The Standard Conceptions of Explanation and Problems of their Applicability in Non-Linear Science
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The first problem to be solved is to define the notion of explanation. The second one is the problem of importance of scientific explanation. The third one, closely related to the preceding two problems, is to determine what is the aim of scientific explanation. While positivist thought that explanation is unimportant: the goal of science is to give answer to the "how?" question, not "why?". Scientific theories are to give descriptions of phenomena and processes: scientific laws describe, not prescribe. The requirement of explanation had been rejected as metaphysical or theological, and, therefore, inadequate to the tasks of natural sciences. So believe today Cartwright and van Fraassen. The goal of science is to give the predictive accuracy and description of processes under study, but not explanation. However, it was well in the 1930-th, that the philosophers of science, such as Hempel, Popper or Oppenheim, deemed the empiric science capable of explanation. And nevertheless, there is still no consensus as to what is scientific explanation, and what is the aim of it. We can discern three principal approaches to the question of how explanation is made.

1. Explanation of a phenomenon should demonstrate that the phenomenon had to be expected. Before explanation, there is nothing besides contingency and occasionality. After it — there is an order. To explain a phenomenon is not only to show that the phenomenon has been the case, but also to show that it had to be expected. This is how explanation is construed in the classical model of explanation — the so-called Hempel's covering-law model of explanation which arose as an attempt at resolving the problem of justification of inductive inference in science. In this model, an explanation of a phenomenon consists in giving an argument which contains at least one law among its premises and concludes with a description of the phenomenon in question. The best explanation is the one, which contains preference for hypotheses of stronger explicative power (for a falsificationist), or, in the Bayesian tradition, preference for the most probable (credible) of the alternative hypotheses, which in both cases constitutes an inference to the best explanation. In purely technical respect, we can discern two constituents of this schema. The term "explanandum" refers to what requires explanation. The term "explanans" refers to what explanation is made with. Under the Hempel's scheme, the latter includes at least one "covering law" and sentences describing initial conditions. The notion, that it is explanans that makes explanandum necessary, relies upon the thesis that during an explanation it is shown that the explanandum is a logical corollary of explanans (of initial conditions and a relevant law).

2. A scientific explanation is to reveal causal mechanisms. Under such an explanation, a phenomenon is subsumed under more general regularities. Phenomenon does not become predictable, for explanation determines only which causal processes and interactions eventuate the appearance of phenomenon. This approach is developed by Salmon.

3. Pragmatic theory treats explanation as an answer to the "why?" question. In order to say what is scientific explanation, it is necessary to consider particular cases: under which circumstances the "why?" question is asked and what kind of information is expected to be retrieved when asking this question. Virtually any explanation, not only scientific kind of it, is determined in pragmatic terms here. This is the main weakness of pragmatic approach, for it is impossible, within its frame, to explicate the characteristic features of scientific explanation.

The most interesting is the Hempel's scheme. Notwithstanding a number of critical arguments set forth against it, the Hemple's model, all in all, grasps our intuitions as to what is to be reckoned as scientific explanation in the most adequate way.

Counter-arguments to the Hempel's model can be divided in two classes. Those, which show that many sorts of explanation do not comply with the nomological model. And those, which show, that it does not provide us with sufficient conditions for explanation. In the former case, they usually refer to the kinds of explanation present in the historical science and evolutionary biology. In the latter case, they refer to the asymmetry, brought about by explanation, whose logic cannot be represented in the deductive-nomological model.

The Hempel's model, despite its insufficiency in that respect that it does not cover a number of kinds of explanation, is yet a good approximation for many cases of scientific explanation. For example, it works well in theoretical physics. However, a certain modification of the model is required. First of all, it is necessary to express the fact that scientific explanation is not deduction. And we have to retain the characteristic feature of this model as the one subsuming under a general law. For example, J. Hintikka in his recent article *Semantic and Pragmatic for Why-Questions* has demonstrated that this is the key aspect both for the procedure of explanation and for obtaining an answer to the "why?" question. To give an explanation of an explanans is to show the "bridge" between them an the conjunction of law with the description of initial conditions. To give an explanation is to determine the "covering-law". What had been wrong in the positivist model of explanation, it had been the conflation of universality of "covering-law" with necessity. Hempel expressed universal laws by the schema "*A* entails *C*", and it is not clear that material conditional is a good translation of "covering-law". But there is no implication of any modal element in the "covering-law". An explanation is an empirical investigation, not a pure deductive process.

