comprehensively organizing the findings of each of the special sciences in a conceptual scheme that integrates them within a coherent and unified picture of the world is metaphysical: 'to complete, to unify, to systematize, to rationalize, to integrate within a consistent and complete view of the world, that is what characterizes best the task of the philosophical enterprise in its properly metaphysical dimension' (Tiercelin 2011: 177) writes, for instance, Claudine Tiercelin.

Fragmentary knowledge does not seem to satisfy human reason. Human reason longs for the intelligibility of the whole of our experience, it longs for a comprehensive perspective of reality. Each of the special sciences selects an aspect of reality and progresses

cautiously along specialized trails. But man longs for a true understanding of the world, not just some scattered lights. And a true understanding must be global. This involves much more than assembling specific scientific findings and hypotheses, as the whole cannot be attained through the mere sum of its parts. There are gaps and even contradictions between the parts, the findings and hypotheses of the sciences; they have to be filled with unifying concepts if we want a coherent whole. Both cuts and additions have to be made that are no longer scientific, but metaphysical. One has to see far beyond what is particular, local, verifiable or testable. This essential intellectual task of achieving an intelligible and meaningful perspective is metaphysical. Mark Wartofsky supports the same idea, suggesting that there is a need for organic unity deeply rooted in the human mind:

> There is a sense of system and a demand for clarity and for the unity of our thought which go to the roots of our thinking activity, and may very well go even deeper, deriving from the kind of organisms we are and the kind of world we have to survive in. Scientific training and practice sharpen this sense and this demand. In a way, then, the scientist, when he forces the philosophical problems that arise in the conceptual framework of science, is advancing a kind of human activity which goes beyond scientific activity to the very roots of our being – our urge to know and understand. (Wartofsky 1968: 9)

The desire to understand the findings of the multiple sciences requires scientists to engage in this metaphysical demand for unity. On the one hand, a metaphysical unifying view surely takes into account the partial views of each science. But scientific theories that convey a fragmentary picture of the world are accepted only if it can't be helped, for lack of a better theory. For metaphysics also makes an important demand to scientific theories: that they are able to inspire a unified and coherent worldview. As the German philosopher Michael Esfeld states in the following passage:

> Science depends on philosophy as well, for any scientific theory needs an interpretation, and it is philosophy *qua* epistemology of science that assesses the criteria of the interpretation of scientific theories. Moreover, that dependence stretches to metaphysics, (...) for the integration into a coherent and complete view of the world is an important criterion in the interpretation of scientific theories. Thus, there is an impact of science on metaphysics but also a constraint that metaphysics imposes on the ontology of science, namely to be rich enough to allow for a coherent and complete vision of the world. (Esfeld 2006: 86)

Therefore, I advocate that metaphysics is present at the beginning, in the middle and at the end of the scientific inquiry. The task is not to make metaphysics 'scientific' but to fully acknowledge the deep philosophical and metaphysical nature of science. Metaphysics is quite a matrix for science - the matrix from where science stems and to where it returns. It is the soil in which science, like a tree, is fertilized, and the ground where the fruits fall and are collected.

5 The metaphysical cycle

'Vague', tentative, general hypotheses about the world are incorporated into science under the form of presuppositions and assumptions. These vague presuppositions and assumptions, however, are able to inspire an elaborate, precise and systematic research. I therefore fully agree with the following passage from Errol E. Harris where he relates a 'pictorial synthesis' from where it all starts with the development of a 'comprehensive synoptic conception':

> As the sciences progress they react upon one another and the effort becomes general to relate all their conceptual schemes and coordinate them into a single all-embracing theory. To

> describe the matter thus, however, is misleading, for in the nature of the case and as a matter of historical fact, the overarching conception is there from the beginning, first as a halting, naïve, and largely pictorial synthesis, but becoming more conceptual, more systematic, and better articulated as the sciences develop. The discipline that produces this finally comprehensive synoptic conception is metaphysics, which began in the West with Tales and Anaximander, gave birth to the sciences one by one, stimulated their development and profited from it, so that each owed its successive advances to the progress of the other, and the historical association, which I noted earlier, was natural and necessary. (Harris 1967: 199-200)

Harris describes here what I call the 'metaphysical cycle'. At the beginning, there are very general, vague hypotheses. Then, when they are handed down to science, those hypotheses become increasingly accurate, precise and systematic. Finally, there is a return to metaphysics, which was never really abandoned even when science became the main character of the plot. Efforts unite to produce a synoptic view, a theory of everything that is always, somehow, an heiress of the first comprehensive vague hypotheses, but highly enriched by the whole process. The findings of science and the activity that generated them grew from an incipient version of the final synopsis. They are elaborations, specifications, developments of that incipient version. But this does not mean that the early theoretical scheme has an *a priori* source independent from all experience. Rather, it incorporates experience as it was organized and developed to that date.

To be unaware of the philosophy or metaphysics underlying the scientific activity and thus refrain from assessing their accuracy is to risk acting on behalf of a mediocre philosophy or metaphysics. As Thagard notes 'Ignoring such issues goes hand in hand with simply adopting a philosophical view that may be deeply flawed' (2009: 242) and 'Those who believe themselves to be exempt from philosophical

influence are usually the slaves of some defunct philosopher.' (2009: 238) If metaphysics and philosophy in general are made in an armchair (which is highly arguable), then let us disabuse the sceptics: metaphysics and philosophy hypotheses and theories do not stay in the armchair very long, but determine our action.

