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New Styles of Reasoning in Contemporary Philosophy and Science

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Abstract: The paper discusses the unexpected trends in the most modern forms of philosophy and science. The traditional differences in the roles of philosophy and science can be traced back to Kant: natural sciences refer to possible experience; philosophy as metaphysics does not affect experience at all. Today, there are very different trends. Some physical theories (such as string theory) have a highly theoretical character and cannot be proved by empirical experiments. A new approach has been developed in philosophy too: experimental philosophy, which makes use of empirical data to inform research on philosophical questions. Are these approaches just contradictions in terms or rather new styles of reasoning? The goal is not a deep analysis of x-phi or string theory but a reflection on the context between tradition and new trends in philosophy and science which are still rather marginal but may play an important role in the future.

Keywords: experimental philosophy, metaphysics, science, string theory, objectivity, intuition.

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1 Introduction

A few years ago, a new approach was formed in philosophy that uses a philosophical method not merely intellectually or speculatively, but actually in the sense of empirical *experiments* (Knobe, 2004; Sosa, 2007; Knobe & Nichols, 2008).[2] This new approach is metaphorically described as a revolutionary movement that burns the armchairs of traditional philosophers who were engaged in pure thought without any connection to the outside (empirical) world. It is about *experimental philosophy* or "x-phi", where are not only the results of the empirical sciences considered, but where are used also the methods of the empirical sciences for testing own philosophical experiments. Experimental philosophers "brought empirical methods to bear on questions concerning knowledge, intentional action, moral responsibility and free will" (Sytsma & Livengood, p. 5). They criticise the traditional philosophical pure or "a priori" or "armchair" methods, want to get philosophers up out of their comfortable armchairs and attempt to find their own *empirical* subject: intuitions. This is a remarkable fact and the questions arise whether the x-phi intends to move the empirical sciences? To date, the experiments have been symptomatic for empirical sciences, while for philosophy, at most, the mental experiments have been considered.

On the other hand, we might also ask what the symptomatic empirical science – physics – means today if the new theories of particle physics have only the status of *models* (such as string theory) which are highly theoretical and cannot be experimentally tested. Therefore, string physicists themselves speak at best about mathematical self-consistence or about the risk of failure, or even they call into question the style of contemporary physical research in general (see Smolin, 2006). In this context, there is even reference to the end of science (see Horgan, 2015). Indeed, experimental philosophy is a marginal approach in modern philosophy and string theory is a relatively borderline approach in modern physics. However, it is significant that both go against the traditional character of (speculative) philosophy and physics (as empirical science). If we identify – as it did the tradition (like Kant) – science with physics and philosophy with metaphysics, it would seem that science and philosophy have now exchanged roles. The following questions arise: What does this exchange of roles between science and philosophy mean? How is it possible to have a "metaphysical science" and an "experimental philosophy"? Are these terms just *oxymorons* or are they really *new styles* of reasoning in science and philosophy?

In the present paper, these questions will be discussed primarily from the point of view of some related approaches from philosophical tradition. The starting point will be the Kantian differentiation between science as a natural science (or physics) and philosophy as metaphysics. Then the logical positivist "Legend" will be discussed, which presents modern science as an experience-based process and philosophy as a meaningless issue. As a middle position between Kant and logical positivists we will have the view of Karl Popper. All this should serve to emphasise the problems associated with the empirical character of experimental philosophy and with the empirically untestable – that is, metaphysical – character of string physics.

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[2] In recent years, there has been a shift towards experimental and empirical methods in philosophy of mind as opposed to "a priori" or "armchair philosophy". In the papers published in the most frequently cited philosophical journals between 1960 and 1999, the majority of these papers (62%) used purely "a priori" methods and did not use the findings of empirical studies. In the sample of papers dated between 2009 and 2013, the majority of articles (82%) relied on empirical data or presented their own experimental results (Knobe, 2015).

