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Elements of Greek Scepticism in Richard Feynman's Views on Science[1]

Abstract: The article considers some aspects of Richard Feynman's philosophy of science. The basic assumptions of Feynman's views on science refer back to the tradition of Greek scepticism. Interestingly, Feynman was probably unaware of this relation, still he became an outstanding modern continuator of this tradition. The analysis is based on Feynman's lectures included in *The Character of Physical Law*.

Keywords: philosophy of science, Richard Feynman, criticism, scepticism, ancient scepticism, epistemology, continuity of philosophical tradition

Richard Feynman, as an outstanding physicist, is well-known to all those interested in the natural sciences. He is less known, however, as a philosopher of science, who proposed a series of intuitions, the roots of which go back to the ancient tradition of skeptical philosophy. The problem is all the more interesting as Feynman himself never seemed to notice this connection. A commentator interested in the history of science must consider this situation unusually interesting, despite the fact that most philosophical views in the history of European science have their sources in ancient Greece. In R. Feynman's case, the situation is all the more interesting due to the fact that his attitude towards philosophy was, gently speaking, distanced. This could be one of those cases, however, when declarations do not always match up with the true

[1] R. Feynman, *The Character of Physical Law* (Cambridge: Massachusetts Institute of Technology Press, 1965).

intentions of those who express them. I hope that the reflections I present will to some degree shed light on this issue.

The present reflections are the result of analyses of the thoughts R. Feynman presents in his text "Seeking New Laws."[2] It was published in a collection of articles entitled "The Character of Physical Law," preceded by an introduction by Paul Davies. In it, R. Feynman presents his convictions concerning the understanding and possibility of describing nature. Reflecting on the way of understanding the basic laws and principles of physics, he comes to the conclusion that these laws and principles do not say what nature itself is like, but show us only what our present understanding of nature is.[3] Feynman asserts that it surprises us every time with the richness of new situations that appear with the development of science and research techniques, which creates difficulties in achieving a full picture of nature. Even when we attempt to tie all the principles together (the laws of symmetry, theory of relativity, and principles of quantum mechanics), it turns out that there are too many of them or that they contradict one another. R. Feynman cites the example of quantum mechanics and the theory of relativity. We try to tie these two great theories together. We are unable to do so, ending up with infinity in our calculations, and "how can we say that infinity agrees with nature?"[4] This implies that our knowledge of nature is limited and teaches caution with regard to the conviction about our ability to cognize nature in a final way. In a philosophical sense, this conviction is in agreement with the position of ancient skepticism. The latter asserts that we only have access to expressions of nature (phenomenons), not to nature itself.[5] Nature manifests itself only through certain expressions, never

[2] R, Feynman, "Seeking New Laws," in: *The Character of Physical Law*, pp. 149–173.

[3] R, Feynman, "Seeking New Laws," p. 157.

[4] R, Feynman, "Seeking New Laws," p. 163.

[5] "And when we question whether the external object is such as it appears, we grant that it does appear, and we are not raising a question about the appearance but rather about what is said about the appearance; this is different from raising a question about the appearance itself." Sextus Empiricus, *Outlines of Pyrrhonism*, Book I, 10, trans. B. Mates (New York, Oxford: Oxford University Press, 1996).

unveiling its essence. This implies the necessity of coming to terms with an incomplete description of nature. It results from two sources: limitations of the way nature presents itself and the limitations stemming from the cognizing subject. The first type of limitation concerns the conviction that reflections on the essence of being lack sense, because being itself is never accessible to us. We cannot, then, say anything about the nature of being, as the phenomena we have at our disposal only tell us about the ways nature expresses itself, not about what it is.[6] The nature of being, according to the skeptics, is indistinguishable (*adiphora*). For this reason, we cannot make any statements about it that would refer to the categories of truth and falsehood. In this sense, they can also say that nothing truly exists (*meden einai te alētheia*), having in mind the essential inaccessibility of nature.[7] The second of limitation results from the cognitive functions of the subject, which is based on the spectrum of the cognizability of phenomena by the senses and the intellect. The senses create images of the world depending on their state and level of perfection, as well as on the situation in which the cognizing subject finds himself. The intellect is dependent on the premises and methods of reasoning, which are unerring.[8] The result of such limitations is the assertion that reaching the nature of phenomena, their essence, is impossible. What remains is only the description of the way in which nature appears to our limited senses and intellect. For this reason, the skeptic is required to assert that nothing "is" more than anything else, no thing is to a greater degree such, than another.[9] The final result of accepting such a position is the conviction that no final judgments can be made about the nature of things, nor can we describe what this nature is like.

