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Cosmologie/*Cosmology*

DÉBAT

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Un débat majeur : la cosmologie du « Big Bang »
A major debate: the Big Bang cosmology

V. Reply to Professor Silk

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In this brief reply I will first deal with specific issues raised by Professor Silk before ending with a few general comments.

It is interesting to look at the history of *CMB* and its temperature so as to appreciate the fact that the subject did exist before 1965 and even before 1948. In his classical book *The Internal Constitution of the Stars*, using diffuse starlight as the source, Eddington had estimated a temperature of the radiation background as 3.18 K. The *CMB* was essentially first discovered in 1940 by A. McKellar through his observations of transitions in the CN molecule, and his estimated temperature was 2.3 K. The paper came during wartime and was in a relatively obscure journal and so did not attract the attention it deserved.

Now, about Professor Silk's claim that 'the temperature was predicted decades before its discovery, to be within a factor of 3': the records show the following. In their 1948 paper Alpher and Herman estimated it at ~ 5 K. Gamow had variously estimated the temperature from 7 K to 50 K at progressively later times. [See an interesting historical article by A.K.T. Assis and M.C.D. Neves in *Apeiron*, vol. 2, July 1995 issue, pp. 79–84.] Since the radiation energy density goes as the fourth power of temperature, the uncertainty of prediction is considerably larger than a factor of three. Contrast this with the much more accurate estimate given by the purely astrophysical scenario of conversion of hydrogen to helium in stars given in my main presentation in this debate.

It is admitted that the prediction of a black body spectrum is indeed a plus point for the Big Bang. Nevertheless, the second law of thermodynamics ensures that if radiation has been around for sufficiently long time it gets degraded by some sequence of physical processes or other. The quasi-steady state cosmology has found an alternative mechanism using metallic whiskers for thermalizing starlight generated in previous cycles. Laboratory experiments have shown how whiskers form, their properties have been tested, and evidence for their likely presence in interstellar and intergalactic space extensively discussed in literature. As a physical theory, this alternative is surely superior, inasmuch as it is repeatable, observable and testable, as opposed to the Big Bang scenario which occurred in a unique sequence of events which cannot be observed.

So far as prediction of $\Delta T/T$ is concerned, the history of structure formation in standard cosmology since the early 1970s shows how the scenario has gone from one epicycle to another, as the observations progressively improved the level of homogeneity of *CMB*. Had COBE reported null results, a further epicycle would surely have been proposed. In the end COBE proved to be a mixed blessing as it drove theorists into further contortions and parameter-fitting exercises. Thus the very elaborate effort to understand the inhomogeneities of the *CMB* in terms of the accoustic peaks is no more than an exercise in establishing consistency of the theoretical scenario with observations. Thus if a peak of certain height is found, it tells us what the value of a particular parameter ought to be, and the efforts are directed at *determining* the parameters more precisely by more sensitive studies of inhomogeneities of the *CMB*. These parameters then tell us more details of the early universe. But where is the predictive power in this procedure?

Concerning future more elaborate studies, e.g., MAP, PLANCK, etc., one can make a safe prediction that if the observations do not bear out whatever has been predicted (I have not yet seen *what is the clear cut prediction* on which the fate of the standard theory rests), a few more epicycles will be invented and claimed with equal certainty as proofs of Big Bang, and further new experiments will be proposed.

'The classical flat model with closure density has long been abandoned by theorists', says Professor Silk and he goes on to propound the current wisdom about (H_0, Ω_0, Ω_B, q_0) with great confidence. I recall attending an international symposium in 1984, at which the late Dave Schramm gave a very persuasive and categorical talk as to why $\Omega_0 = 1$. Thus one may justifiably feel cynical and sceptical about today's categorical claims.

In the last analysis, I wish to reiterate a point made by physicists, as to whether the big bang cosmology is 'physics'. It presupposes initial conditions in the very early universe, which cannot be observed or independently checked; it then proceeds to use physics at high energies ($\sim 10^{16}$ GeV) that has never been tested, goes through a 'non-linear regime' which cannot be adequately handled by current techniques of applied mathematics, to describe a sequence of events which can never be repeated and which lie beyond the 'surface of last scattering' and ends with a final product which is claimed as 'Voilà, the ultimate truth', which has, as Professor Silk argues, only 'relatively minor defects'. With great respect I wish to state that there is a world of difference between the 'standard model of particle physics' which has been amply tested upto energies of $\sim 10^3$ GeV and the 'standard model of cosmology' which rests on very shaky foundations.

Finally, a correction: Professor Geoffrey Burbidge is a co-author of the *QSSC* along with Professor Hoyle and myself. Despite Professor Silk's condescending remarks on the theory on behalf of the cosmological community, an objective assessment of the credibility of the *QSSC* is that work on it has appeared and is continuing to appear in refereed international journals and in proceedings of international symposia. The *QSSC* is not claimed by its authors as the ultimate theory (as the Big Bang is so claimed). Indeed it may suffer from incompleteness and defects, but it has one important plus point vis-a-vis the Hot Big Bang Cosmology: unlike the latter which rests on several untestable initial postulates, the *QSSC* is based on currently observable phenomena in the universe, and makes testable and disprovable predictions.