2 Kant's distinction between science and metaphysics

In the second half of the seventeenth century, Isaac Newton formulated the law of gravity and the basic laws of motion as the foundations of modern physics. A hundred years later, Immanuel Kant reflected on the relationship between Newtonian physics and Leibniz's metaphysics: How can the link between empirical and intelligible reality be thought? (Irrlitz, 2010) Thus, the cardinal question of the *Critique of Pure Reason* arose: "How are synthetic judgments *a priori* possible?" (Kant, CPR. B19) Kant intended to answer this question by determining the conditions of pure science as the conditions of all possible experience.[3] The special feature of the Kantian approach is that the scientific laws do not come from nature but are derived from *a priori* forms of human understanding (*Verstand*). The *a priori* forms of sensibility (i.e. space and time) and understanding (i.e. categories) are the conditions for pure sciences (that is, pure mathematics and pure physics). These *a priori* forms facilitates our knowledge of the empirical objects but only as appearances. When we move in this area of possible experience (i.e. of appearances), we move in the realm of the "logic of truth" (Kant, CPR. B87), and we can then say that this allows an empirical objectivity of the empirical sciences.[4] Kant (CPR. B194–197) writes:

"If a cognition is to have objective reality, i.e., to be related to an object, and is to have a significance and sense in that object, the object must be able to be given in some way. […] The possibility of experience is therefore that which gives all of our cognitions a priori objective reality. […] The conditions of the possibility of experience in general are at the same time conditions of the possibility of the objects of experience, and on this account have objective validity in a synthetic judgment a priori."[5]

In addition to sensibility and understanding, Kant presupposes one other cognitive ability: reason (*Vernunft*) that has nothing to do with experience but with the ideas that belong to the realm of metaphysics.[6] Metaphysics as a transcendental use of reason is not conditioned by logical truth but by dialectical or "transcendental illusion" (Kant, CPR. B352). Metaphysics does not relate to possible experience but to ideas of pure reason that transcend all possible experience. Consequently, metaphysics has a dialectical character and we need to be careful not to proceed dogmatically here; we should always assume that no "objective" certainty can be achieved in metaphysics.[7] Kant (CPR. B170) writes:

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[3] Kant distinguishes between "pure" and "empirical" cognitions (CPR. B2). Pure cognitions a priori *"occur absolutely independently of all experience" (CPR. B3) and the features of a pure cognition* a priori *are "necessity and strict universality" (CPR. B4). Newtonian physics can be considered to be an empirical science (Hahn, 1982, p. 17).*

[4] What is meant here is the Kantian difference between the "empirical reality" and the "transcendental ideality" of space and time (Kant, CPR. B44, B52).

[5] This means that the a priori *forms of pure sensibility and pure understanding are the conditions of pure science and possible experience. A pure science determines an area of the laws of nature, and a possible experience determines an area of the objects of the empirical sciences.*

[6] What is meant here is the Kantian distinction in the introduction of Critique of Pure Reason*: pure mathematics, pure natural science and metaphysics as a natural predisposition. In the broadest sense, Kant writes at the end of* Critique of Pure Reason *(CPR. B866) about philosophy as "the system of all philosophical cognition" which one must objectively take "if one understands by it the archetype for the assessment of all attempts to philosophize".*

[7] "No objective deduction of these transcendental ideas is really possible." (Kant, CPR. B393)

"The transcendental use of reason is not objectively valid at all, thus does not belong to the logic of truth, i.e., the analytic, but rather, as a logic of illusion, requires a special part of the scholastic edifice, under the name of transcendental dialectic."

According to Kant, the empirical sciences can achieve logical truth and empirical objectivity, whereas metaphysics can claim no truth and objectivity. Metaphysical questions do not refer to the possible experience and the empirical objects but to the ideas of pure reason which represent something that is unconditioned – in other words, something that cannot be experienced, that cannot be recognizable (*erkennbar*), but that can be only thought (*denkbar*). They have no constitutive (truthful) function for knowledge but only a "regulative" function (Kant, CPR. B648). It must be emphasized that, according to Kant, this regulative function is of major importance for human knowledge since only metaphysics can meaningfully enquire about ideas such as freedom, immortality or infinity.

Thus, referring to Kant, it is possible to summarise the traditional role of philosophy as metaphysics as follows: "Philosophy itself is regarded [...] as a 'pure armchair science', which strives for *a priori* knowledge, that is for knowledge which is independent of sensory experience and empirical data – this approach has found its paradigmatic expression in the work of Immanuel Kant." (Grundmann et al, p. 9)

3 Legend of science and its disorders

After the further development of the natural sciences, the logical positivists also defined science through empirical experience but completely independent of both, the Kantian conception of pure science and the meaningfully "regulative" function of metaphysics. The logical positivists of the Vienna Circle consider metaphysics and every metaphysical question to be completely meaningless (*sinnlos*). Rudolf Carnap (2004, p. 82) makes it clear: "In saying that the so-called statements of metaphysics are *meaningless*, we intend this word in its strictest sense."[8] He reveals the alleged statements of metaphysics as pseudo-statements (*Scheinsätze*). "If something were to lie, in principle, beyond possible experience, it could be neither said nor thought (*gedacht*) nor asked." (Carnap, 2004, p. 102)[9] This is in strong contrast to Kant because in his view, the claims of metaphysics make sense and they can be thought.