[6] "We do not investigate nature to make judgments with unmoving conviction about any of those things, about which judgments are made in the field of natural science […]," PH I, 18–19.

[7] Diogenes Laertius, *Lives of Eminent Philosophers*, IX, 61.

[8] The justification for this is a series of arguments proposed by Ainesidemus and Agrippa.

[9] "We should not conjecture […] saying of each and every thing that it no more is this then is not, or both is and is not, or neither is nor is not […]." Aristocles, apud Eusebius, *Praeparatio evangelica*, XIV, 18, 3n.

When we look at R. Feynman's views, we get the impression that he would agree with many of the skeptics' theses. Above all, this concerns the conviction that we do not know what the essence of nature is, even when it seems to us that we have discovered the principles that govern it. For, when we attempt to construct a coherent picture of the whole according to these principles, we stumble upon problems that are unsolvable; R. Feynman calls them contradictions. He again cites the example of quantum mechanics and the theory of relativity:

> In addition to these particles we have all the principles that we were talking about before, the principles of symmetry, of relativity, and that things must behave quantum mechanically; and, combining that with relativity, that all conservation laws must be local. If we put all these principles together, we discover that there are too many. They are inconsistent with each other. It seems that if we take quantum mechanics, plus relativity, plus the proposition that everything has to be local, plus a number of tacit assumptions, we get inconsistency, because we get infinity for various things when we calculate them […].[10]

For decades, attempts at connecting quantum mechanics and the theory of relativity have not given coherent results. Therefore, either one of the theories is false, or both are false and new theories must be sought. We cannot exclude the possibility that reality is so rich that it cannot be explained with the help of one coherent theory. Neither can we exclude the possibility that nature reveals itself in "layers," and we only have access to the "layer" that is presently available to us. For skeptics, from this follows the conviction that final judgments regarding the way nature exists must be suspended. For R. Feynman, this is the basis for his assertion that the wish for the creation of a uniform theory and assertion about the existence of one coherent world is an illusion, which can be compared to the situation in which the tail wags the dog, instead of the other way around.[11] Feynman states:

[10] R. Feynman, "Seeking New Laws," pp. 162–163.
[11] R. Feynman, *The Character of Physical Law*, p. 175.

> I do not think that you can get a general theory of everything from arguments about consistencies[12] […] there is always some phenomenon which has just been discovered, which is very hard to measure, and which disagrees; and as soon as you have the explanation of that one there is always another one, and it gets slower and slower and more and more uninteresting.[13]

Then, philosophers will appear on the scene and the situation will become even more difficult. Feynman writes:

> The philosophers who are always on the outside making stupid remarks will be able to close in, because we cannot push them away by saying, 'If you were right we would be able to guess all the rest of the laws', because when the laws are all there they will have an explanation for them. For instance, there are always explanations about why the world is three-dimensional. Well, there is only one world, and it is hard to tell if that explanation is right or not, so that if everything were known there would be some explanation about why those were the right laws. But that explanation would be in a frame that we cannot criticize by arguing that that type of reasoning will not permit us to go further. There will be a degeneration of ideas, just like the degeneration.[14]

There are two interesting issues here. The first concerns the debate about the possibility of the existence of a final theory, and the second, possibly more significant, the conviction that even knowledge about the principles and laws of nature, even the ability to predict phenomena, does not allow us to assert that we have come to know nature itself. In R. Feynman's opinion, a new phenomenon will always appear which will contradict the theories we have held up to that point. Often, it seems that knowledge of laws and principles suffices to know the essence of things. Feynman also questions this certainty. For this reason, dreams about a final theory will always remain only dreams. Also, the argument that a theory allows us to predict phenomena does not mean that we have reached the essence of things or come to know nature itself. It only means that the theory is heuristically productive.

[12] R. Feynman, *The Character of Physical Law*, p. 175.
[13] R. Feynman, *The Character of Physical Law*, p. 181.
[14] R. Feynman, *The Character of Physical Law*, p. 181.

We must keep in mind that false theories which allow us to predict phenomena correctly do exist. An example is Ptolemy's astronomical theory, which allowed for precise predictions of many phenomena, though it was based on completely false premises.