I defend that science should be viewed as part of the *metaphysical project* of investigating the nature of reality, of describing, understanding and explaining the world in its most general and fundamental aspects and, even more, to understand its deepest meaning. The sciences make essential contributions to this metaphysical task by focusing in specific areas of reality and by introducing an exceedingly high degree of accuracy; they define the problems and refine the methods suggested by metaphysics. But what we ultimately look for in the sciences is the access, not to a specific knowledge, but to the whole. I therefore understand science as an experimental form of philosophical inquiry with deep metaphysical commitments, similar to what Alfred Tauber describes in this passage:

> when we consider science as a broader form of philosophical inquiry with deep metaphysical commitments, then, the positivist program collapses as facts move beyond the laboratory to help construct world views that go well beyond science's distinctive epistemology. Indeed, facts are always interpreted and extended within larger contexts, and "interpretation" easily slides to "meaning". (Tauber 2009: 36)

6 Conclusion

In recent centuries, the progressive aloofness of scientists from philosophy and metaphysics, and of philosophers from science, has benefited no one. And the excessive submission of philosophy to science, a result from that aloofness and from a wrong conception of

scientific knowledge as certain knowledge, leads to devitalized philosophical and metaphysical theories, theories that are not able to inspire science. Science needs a source of new ideas; a source of new research programmes capable of leading to novel ways of solving the kind of problems it cannot fix from within its own frames and accepted standards.

Even though the empirical success of science invites us to respect its great deeds, this should not be an obstacle for the revision of the metaphysical beliefs that underlie it. It is precisely because many metaphysical problems related to scientific theories are being systematically ignored that scientifically informed metaphysics - not submitted to science – is now needed more than ever.

The way each of the special sciences studies the world is not all there is and is not enough. An intense dialogue and concerted action of philosophers and scientists together can bring about a new and valuable outlook to unsolved questions. I therefore subscribe the following words of Craig Callender:

> My picture is thus entirely symmetric between 'metaphysics' and 'science'. (...) Metaphysics is deeply important to science. Laying bare the metaphysical assumptions of our best theory of the world is a crucial and important part of understanding the world. And metaphysical speculation, when anchored in systematic theorizing connected to epistemically worthy pursuits, can aid our search for new and better theories of the world, and hence, better science. (...) In slogan form, my claim is that metaphysics is best when informed by good science, and science is best when informed by good metaphysics. (Callender 2011: 48)

Again, the word chosen is 'informed' and not 'submitted'. I endorse Callender's words but I refuse to consider this metaphysics 'scientific', as he does. For Callender, this 'scientific' metaphysics is the only one worth pursuing, the only one that, due to its concomitance with

science, has epistemic value. But the real problem is not to know what kind of metaphysics can be considered 'scientific' or what 'scientific metaphysics' means. The problem is not to investigate the degree of scientificity of metaphysical theories. The real problem is to realize how metaphysical science is.

I maintain that metaphysics is an indispensable part of the human quest for knowledge. And I believe that the quality, the value and even the usefulness of metaphysics to science depends on the fact that *it is not a science.* Its role is to open ranges of possibilities, to suggest new conceptions of nature, to act as a stimulus to new research programmes.

Metaphysics will do a better service if it keeps on thinking beyond science, as it has always done. The advancement of science depends much on the vitality and creativity of metaphysics, on its ability to point to different directions. It was from metaphysical theories that many of the ideas for a new and rational understanding of nature have stemmed; it is from them that alternative research programmes spring when science's adopted programme is unable to overcome persistent problems.

I am afraid that if the project of making metaphysics 'scientific' could succeed, an age of scientific stagnation would follow, an era where the same old problems would drag on too long with no alternative in sight. Actually, the current philosophical problems in quantum physics and the problem of the theory of everything owe perhaps their persistence to the project of a 'scientific metaphysics' that serves science without inspiring it.

It may be argued that I do not offer a precise difference between metaphysics and science. I do not intend to offer a clear and precise difference between metaphysics and science, and even less to offer more than a minimalist definition of metaphysics. The reason is, precisely, because metaphysics cannot be clearly demarcated from

science. This is one of the theses being defended here. I make mine E. J. Lowe's words:

> (...) a consequence of not providing an absolutely clear-cut delineation of the province of metaphysics is that metaphysics may not appear clearly distinct from certain other enterprises, such as those undertaken in the name of the empirical sciences. However, although I shall (...) argue that all empirical science presupposes metaphysics, I do not in fact believe that a clear-cut distinction should be made between metaphysical concerns and some of the more theoretical concerns of science. Drawing sharp boundaries in such matters is unhelpful, and is not needed in order to maintain that metaphysical concerns are sufficiently distinctive to form the core of a relatively independent discipline – one whose intellectual credentials are worthy of exploration. (Lowe 1998: 2-3).

The task of metaphysics is so important that, when philosophers do not assume it, it is assumed, for better or worse, by the scientists themselves. In fact, as metaphysicians may act as scientists when they feel the need for actual facts or localized hypotheses, scientists often act as metaphysicians when details of their research field force them to take into account broader perspectives. Science, as we have seen, points beyond what is strictly 'scientific'. And if metaphysicians give up investigating problems that traditionally belong to them, scientists will replace them.

What really matters is that, given the complementary role of metaphysics and science, a thorough understanding of one of them is not possible without a thorough understanding of the other. The deep bond that metaphysics and science shared at the time of natural philosophy should be restored. Better, it should be assumed, because they never really parted.

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