According to the logical positivists, however, nothing has changed for science: only "meaningful" statements can be considered, which are *empirically* verified. The positivistic rule was expressed by Carnap (2004, p. 102): "The meaning of a statement lies in the method of its verification. A statement asserts only so much as is verifiable with respect to it. Therefore, a sentence can be used only to assert an empirical proposition." It is precisely with this positivist picture of science that the "Legend of science" reached a peak: science as a continuously successful rational and objective accumulation of the truth about the world (Kitcher, 1993, p. 3–5).

A middle position between Kant and the logical positivists can be found in Karl Popper who also considers the empirical basis to be an important tool for the scientific procedure. However, he rejects the empirical verification and instead postulates falsification as the deductive method

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[8] The problem of the meaninglessness of metaphysical statements already exists in meaningless metaphysical concepts such as "principle", "God", "the Idea", "the Absolute", "the Unconditioned", etc. (Carnap, 2004, p. 90).

[9] For our line of argument, we use intentionally only the views of the early Carnap because his turn to testability and confirmation in his later period is not usually perceived as a core of "logical positivism" (see Blumberg; Feigl, 1931).

of justification for empirical science. In contrast to the logical positivists, Popper acknowledges that the metaphysical assumptions play an important heuristic role in improving scientific knowledge. The formulation of scientific theories is in fact a deductive process: first, a theoretical hypothesis (and often this hypothesis is of a metaphysical nature) is designed, then the conclusions from the hypothesis are logically deduced, and finally, these conclusions are empirically tested (falsified). According to Popper, scientific objectivity is based precisely on such intersubjective testing of scientific hypotheses. Popper (2002, p. 34) writes: "For the requirement of scientific objectivity can also be interpreted as a methodological rule: the rule that only such statements may be introduced in science as are inter-subjectively testable." At the same time, Popper ascribes the importance to the idea of the truth, which for us means only a regulative criterion (in the Kantian sense) – while we cannot define the truth, we can approximate it through trial and error. This is still in line with the above-mentioned Legend of science.[10]

Nevertheless, in the philosophy of science, it has been shown that an empirically "given" fact cannot be entirely "objective" (in the positivist sense) because the very naming of this fact involves a theoretical context. It is known as the "theory-ladenness problem" (Hanson, 1958). Moreover, it was increasingly emphasised that scientific theories are shaped to a large extent by different kinds of values, which raised the issue of value neutrality (*Wertfreiheit*) as a condition of scientific objectivity. On the one hand, there were philosophers (such as Max Weber, Karl Popper and Hans Albert) who defend the value neutrality of science and assert: "Empirical science can teach no one to do what he should, only what he can." (Weber, 1988, p. 151)[11] On the other hand, there are also philosophers (such as Theodor Adorno, Thomas Kuhn and David Bloor), who reject value neutrality, emphasising the social character of scientific knowledge and consequently renouncing scientific objectivity.[12] We will come back to this later.

In general, despite all philosophical objections, science seems to be in perpetual progress. In the modern sciences, the principle of fallibilism has been established, which is close to Popper's conception: it assumes that scientific theories are in fact hypotheses with an open and revisable character. Although today theoretical physicists are working with various alternative hypotheses or "models", the *leitmotif* of contemporary physics is the one all-encompassing hypothesis, known as the final theory or the *Theory of Everything*, which should unite all particles and all forces in the known universe (Hawking, 2005). A more general definition is:

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[10] For example, Popper's emphasis on a deductive character of science was a reaction to the development of physics at that time – to Einstein's theory of relativity and, above all, to Heisenberg's uncertainty principle. Heisenberg formulated the fundamental theory of quantum physics, that is, the uncertainty relation (1927), which states that two complementary properties (for example, location and impulse) of a particle cannot be precisely determined at the same time, which is a consequence of the basic principles of quantum mechanics. Popper attempted to include these findings of modern physics in epistemology. He partly agrees with Heisenberg on the vagueness of the predictions, but he tries to show that Heisenberg's formula does not necessarily lead to indeterminism. According to Popper (2002, p. 245), "the metaphysical belief in causality seems thus more fertile in its various manifestations than any indeterminist metaphysics of the kind advocated by Heisenberg". Here, he was aiming to save the objectivity of science because it requires the uniqueness of the subject.