This situation makes it necessary to postulate the perpetual necessity of investigating our knowledge and the interpretations that we build on this knowledge. This is a barrier protecting us from two dangers: that of dogmatism and absolutism. Dogmatism is the defense at any cost of a once-accepted theory, whereas absolutism holds that our theory has reached the essence of things. The result is the acknowledgment that we know what the nature of the world is like, and our argumentation concentrates on proving that we are correct, while others are not. R. Feynman, like the skeptics, seems to warn against such behavior. We cannot reach the final nature of things. For this reason, the only wise position is maintaining the highest caution in making judgments on the nature of the world and its essence. This is why (as the skeptics propose), the proposition of suspending judgment [*epoché*], final judgment on the nature of things, seems right. It is worth making a reference to the history of science here. How many times has the conviction that essence of the world has been understood been declared? Such tendencies have been visible in all of the great theories. It is enough to cite Newton's theory and the conviction about its final character. Many theories turned out to simply be false, despite the fact that they correctly predicted phenomena. We cannot dismiss the situation in which nature turns out to be so rich that contradictory theories are confirmed.

R. Feynman is deeply aware of this situation, asserting that the only thing we can do is attempt to falsify unambiguous theories. He sees hope in this "methodological skepticism." For, he asserts, we cannot prove that an unambiguous theory is true. This unachievable longing becomes the basis of all dogmatism. Let us assume, Feynman says, that we have formulated an accurate hypothesis, calculated all the predictions that result from it, and seen that each time they are in accor-

dance with the results of the experiment. Does this mean that the theory is true? No, it only means that the theory has not been falsified. New experiments may be conducted and it may turn out then that the theory is false. We cannot exclude this possibility. We cannot prove the truth of a theory or hypothesis. We can only demonstrate its falsehood. This protects us from dogmatism. At the same time, it puts forth the methodological postulate of conducting experiments and studies especially when we have the chance to demonstrate that a theory is… false. As Feynman states: "we are trying to prove ourselves wrong as quickly as possible, because only in that way can we find progress."[15] "We never are definitely right, we can only be sure we are wrong. However, it is rather remarkable how we can have some ideas which will last so long."[16] Certainty is only the certainty of demonstrating falsehood. But, it is key to remember, this certainty is not the same as confirming truth. Usually, it is said that if something cannot be falsified, its truth has been confirmed. R. Feynman notes that if a theory or hypothesis cannot be falsified, this does not mean that it true, but we can have only some ideas which will last so long.[17] In this case "last so long" takes the place of truth. "Last so long" refers to situations in which, in light of our state of knowledge at a given time, we acknowledge that a theory correctly describes the reality studied. This has nothing to do with truth understood as reaching the essence of things, or final knowledge of nature. "Last so long" is always temporary and can be questioned, or substituted by another "last so long" at any time.

In this situation, what criteria for evaluating theories should be accepted? R. Feynman's answer seems in agreement with the convictions of the ancient skeptics. Like the skeptic Carneades, R. Feynman asserts that the idea of probability should be substituted for the idea of truth, perhaps like Plato wanted in the *Timaeus*, acknowledging

[15] R. Feynman, *The Character of Physical Law*, p.158.
[16] R. Feynman, *The Character of Physical Law*, p.158.
[17] R. Feynman, *The Character of Physical Law*, p.158.

probability as a sufficient criterion of describing the world.[18] Carneades strengthened this conviction, asserting that within the bounds of scientific theory we can at most say that something is more or less probable. That being said, scientific theories should not express certainty, but only probability (*pithanon*).[19] This guards against the accusation that skeptics are dogmatics declaring that the only certain thing is that nothing final can be said about nature. The theory of probability does away with this accusation (though it does not do away with others, like the problem of the criterion of probability itself). Theories can only be more or less probable. The theory which seems most probable should be accepted. At the same time, we must presume that it can change. We can find a confirmation of this in the history of science, when theories considered true and final had to be changed or rejected later. We always have to take into account only the approximate state. R. Feynman refers to the example of perfect and broken symmetries. The fact that nature is almost symmetrical, not perfectly symmetrical, excludes the idea that the theory of perfect symmetry can be corrected by the addition of a small "complication," which would explain the problem. Why are the orbits of other planets almost symmetrical? This is not connected with any small correction to perfect symmetry, but results from the existence of a very complex mechanism of tidal friction.[20] It is only an intuition that nature is perfectly symmetrical. No one knows how it is in truth. R. Feynman suggests the consideration of two different theories, which both lead to the same predictions and are equally proven experimentally. There is no scientific criterion which would allow us to choose one of them. Only the psychological aspect, in his opinion, would lead these two theories to be treated as non-equivalent. For, one of them may lead to the appearance of new, interesting intuitions, while the second

[18] "[R]emembering that both I who speak and you who judge are but human creatures, so that it becomes us to accept the likely account of these matters and forbear to search beyond it." Plato, *Timaeus*, 29d, trans. W. R. M. Lamb (Cambridge, MA: Harvard University Press and London: William Heinemann, Ltd, 1925).