However, the universal character of scientific laws is challenged by N. Cartwright in her book *How The Laws of Physics Lie (1983)* where she says:

A long tradition distinguishes fundamental from phenomenological laws, and favors the fundamental. Fundamental laws are true in themselves; phenomenological laws hold only on account of more fundamental one.

The fundamental laws in conjunction with true description of initial conditions are the ground for derivation of the empirical or phenomenological laws. As such, the fundamental laws do not contain the normal conditional clauses. It follows that phenomenological laws will be those regularities derivable from fundamental laws and a true description of initial conditions. In this case, the sound derivations provide the explanation: phenomenological laws are explained by their sound derivations. But N. Cartwright posed a serious challenge to such account. She notes that a real derivation contains idealizations and approximations. Therefore, sound derivation cannot be given as explanation of empirical law, since such derivations do not exist. The validity of derivation of these causal stories as consequences from mathematical formalism is dubious since these phenomenological laws can not be considered as simplifying description of the processes under study. There is always present a kind of under-determination of mathematical treatment by the data, which makes the deductive-nomological model hardly acceptable. Cartrwright is concerned not only with denying the "covering-laws" mode of explanation. She goes much further by asserting the explanatory priority of phenomenological laws. We often need the causal stories in order to understand the processes under study. The causal stories provide the sound basis for scientific explanation of what is going on.

The central idea of deductive-nomological model is that we understand a phenomen once we see how it derives from the deeper regularities. In such deductive-nomological model, "covering-laws" are universal laws, as expressed by the the schema " *A* entails *C* ". Having constructed the interrogative model for explanation, J. Hintikka made manifest that disclosing the "covering-laws" is an inherent part of the process of scientific explanation. Such "covering-laws" possess the universal form, but contain no modal elements. N. Cartwright asserts that it is not universal, but phenomenological laws describing causal regularities, that we need for the purpose of scientific explanation. Thus, the question about the kind of laws remains open and needs further study. If the task of scientific explanation is to give phenomenological laws, then the characteristic features of explanative procedure in distinction from description are lost. At the same time, if N. Cartwright is right, and often we need a causal story to penetrate into the essence of what is going on, then we have to show, how phenomenological laws can explain anything at all, provided that explanation has a sense different from description.

The problems raised by N. Cartwright undermine the deductive-nomological mode of explanation, but can be resolved taking into account that explanation is not pure deduction, so does not prediction. Still Hempel, while analyzing the possibility of positing the deduction of predictions from such a kind of hypothesis as the criterion of verification, detects in the scheme of derivation of predictions the elements of reasoning, which are neither induction, nor deduction. He called them quasi-induction. An act of this sort consists in accepting the hypothesis which goes in addition to the observation report.

Stepin has shown that the process of propounding a mathematical hypothesis and its verification in contemporary physics is by far more complicated than it may seem in retrospect. Equations are taken from the adjacent area, then transformed and propounded as hypothetical equations for the area under study. The distinctive here is that the interpretation of quantities is tacitly implied. Otherwise the equations purporting to express physical laws would not differ from mathematical equations. Due to this circumstance, there are usually a number of possible approximations, idealizations or auxiliary theories. Which of them may be required to verify the hypothesis is determined by the particular experimental situation or, what is more accurate, by the investigation of that area of reality that a theory is constructed for. So, the idealizations in use are verified independently when a theory is accomplished from below. And explanation, in this case, becomes a theoretical problem, while deducing consequences from a theory becomes the solution for this problem. Using the methodology of science developed by Stepin and Smirnov, including their ideas as to the hierarchical structure of scientific knowledge, it is possible to demonstrate that explanation is not solely a deductive procedure, as well as to stress the importance of fundamental theoretical schemes for the process of explanation.