[11] Werturteilsstreit *(value judgement dispute, Albert & Topitsch, p. 1971) was a discussion that questioned the value of (in particular, social) sciences. This discussion later continued under the name of* Positivismusstreit *(positivism dispute, Adorno, 1972). An analogous discussion "positivist dispute" also took place in Anglo-Saxon countries (Lacey, 1999).*

[12] The culmination of these tendencies was the formulation of the Strong Programme in the Sociology of Knowledge by David Bloor in his book Knowledge and Social Imagery *(1976). (Benda, 2011, p. 449)*

"The Theory of Everything is a term for the ultimate theory of the universe – a set of equations capable of describing all phenomena that have been observed, or *that will ever be observed*." (Laughlin; Pines, 2000, p. 28). That is in fact an objectivist idea in Popper's sense of the regulative idea of truth. Or, essentially, this *leitmotif* can be compared to the big metaphysical systems of classical German philosophy.[13] Some physicists strive for the synthesis of quantum field theory, general relativity and gravitation with a model of quantum gravity. In the past 40 years, so-called string theory has been popular.

However, there is a big "but". These theories have many unsolved shortcomings, such as unclear formulation of principles, ambiguous and untestable predictions, mathematical complexity and, above all, a weak relationship to experimentation. For example, Lee Smolin (2006, p. xiv) writes that over 40 years, "no experiment will ever be to prove it [string theory] true". Davide Castelvecchi mentions Richard Dawid who accept that "string theorists had started to follow the principles of Bayesian statistics, which estimates the likelihood of a certain prediction being true on the basis of prior knowledge, and later revises that estimate as more knowledge is acquired", but Dawid criticizes that "physicists have begun to use purely theoretical factors, such as the internal consistency of a theory or the absence of credible alternatives, to update estimates, instead of basing those revisions on actual data" (Castelvecchi, 2015). Therefore, there is a serious debate about whether string physics is a "science" and even if it could redefine the scientific method and our understanding of the universe. Because scientists cannot answer, philosophers are also involved in the debate. The most discussed topic is testability that was defined by Karl Popper as falsifiability. It is obvious for physicist and for philosophers too that string theory abandoned this Popperianism. In the case of string theory, we can only talk about heuristic models, not testable theories. And we can say that these models have a *meta*-physical character because they are not empirically verifiable or falsifiable. Castelvecchi nevertheless cites David Gross who sees "string theory as testable 'in principle' and thus perfectly scientific, because the strings are potentially detectable", but according him "much more troubling are concepts such as the multiverse because the other universes that it postulates probably cannot be observed from our own, even in principle" (Castelvecchi, 2015). Indeed, in the future, it will be possible to develop instruments to test string theory. However, it will not be in the foreseeable future and therefore it has a rather heuristic character.

In this context, some physicists speak about the end of reductionism: "Rather than a Theory of Everything we appear to face a hierarchy of Theories of Things, each emerging from its parent and evolving into its children as the energy scale is lowered. The end of reductionism is, however, not the end of science, or even the end of theoretical physics. How do proteins work their wonders? Why do magnetic insulators superconduct? […] The list is endless, and it does not include the most important questions of all, namely those raised by discoveries yet to come." (Laughlin & Pines, 2000, p. 30). We will return to this point later, too.[14]

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[13] "Hegel's concept of the all-encompassing and self-determining Concept may appear radical, but it is certainly not a dead thesis." (Lau, 2016, p. 31)

[14] On "Metaphysics in Physics" (see Bigaj & Wuthrich, 2015). In another sense, Karl Rogers (2005) refers to the metaphysical character of the empirical sciences: what is known as "operational metaphysics" is intended to represent the role of technology in the development of theories and observations within physics.

