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ON SCIENTIFIC KNOWLEDGE

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Contemporary society sees in scientific activity a fundamental source of knowledge[1]. In many situations of our daily life, we can observe people asking about the foundation of a widespread belief, about the sources that justify surprising information, about the research that bases an idea. Basically, they claim for the scientificity of knowledge. In this framework, one might ask: why science is so emblematic in our time? But behind this question there are even more fundamental ones: what is even scientific knowledge? How does it operate?

To the extent that the scientist produces science, he acts in society, fulfills his role, but nothing in his own action is capable of justifying the place which he occupies in this society, and much of its value as science must be established by a reflection which is external to scientific activity itself. The step-back exercise is always fruitful for the scientist in that it can help you to reflect on himself as an actor in a society that so much complains about his performance.

According to the book Philosophy of science[2], the word science comes from Latin scientia, which means “right, universal and necessary knowledge.” According to the authors, five criteria are required to obtain this knowledge: its object must be trimmed (in this sense, science operates a specialization of knowledge); its language must be rigorous (it is necessary that science be expressed without ambiguity so that it can describe and explain the phenomena); its body of knowledge must be epistemologically democratic (that is, it must belong to the public domain); their theses must be able to establish predictions (science tells us about the regularity of phenomena, and thus it is able to correctly anticipate events); and its knowledge must be controlled by logical forms (scientific thought operates by deductions or inductions). Although we take scientific activity through such criteria (trim, language, democratization, foresight and control), those questions remain unanswered and for them we can always retake thinkers who have so much reflected on the foundations of scientific knowledge. From Karl Popper[3] to Thomas Kuhn[4] from Bertrand Russell[5] to Paul Feyerabend[6], epistemologists have made important contributions so that we can gradually understand the scope, value and power of science in knowing the real. Next, it is proposed to return to the contributions of two equally classic names in such a debate: Poincaré[7] and Bachelard[8].

Just over a hundred years ago (1905), the mathematician, physicist and philosopher Henry Poincaré wrote texts that were collected in the book The Value of Science (1995)[7]. There, the author assumes an epistemological position that we could classify as naturalism (with a strong objective trait, based on the invariance of the laws of Nature). His paper argues that scientific activity always holds an underlying belief in the regularity of "laws of nature" and a variance of "laws of science", because in the face of a conflict between scientific theories and raw facts, Poincare[7] argues for the maintenance of Natural reality as that which remains immutable even when it is necessary to adapt the theories to account for such a permanent reality. This means that scientific representations are always changeable, that just as there are no words common to all languages, there is no "universal invariant" in scientific language (in the representations of science), and all invariance is an attribute of Nature Herself (hence naturalism).

With regard to the question of control (and of the logical forms of reasoning), Poincaré[7] stresses the importance of induction in scientific activity. The principle of induction, although difficult to have a definitive justification (for reasons that cannot be detailed here), is powerful for science, because it allows the construction of regular "laws" on reality. As we have seen, such laws are, in the author's view, representations that can be reformulated, so they are not laws in the strong sense (they are not immutable) since they are always representations. In the quest to achieve such laws, science establishes connection between isolated facts, inferring a recurrent pattern. In the author's words, "The law sought may be represented by a curve. Experience has revealed certain points of this curve. By virtue of the principle [of induction], we believe that these points can be linked by a continuous trait"[7].

Similarly, Gaston Bachelard[8] goes. In The New Scientific Spirit, the author makes a valuable contribution to science in the twentieth century, which, in the reading of the author, must undergo a conceptual update to account for its new spirit. The central thesis of non-Cartesian epistemology, as it was called by Bachelard[8], consists, like Poincaré[7], of shifting the emphasis from analysis to synthesis, from deduction to induction, and, moreover, consists of replacing the idea of linear progress of scientific theories by the eternal revolution in the fundamental principles of those theories. Science, in re-elaborating the axiomatic framework, elaborates syntheses, creates inversions of thought, helping science itself to progress in a more complex scene than the current one[4].

When mentioning the example of the revolution of Einsteinian physics, Bachelard recalls that while the basis of Newtonian physics was considered as the foundation of the experiments, physics did not undergo major transformations, but it was only when this system proved problematic that, through a process of "transcendent induction"[8], Einstein's theory generated a kind of revolution, with a great effort to renew the postulates, thus extending the soil of physics, in order to involve Newtonian physics in a much wider theoretical system. Thus, an amplification is carried out and only then it is fulfilled the deduction of the previous theory, that is, "after this induction one can, by reduction, obtain the Newtonian science".

In the twentieth century, the scientist has also become aware of the limitation of the results of his experiments by the very condition of observation in the laboratory. From the Heisenberg principle, it is known that particles cannot be observable without the observer interfering with the observed object. Therefore, besides the empirical knowledge obtained by the experiments, the scientist obtains knowledge from a probabilistic method, centered in the abstraction of the relations of the real. However, once the object gains "reality" in mathematization, it arises a sort of duality of the real conceived by the scientist: either it is seen as a real (outer) substance, to be revealed experimentally; or it is the result of a logical (internal) formalization, to be proved mathematically.

In this sense, Bachelard[8] understands that the scientific object is real in its relations. Its immovable and sensuous external reality disappears from the horizon and in its place, a new real is created (translatable in numbers). This Bachelard[8] mathematically real no longer consists of an invariant exterior idea, as in Poincaré[7], but it still has a relational aspect in the possible experiences to which it applies, since reality is understood here from the foundation of probability. Establishing the reality of the position of a subatomic particle, for example, is possible because of a measure of frequency of a possible collection of events.

In this very movement of science, there is an interval to arise a nonrealistic thought, that is, a thought that has a constructed real (through mathematics, through representation). In this way, the realist and naturalistic positioning itself can be submitted to criticism. Thus, the science of the twentieth century was consolidating as an activity increasingly non-Cartesian and non-Newtonian. Descartes's[9] method is insufficient because: it is essentially deductive (not inductive) and is not capable of complexifying experience (it is believed to explain the world in its substantial reality, and not through representation).

The most serious consequence of Cartesianism is the very early tendency to simplification, which, sooner or later, results in a determinism that pretends to see the simple in the complex. However, the simplicity of the real is, in fact, a simplification of the real for pedagogical purposes. "In reality, there are no simple phenomena; the phenomenon is a web of relationships. There is no simple nature, no simple substance; the substance is a contexture of attributes". In fact, science has the ultimate purpose of knowing the bonds of reality. But how to do that? Through composition, multiplication of relations, functions and interactions, so as to engender a dense tissue. "The bonds of the real will be so much better understood as the more closed it is to make the fabric of them, if the relations, functions, and interactions multiply. The free electron is less instructive than the bound electron; the atom, less instructive than the molecule".

If we take this type of background into account for all scientific activity, we can say that it is based on the certainty of the permanence of the real as subsistence and on the variance of the laws that represent it. In representing the real, science infers its laws by induction, by synthesis. As we saw in the twentieth century, science begins to induce the real through (probabilistic) constructions of reality, which to a certain extent begins to present the limits of the naturalistic and realistic model of science, insofar as it proved to be too much simplifying for the problems that science is increasingly facing. If reality is complex, it is up to science to complexify its models, highlight the relevance of relationships, and propose a knowledge capable of addressing the most emblematic issues that society needs to continue constructing its history.

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