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ON THE COSMOLOGICAL RESEARCH TRADITIONS
Philosophy of Science and Modern Cosmology

Abstract

Modern cosmology during its development touched upon some problems that had been traditionally discussed over a period of several hundred years in the realm of philosophy. One can hardly say that cosmology can propose a solution to a significative subset of these problems; and the opinion expressed by P.C.W. Davis who affirmed that: “ten years of radioastronomy have taught humanity more about the creation and organization of the universe than thousands of years of religion and philosophy”, should be regarded as an example of an over-optimistic and uncritical vision of the relation between philosophy, religion and modern cosmology.

The problem of creation, the nature of the origin of the universe and the idea of what the universe is may serve as examples of such overlapping questions, discussed both in the area of cosmology and philosophy or theology. Besides the strictly philosophical issue at hand, cosmology is a very interesting subject for methodological analysis, in which such problems as: verifiability, generality and predictability of cosmological models may be studied in a fruitful way.

The methodological inquiry into cosmology can be – *prima facie* – divided into two blocks: (1) *external methodology of cosmology*; here the discussion revolves around such problems as: the possibility of falsification and verifiability of cosmological models, the development of cosmology, etc., and (2) *intrinsic methodology of cosmology*, i.e., fundamental principles that are necessary for cosmology to be an experimental science.

Cosmology may be defined in many ways, but probably the most common definition could be expressed as follows: cosmology is the study of the large-scale structure and evolution of the universe. Some authors stress both the peculiar character of cosmology as a science and its method that distinguish it from other sciences. Reference to “extrapolation” is usually made in this context. The above mentioned “extrapolation” is, in fact, so important to cosmological investigation that it should be included into the definition of cosmology itself. Cosmology is thus characterized – not only – by the object of its study (the universe as a whole) but by its principal method, as well. In other words, cosmology consists in not only the study of the structure and the evolution of the universe, but also in the study of the assumptions

which have to be made in order to render the science of the universe possible.

From what has been said so far it is not so difficult to see that the construction of a cosmological model is a very subtle and complicated process which remains open to many different modifications. It should be stressed that what cosmologists do does not consist in constructing new physical theories (in the sense in which Einstein proposed his special and general theories of relativity); rather it consists in developing models of the universe based on local physics. In fact cosmology is a peculiar branch of science which is a synthesis or summary of all other branches.

This synthesis usually involves a global extrapolation of laws of physics verified only locally. This extrapolation is the source of many uncertainties generated by the great variety of different possible procedures in reaching such a synthesis. Such uncertainties have to be settled with far reaching and arbitrary assumptions. These assumptions – which are necessary in order to obtain a definite cosmological model – are usually called *cosmological principles*. Such principles, as for example the Copernican principle, the probability principle or the anthropic principle, are sometimes contradictory and thus add to the uncertainty of a given cosmological model. This uncertainty may be of a philosophical (or at least methodological) nature, in the sense that the choice of one or the other principle depends on the philosophical or even religious prejudices of the cosmologist. However, for the methodological analysis proposed in this essay it is not so important to know how different cosmological principles are actually applied in the real cosmological models; it is enough to notice, that such principles are necessary in order to construct any cosmological model.

The bulk of the essay deals with a methodological model of cosmology based on the L. Laudan's proposal. The understanding of the methodology is the following one: the methodology proposes certain methodological structures (e.g., the scientific research traditions of L. Laudan) aiming in describing the development of science (cosmology) using the hypothetico-structural explanation as a mode of reasoning, and the results of history of science (cosmology) and analysis of the current situation in science (cosmology) as a space of facts to be explained.

According to Larry Laudan, the basic idea in the description of science is an idea of tradition of scientific research (*ScRT*). *ScRT* is a set of general assumptions about the essential entities and processes in certain domain of study. The notion of *ScRT* includes as well methods that have to be employed in order to explore problems and to construct theories in this domain. In other words, *ScRT* specifies in an abstract way what the world is made of and how it should be studied.

However, *ScRT* does not give particular solutions to specific problems, for such traditions are neither explicative, nor predictive, nor controllable in a direct way. Their main role is to provide instruments for the solution of scientific problems. There are two types of scientific problems: empirical problems and conceptual problems. Empirical problems are problems of the first order, i.e., they represent a fundamental question about the domain entities and relations between them.

Now, it is not so difficult to apply the *ScRT* logic into the domain of cosmology, which eventually leads to the conception of the Cosmological Research Tradition (*TRC*). *TRC* can be defined as follows:

$$TRC \rightarrow [I_c; O_c; R_c; M_c; \{T_c\}; \{P_c\}];$$

where: I_c stands for the so-called *thêmata* (in the sense of G. Holton) of the cosmological tradition; O , R , and M stand respectively for the fundamental entities, relations between them, and particular methods used in cosmology (e.g., one can assume that O , and R are fully described by the theories of modern physics, while M stands for some cosmological principles), $\{T\}$ stands for different cosmological models and approaches inside the same cosmological tradition (e.g., S.W. Hawking's quantum cosmology without boundaries and time, and R. Penrose's twistor and time program) different versions of the standard cosmological models), and $\{P_c\}$ stands for empirical problems in cosmology. The basic details of this methodological structure of cosmology are summarized in tab. 1.

To show how *TRC* works, the conclusion of the essay describes the application of the *TRC* model to the *Hot Big-Bang* standard cosmology. Eventually, some new research possibilities are also suggested.