4 Experimental philosophy: problems and inspirations

In contrast, we can see a very different trend in philosophy than in modern physics. In some areas, particularly in analytic philosophy, we have for a long time encountered *naturalism* (e.g. Quine, 1969). Frequently mixed in various philosophical disciplines is *empirical philosophy* that reflects the scientific results in philosophical considerations.[15] This means: "Integrating lessons from various branches of psychology (cognitive, developmental, social, and cross-cultural), neuroscience (cognitive, molecular, and clinical), evolutionary theory, experimental economics, and other 'scientific' fields." (Prinz, 2008, p. 189) This trend is particularly apparent in philosophy of mind and in moral philosophy. The question of empirical philosophy is of a *general character* – for example, the question of the nature of emotions (not the nature of a specific emotion). Jesse Prinz (2008, p. 198) writes that empirical philosophers "do armchair conceptual analysis to guide or interpret first-order empirical results". That is not all, however.

Another approach, a relatively new one, is manifesting itself in philosophy – since the beginning of the twenty-first century, we have recognised *experimental philosophy* or "x-phi", which not only takes into account the results of empirical sciences but also uses empirical methods and conducts its *own* empirical experiments. These experiments are particularly inspired by sociology and experimental psychology. Joshua Knobe and Shaun Nichols (2008, p. 3), one of the founders of x-phi approach, define it as follows: "Experimental philosophers proceed by conducting experimental investigations of the psychological processes underlying people's *intuitions* about central philosophical issues." They ask more *specific questions* than empirical philosophers and they are mainly concerned with the concepts of folk psychology. Rather than "armchair methods" of transcendental metaphysics (in the Kantian sense), they use specific experiments – and these experiments are not thought experiments (which are used in analytic philosophy and are quite independent of experience), but actual empirical experiments.

At first sight, x-phi seems to be the opposite of traditional philosophy. But Knobe (2008) sees the x-phi as a return to the traditional philosophical questions about human beings and he emphasizes continuity with traditional philosophy. In a similar vein, Prinz [2008] argues that experimental philosophers also use conceptual analysis (of intuitions) that was symptomatic of Plato's philosophy. In x-phi, this conceptual analysis is characterized as an empirical activity: introspection. Ernest Sosa (2007) sees the only difference between traditional and experimental philosophy in the empirical nature of the methods used in experimental philosophy. Grundmann et al. (2014, p. 9) note that there have always been empirical and naturalistic approaches in philosophy, but "the application of empirical methods by experimental philosophy […] is a very selective venture that is focused on a highly specific subject, namely on the exploration of philosophical intuitions".[16]

The main problem with x-phi, however, is that its proponents disagree on the definition of intuitions and their role in knowledge. At least three approaches can be found within

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[15] There is even the field of analytical metaphysics that denies Carnap's rejection of metaphysics and seeks inspiration in contemporary physics. For example, Muntean (2015) proposes a research program in analytical metaphysics based on string theory.

[16] Moreover, Sytsma and Livengood (2016, p. xviii) claim: "Experimental philosophy is part of a long tradition." They refer to Bacon, Boyle, Hook, Newton and Locke, who established the experimental tradition and introduced the label "experimental philosophy". Use of this label was not short lived and continued in the eighteenth and nineteenth centuries, and then by the end of nineteenth century, it had fallen into disuse. But in the beginning of the twenty-first century, the label "experimental philosophy" came back into use. (Sytsma & Livengood, 2016, p. 4–5)

experimental philosophy. Thomas Grundmann et al. (2014, p. 14–16) distinguish them as follows:

i. *Experimental restrictionism* calls into question the relevance of intuitions about hypothetical cases in thought experiments and claims that "the intuitions change through psychological and social circumstances that are unrelated to the truth of the philosophical theses and theories in question".

ii. *Experimental analysis* aims to "continue the traditional philosophical project of conceptual analysis by experimental means".

iii. *Experimental descriptivism* is more interested in "the psychological mechanisms and structures underlying the intuitions". For example, the experimental descriptivists enquire about the influence of our normative judgements on our judgements about philosophical issues.

Another problem with x-phi is the implicit failure in communicating the intuitions, if precisely the reports of intuitions are to serve as the basis for formation of common philosophical theory. Then it is difficult to assess how great the role of intuitions is in epistemic casuistry.[17] Nevertheless, according to Sosa (2007, p. 106), two advantages of experimental philosophy should be acknowledged: first, "intuition's role in epistemic casuistry is indispensable", and second, "the way intuition is supposed to function in epistemology and in philosophy more generally, which is by analogy with the way observation is supposed to function in empirical science".

