On the epistemological limits of physical cosmology

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In the fifth and early sixth decades of the last century several significant works were published on the philosophical background and epistemological limits of physical cosmology such as Bondi's epistemological discussion in the first chapters of his Cosmology[1], Dingle's paper in Vistas in Astronomy[2] or Harre's analysis in the British Journal for the Philosophy of Science[3]. In the light of the intensive development of relativistic cosmology following the discovery of the cosmic background radiation in 1964, such works may seem outdated, and the problems raised by them have actually been forgotten or suppressed by the community of philosophers and physicists alike over the last decades.

However, as with any genuine philosophical issue, the questions discussed in those works (while relevant to the scientific debates of the time) concerned physical cosmology in general, that is, regardless of factual theories. Hence the development and the intensive changes in the field of physical cosmology over the second half of the past century did not solve or supersede those problems. The case is similar to that of the Newtonian gravitational force as action at a distance. While Newton and his contemporaries felt deeply uncomfortable with the notion, subsequent successes of Newtonian physics suppressed its problematic character, and action at a distance became a legitimate scientific term for most physicists in the nineteenth century. This, however, did not entail that the problematic character of the concept had been transcended. Similarly, the intensive development and theoretical shifts within physical cosmology have not transcended the epistemological problems highlighted by Dingle, Harre and others more than half a century ago . Their warnings concerning the epistemological limits of physical cosmology may be forgotten today, but this should be attributed more to the psychology and sociology of science than to scientific development.

The aim of this paper is to revitalize the debate on the epistemological limits of physical cosmology and to call attention to those limits once again by analysing some basic epistemological and ontological assumptions of contemporary physical cosmology in a period when this science is uncritically boasting of its alleged achievements in solving traditional metaphysical problems by physical methods. Considering its limited framework, the paper is restricted to the theories of the present structure of the universe and the so-called 'plurality of universes'. The epistemological problems concerning the Big Bang and the early universe should form the topic of another study.

The first part of the paper deals with the specific basic assumptions of Einstein's classical cosmological paper of 1917 which, even today, form the epistemological foundation of the

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[1] Bondy, Herman., *Cosmology*. Cambridge: Cambridge University Press, 1952.
[2] Dingle, Herbert., "Philosophical Aspects of Cosmology" in: *Vistas in Astronomy*. Volume 1. (1955) pp. 162-166.
[3] Harre, R., „Philosophical Aspects in Cosmology." *The British Journal for the Philosophy of Science* 13. (1962) No. 50. pp. 104-109.

generally received cosmological theory (the so-called standard cosmological paradigm and its contemporary mutation, the theory of the inflationary universe). Of course every scientific theory must be based on certain assumptions, for science is possible only if we are committed to ontological beliefs which may nevertheless be challenged from a philosophical point of view. For example, we know since Hume that we do not have any theoretical or empirical grounds to predict that the sun will rise tomorrow. Science however predicts this event, since the conviction that the temporal behavior of nature is characterized by continuity is the cornerstone of any scientific enterprise. This assumption cannot be questioned while one is pursuing science for it forms a precondition of this avtivity, or (in Wittgenstein's words) of playing the language game called science. In the phrase 'specific basic assumptions', used in connection with Einstein's cosmological paper, the word 'specific' is meant to refer to the fact that apart from the general assumptions functioning as the foundation of science in general, Einsteinian cosmology needs further assumptions which are significant specifically for relativistic cosmology but, as such, are no less fundamental for this branch of science than the general assumptions are.

We will identify and analyse three basic assumptions in Einstein's mentioned paper:

1.The validity of the general theory of relativity as a theory of gravitation for the physical universe as a whole.

2. The claim that the universe as a whole is an object analogous to one if its parts, namely, to a gaseous ball or mass of gaseous matter relatively separated from its environment. (The gas ball analogy.)

3. The homogeneity and the isotropy of the universe as a whole.

In our analysis we will show that in their metaphysical and speculative character these assumptions transcend normal scientific assumptions. Of course, it is not easy to set up a clear measure for grasping and describing the metaphysical or speculative features of a statement in an exact, quantitative manner. Therefore, following Popper's philosophy of science according to which even the most extremely speculative assumption may become the basis of a scientific theory provided that falsifiable predictions are derivable therefrom, we will demonstrate that the three assumptions above are unfalsifiable, and any successful prediction based on these assumptions will also be consistent with the opposite assumptions.

In the second part of the paper we will deal with the various speculations on the plurality of universes. Ironically, although Dingle pointed up the non-scientific character of such speculations as early as the fifties of the past century, scientific journals and conferences even today abound with allegedly scientific theories of other universes. It seems as though contemporary cosmologists have deliberately turned against Dingle, ignored his warnings, and converted physical cosmology into metaphysics and magic.

We will show that the problem of the plurality of universes appears on two levels. At *the first level* we face the notion of physically possible evolutionary paths of the early universe. According to the generally accepted view, the early universe might have developed along evolutionary paths different from the one it actually developed along, a conviction based on the fact that the relativistic cosmological equation has multiple solutions. Pondering potential

evolutionary paths of the universe, so popular in contemporary cosmology, follows from a special interpretation of these solutions in which they are considered as mathematical descriptions of physical possibilities for the development of the universe in its early phase. However, this interpretation is only one of several possible options and it is also erroneous from both a scientific and an epistemological point of view. Firstly, the fact that the cosmological equation has a manifold of solutions may indicate that the cosmological problem is underdetermined in the general theory of relativity, even if we restrict the theory by the Einsteinian assumptions discussed in the first part of this paper. Secondly, our universe is an object which exits only in one example and physical cosmology is intrinsically a theory to describe this single object whose evolution occurred only once and no more. Therefore any statement which speaks of possible evolutionary paths is scientifically untenable as it relocates physical cosmology from the realm of science into that of metaphysics. This erroneous interpretation of the existence of multiple solutions to the cosmological equation forms, at *the second level*, the basis of all eccentric theories on the manifold of other universes, where the solutions are interpreted not only as mere possibilities but as mathematical descriptions of actually existing other universes.

If we assume that the cosmological equation is an equation of magic character and, therefore, each of its solutions must have physical meaning, then, of course, we cannot but speak of possible evolutionary paths of the one universe or declare the existence of other universes. And it is precisely this consideration that gives the clue to the standard theories of contemporary scientific cosmology. Most cosmologists relate to the cosmological equation as if it were a magical entity, a magical clue to the secret of the cosmos. If they are right, if the cosmological equation is of truly magic character, if it is a notion that must be respected uncritically, then it may really help physical cosmology to solve classical theological and metaphysical problems. However, in this approach the cosmological equation will appear as a revelation given to humankind by nature or God; physical cosmology will turn into magic and theology and the solution will not be given by science but revelation. And this is indeed the case. Relativistic cosmology transcends its epistemological limits and, as a consequence, scientific elements are inseparably interwoven in it with magic and metaphysics dressed in a scientific garb.