[19] Sextus Empiricus, *Adv. Math*., VII, 166–175.

[20] R. Feynman, "Seeking New Laws," pp. 167–168.

renders this impossible. That is why we generally have several equivalent theories in store. We consider the one which points to more interesting consequences and more interpretive possibilities the better theory.[21]

The question of a theory's agreement with experience is essential here. This is no easy matter. Experience always refers to phenomena; these, on the other hand, are interpreted each time in light of the theory accepted at the time. We do not have "pure" experience at our disposal. The incompatibility of experience with a theory only indicates the theory's limitation, not the absolute value of experience itself. In the debate on the role of experience, the argument of effectiveness has always played an important role. A theory is good, as long as it is effective. R. Feynman suggests maintaining a great deal of caution and states: "for instance, Newton's ideas of time and space agreed with experiment very well, but in order to get the correct motion of the orbit of Mercury, which was a tiny, tiny difference, the difference in the character of the theory needed was enormous. The reason is that Newton's laws were so simple and so perfect, and they produced definite results."[22] A phenomenon which will completely change the form of hitherto accepted theories may appear: "sometimes that means that we have to reject some accepted ideas; in any case, in the past it always turned out that in situations like this it was the time-honored conviction that needed to be rejected."[23] There have been unusually effective theories that had to be rejected. This is an important warning, especially for those who view the essence of scientific theories in their effectiveness. This scientific "Machiavellianism" is dangerous, because it is etched into the myth of a scientific view of the world, for which effectiveness is identical with the essence of science. Scientific theories are not limited to an effective manipulation of the world. Above all, they are the method of its description, which allows for the understanding of certain aspects of nature. They change and are limited by the cog-

[21] R. Feynman, "Seeking New Laws," pp. 168–169.
[22] R. Feynman, "Seeking New Laws," p. 169.
[23] R. Feynman, "Seeking New Laws," p. 166.

nitive possibilities of the subject. R. Feynman predicts that the time of great discoveries in science will come to an end sometime. We will then gain an understanding of the world that will satisfy us. But, then, the situation may arise when "explainers" of the world, philosophers, will appear, and will attempt to—finally—justify such a theory. Such explanations will not be criticized. In the world of ideas, writes Feynman, a degeneration similar to the one great travelers speak of, when tourists appear in newly-discovered lands.[24] The threat of dogmatism may be great, and the debates between dogmatic schools—unpredictable in their consequences. Above all, the danger of "closing ourselves" to new areas of research appears—stagnation of thought, which petrifies when deprived of freedom. However, R. Feynman hopes that this will not happen.

His skeptical arguments, or rather their skeptical tone, cannot erase the differences visible in these propositions. We must indicate them, not only simply because they are present, but also to help us understand the modern form of skeptic argumentation that R. Feynman seems to represent. He is convinced of the existence of the basic components of matter, whose nature and existence cannot be questioned in any way. Our discernment of the world has rendered certain areas of it to be cognized to a large enough degree that knowledge about them is beyond any doubt. This refers above all to many behaviors of matter within the world of classical physics.[25] R. Feynman also thinks that we have at our disposal a precise methodology that allows for a verification of our hypotheses and the search for new laws: "in general, we seek new laws in the following way. First, we try to guess them. Then, we calculate the consequences of the hypothetical law to see if our intuition was correct. We compare the calculations with the results of experiments or direct observation to see if they agree. If the hypothesis does

[24] R. Feynman, "Seeking New Laws," p.173

[25] "[O]ur theory of what goes on outside the nucleus of the atom seems precise and complete enough, in the sense that given enough time we can calculate anything as accurately as it can be measured." R. Feynman, "Seeking New Laws," p. 152.