In any case, we can say that x-phi attempts to be objective in the Kantian sense of empirical science because it found its own empirically determinable object of research: the intuitions. But can philosophy really capture intuitions in a scientifically objective way? So far, it seems that experimental philosophers cannot agree on how intuition should be clearly defined. Can philosophy claim objectivity on the basis of using experiments? Individual intuitions vary from one person to another, and it is therefore very difficult to communicate them. Can philosophy become an (empirical) science? Or, in other words, can experimental philosophy produce relevant results and thus overcome the dialectical character (in the Kantian sense), refute meaninglessness (in the positivist sense) and lose the "armchair character"? This will perhaps be shown through many philosophical experiments. Justin Sytsma and Jonathan Livengood (2016, p. 5) are convinced that "philosophers can fruitfully employ empirical methods in attempting to answer philosophical questions" by systematically collecting and analysing empirical data and they adamantly refute the three main objections to x-phi.[18] In 2016, *A Companion to Experimental Philosophy* was published in the series of Blackwell Companions to Philosophy. Its content includes perhaps every traditional branches of philosophy: Free Will and Philosophy of Action, Moral and Political Philosophy, Philosophy of Mind, Epistemology, Philosophy of Language, Metaphysics, Philosophy of Science, Logic, Metaphilosophy. This demonstrates a broad extension of the x-phi approach.

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[17] Casuistry is a discipline of reasoning with generally applicable rules that deals with rules and assessments from the practical side.

[18] The mischaracterization objection claims that philosophers seldom appeal to intuitions to support the claims made in their arguments. The error objection accepts that philosophical intuitions are of evidential value, but doubts that philosophical intuitions of non-philosophers can be identified. The expertise objection claims that data concerning the philosophical intuitions of laypeople is relevant to contemporary philosophy. (Sytsma & Livengood, 2016, p.81–117)

5 The end of science?

There has been talk for a long time now about the end of philosophy as metaphysics (Rudolf Carnap, Martin Heidegger and Jacques Derrida are considered to be sharp critics of metaphysics) and perhaps x-phi crowns this trend. But some are of the opinion that science is coming to an end, too. Philip Kitcher (1993, p. 5) refers to the "Legend" that was articulated by the logical positivists – this Legend celebrated science for its objectivity and scientists for providing the complete true story of the world, but since the late 1950s, "attacks on Legend's conception of the rationality of science accompany the critique of scientific progress" and the Legend begun to fall (Kitcher, 1993, p. 6). John Dupré (1993, p. 11) claims "scepticism about cosmic order" that is associated with doubts about the unity of science and even with the universality of science. The end of science is explicitly referred to in the twenty-year-old book by John Horgan on the subject, *The End of Science*, published in a new edition in 2015. He also describes a philosophical scepticism about science, which first included Karl Popper and then Thomas Kuhn and Paul Feyerabend. Horgan emphasizes a very important aspect of approaches by this kind of philosophers of science: they did not attempt to show how science is practised but how it *should be* practised. It is precisely here that he finds the point of philosophical scepticism about the end of science because the philosophers are too strict in their view of science: "In fact, their scepticism was motivated by their belief. Their biggest failing, perhaps, was to credit science with more power than it actually has." (Horgan, 2015, p. 26) According to Horgan, our knowledge "is in many respects true; most new knowledge will merely extend and fill in our current maps of reality rather than forcing radical revisions" but he admits that "some major remaining mysteries – Where did the universe come from? How did life begin? How, exactly, does a chunk of meat make a mind? – might be unsolvable" (Horgan, 2015, p. XIII).

Specifically, in the context of string theory, Richard Dawid considers in the book *String Theory and the Scientific Method* (2013) two aspects of contemporary fundamental physics which have already been described here. In short, the *positive* aspect is that string theory can be a truly universal theory of all fundamental aspects of the physical world; the *negative* aspect is that this area of physics loses touch with empirical examination. Thus, Dawid (2013, p. 2) poses a classical methodological question as to whether either "the problematic aspects of the present situation to them [string physicists] appear as complications of the kind that have always inhibited scientific progress, just to be overcome at the end by improved methods and more ingenious thinking" or, on the contrary, "the decoupling from experimental testing virtually destroys the relevance of optimistic claims based on string physics and related theories". He notes that the criteria of theory assessment have been significantly transformed in fundamental physics.[19]