not agree with experiment, it is false. This simple statement is the key to science."[26] We have at our disposal, then, a strong criterion that allows us to evaluate the value of scientific hypotheses. We can at least demonstrate which of them are false, which is very important. This is a lot, keeping in mind the skeptic's conviction about the impossibility of possessing such criteria. R. Feynman also accepts as important the principle proposed by W. Heisenberg, which states that in the natural sciences we should not make use of quantities that cannot be measured. Theories and conceptions must be of such a character and construction that the conclusions drawn from them may be compared with the results of experience. That is why above all we seek hypotheses that can be experientially verified and are measurable. R. Feynman suggests avoiding empty speculation here. This guards against the loss of rationality and the creation of arbitrary images of the world, which result solely from the interpretation of phenomena available to us. Feynman believes that different theories allow us to predict certain behaviors of nature with varying results. He presumes that some theories are better for this than others. That is why a good physicist knows several different theoretically equivalent descriptions of the same phenomena and analyzes which of them allows him to draw more interesting conclusions. The point is "If you can find any other view of the world which agrees over the entire range where things have already been observed, but disagrees somewhere else, you have made a great discovery."[27] R. Feynman also believes in the gradual process in which certain levels of reality appear that were previously inaccessible to us and not visible on our thought horizon. He also seems to represent the position which presumes that nature unveils itself before the cognizing subject "in layers," each time uncovering a hitherto unknown layer. We can understand and describe it relatively accurately, as occurs in the case of many areas of classical physics. At the same time, we can be sure that another layer

[26] R. Feynman, "Seeking New Laws," pp. 163–164.
[27] R. Feynman, "Seeking New Laws," p. 171.

will soon appear. R. Feynman states: "These guesses, incidentally, are often very different from what you have already seen—they take a lot of thought."[28] That is why we cannot assert that in uncovering the most recently studied layer, we reach the essence of things. Each layer carries with it only a part of the whole truth about nature. Within the scope cognitively accessible to us, the understanding of a given aspect of nature is possible, but always within this limited scope, which is connected with our subjective manner of cognition.

R. Feynman also believes that nature manifests itself through beauty and simplicity. Whenever we deal with beauty and simplicity, an indication appears that allows us to predict how nature will behave along with the possibility of understanding it properly. In place of the Cartesian ideals of clarity and distinctness, Feynman puts beauty and simplicity. He treats them as expressions through which nature manifests itself. At the same time, he is aware that in making such statements, he goes beyond science, if the latter is to be understood as natural science. Feynman asks: "What is it about nature that lets this happen, that it is possible to guess from one part what the rest is going to do? That is an unscientific question: I do not know how to answer it, and therefore I am going to give an unscientific answer. I think it is because nature has a simplicity and therefore a great beauty."[29] This is a peculiar statement. If we were to accept (as Feynman asserts) that the essence of science is the ability to make predictions about unknown phenomena on the basis of known phenomena, it turns out that the condition of such predictions is—beauty and simplicity. What are they in themselves, being that they decide about the essence of creating science to such a large degree? We can suspect, looking at R. Feynman's biography, that in science, as in his personal life, these two criteria were essential for him. This means that regardless of his declared distancing from philosophy, R. Feynman was immersed in it very deeply

[28] R. Feynman, "Seeking New Laws," p. 173.
[29] R. Feynman, "Seeking New Laws," p. 173.

and intuitively. He would most likely be surprised at the level of agreement between his views and those of the ancient skeptics. He would be in trouble if the time came to justify his thesis about the role of simplicity and beauty in science. He would probably have to verify his judgment about philosophers only making foolish comments. Do we lack physicists and mathematicians who make foolish comments?

R. Feynman's statements suggest that what we could call skepticism and attribute to him takes on a very original form. Feynman retains certain elements of Greek skepticism: his anti-dogmatism, conviction about the impossibility of final knowledge about nature, as well as the conviction about the limitations stemming from human cognition. At the same time, he goes beyond Greek skepticism, asserting that the possibility of creating a reasonably full description of certain structures or areas of nature that is manifest in experience exists. He also expresses faith in the existence of a criterion of beauty and simplicity, along with the intellectual capability to describe. The only thing he does not accept is the presence of "tourists" in science.

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Argumenty sceptyckie w koncepcji nauki R. Feynmana

Streszczenie: Prezentowana praca stanowi próbę rozważenia niektórych aspektów filozofii nauki Richarda Feynmana. W swojej koncepcji nauki Feynman proponuje tezy, których podstawowe założenia nawiązują do tradycji starożytnej filozofii sceptyków. Oryginalnym wydaje się fakt, że tego związku Feynman nie był zapewne świadomy, jednak stał się jej wybitnym współczesnym kontynuatorem. Praca powstała na gruncie analizy wykładów Feynmana zawartych w pracy *The Character of Physical Law*.

Słowa kluczowe: filozofia nauki, Richard Feynman, krytycyzm, sceptycyzm, sceptycyzm starożytny, epistemologia, ciągłość tradycji filozoficznej