This line of questioning and the above-mentioned scepticism about science do not come only from philosophers. Many scientists also doubt modern science. For example, theoretical physicist Peter Woit says in his book, *The Failure of String Theory*, published in 2006, that particle physics has been a victim of its own success for almost a quarter of a century: "Without

[19] *"It may seem surprising at first glance that scientific underdetermination should play any role at all in assessing string theory. […] The question of underdetermination would arise more naturally if we were dealing with a theory that had found some empirical confirmation and asked the question how many alternatives could be constructed in agreement with the available empirical data." (Dawid, 2013, p. 50)*

any new experimental data to provide clues as to which direction to take in order to make further progress, the field has stagnated and worked itself a long way down a blind alley." (Woit, 2006, p. 258) In the same year, another theoretical physicist, Lee Smolin, published his book *The Trouble with Physics*, where he also writes that the main progress in physics of the past two hundred years is over. The great discoveries of Faraday, Maxwell, Planck, Einstein, Feynman, and others – when *theory and experiment had marched hand in hand* – ended with the standard model; then, since about the 1980s, many new theories for explaining the standard model in more detail have been posited and explored, "but none has been confirmed experimentally" (Smolin, 2006, p. xiii). Moreover, there is a large collection of approximate calculations called "string theory", so, according to Smolin, we should speak about a "model" or even a "hunch" rather than a "theory".

Smolin (2006, p. xvii–xviii) considers two alternatives. Either string theory is correct, the world has more dimensions and more particles and forces than we have seen so far – and then "string theorists will turn out to be the greatest heroes in the history of science". But no theory or experiment to date provides evidence for the existence of extra dimensions, so string theory is associated with a very high risk of failure. Or string theory is wrong, there are no new dimensions and symmetries, and so string theory is the greatest failure which Smolin compares to continuing "to work on Ptolemaic epicycles while Kepler and Galileo forged ahead". In his opinion, there are good reasons to take string theory *seriously as a hypothesis* about nature, but this does not mean that it is true.

6 Conclusions: new styles of reasoning

It has been shown how it happened in the part of the most developed empirical science – physics – that the positivist legend of science has dissipated because the empirical basis no longer suffices, and the metaphysical heuristics play a more important role for some (physical) theories. After all, Popper presented this deductive metaphysical trend in science long ago. However, it is not just about the metaphysical nature of heuristics (*context of discovery*) but also about the metaphysical character of justification, which cannot be confirmed by experiment (*context of justification*). In simple terms, theory and experiment no longer march hand in hand.

One fact that is of particular interest is that Smolin refers to a new "style" of research. According to him, "different styles of research are needed to solve different kinds of problems", so now we need people who can invent new solutions to long-standing foundational problems, people with "different kinds of thinking" (Smolin, 2006, p. xxii). He distinguishes between two particular styles of research. On the one hand, there is the style of the relativity community (i.e. Einstein et al.) that is characterized by "respect for individual ideas and research programs, suspicion of fashion, a reliance on mathematically clean arguments, and a conviction that the key problems were closely related to foundational issues" (Smolin, 2006, p. 263). On the other hand, there is the style of the string theory community with a more brash, aggressive, and competitive atmosphere, irrespective of the philosophical issue. In Smolin's view, this second style came to dominate physics although it is the least suitable for solving the main problems.

However, we can also consider another option that the earlier style of Einstein is no longer relevant or is at least exhausted and the string theory is an example of the new style of scientific argumentation in the sense of "styles of reasoning" by Ian Hacking (2002, p. 178). According to Hacking, a new style becomes a new standard of objectivity: "Each style has become what we think of as a rather timeless canon of objectivity, a standard or model of what it is to be reasonable about this or that type of subject matter." (Hacking, 2002, p. 188) Every style of reasoning introduces new types of objects and laws, implements new techniques of self-

stabilization, and has a special kind of persistence. In this sense, metaphysical science, like string theory, is entirely possible if it truly represents a *new style* of scientific argumentation.

So analogically, X-phi can be described as a new style in philosophy. The old one, namely the traditional "armchair" philosophy was based on purely theoretical reasoning without overlapping experience, while the new one, namely the experimental philosophy includes empirical experiments in philosophical methodology. We can talk about a posteriori approach which seems to contradict the traditional "pure" essence of philosophy. But in fact, x-phi rather extends the scope of philosophical research. The Kantian demarcation between empirical science and metaphysical philosophy is overcome after two hundred years. Someone may fear the end of these disciplines, but we are looking forward to new discoveries.

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