THE MICROWAVE BACKGROUND RADIATION: AN ALTERNATIVE VIEW

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1. THE NEED FOR ALTERNATIVES

Why do we need to think about any alternatives when the primordial interpretation of the microwave background radiation (MBR) has been accepted by so many for so long? The answer is that the primordial interpretation, in spite of its successes has manifest shortcomings in spite of attempts to remove them by so many for so long. To mention a few:

a) Why is the MBR temperature 2.7 K? The value is taken as a parameter in all early universe calculations; it is not predicted by the hot big bang theory with or without inflation.

b) There are other astrophysical processes of comparable energy density and other radiation backgrounds that have no primordial origin; why should MBR alone stand out as the odd one out just at this epoch?

c) Why are there no signatures of structure formation on the MBR; why is it so smooth?

d) The hot big bang model relates to the universe in the first three minutes while the MBR is observed in the more recent past; are we not making too long a jump across from the one to the other?

2. AN ALTERNATIVE INTERPRETATION

The clue to a possible alternative is provided by a)-d) above. We need to look for an astrophysical process of comparatively recent origin, repeatable over a period of ~ $(3H)^{-1}$ if some version of the steady state theory is right. The process must have an energy reservoir of ~ 4×10^{-13} erg cm^{-3} and should be able to deliver a highly smooth perfectly thermalized background.

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It has been known since the early days of the MBR [1] that if all observed helium were made in stars, the bulk of it in supermassive ones, the resulting excess starlight, when thermalized, would give a temperature very close to 2.7 K. Being a 'recent' process the resulting MBR need not carry the imprint of galaxy formation. It must, however, meet the observed requirements of a Planckian spectrum and the stringent limits on $\Delta T/T$ discussed by others at this session.

It has taken several years to arrive at a reasonable alternative [2-5], which still needs polishing up. Given the excess starlight, how do we thermalize it? By long needles of iron or graphite in the intergalactic space. Needles ~1 mm long and ~10^{-6} cm in radius can do the trick. They can form by condensation of metallic vapors as seen in laboratory experiments. Their natural production site is in the vicinity of supernovae that eject the heavy nuclei. The amounts required for needles are easily met by the available cosmic abundances. For details of the process see [3-5].

3. SOME CONSTRAINTS AND TESTS

The process described above is free from objections a)-d). Being of relatively recent origin it can work in the big bang as well as the steady state model or in a cross between the two requiring on-going mini-bangs as proposed in [5]. Some possible questions that arise are answered as follows.

i) Is the spectrum Planckian? Yes, because the characteristic time for thermalization is $<(3H)^{-1}$.

ii) Does it not make the universe unacceptably opaque? No. In most cosmological models the optical attenuation by this type of dust allows one to see QSOs and galaxies out to redshifts of 3-5. In radio wavelengths also there is no conflict with the present data on discrete sources.

iii) What are the limits on $\Delta T/T$ in the process? The dust produced around the supernovae is ejected by the shock wave mechanism with velocities ~ several hundred km s^{-1} that take the grains out to distances of 3-10 Mpc. Thus intergalactic space gets smeared by dust. If we consider the net effect in any given direction by clusters along the line of sight a small angle isotropy of $\Delta T/T < 10^{-4}$ is easily achieved. If the typical 'dust blobs' are smaller in size and more numerous then these limits can be further lowered.

iv) Aren't metallic whiskers somewhat esoteric to propose? They have been observed in the laboratory which is more than can be said for nonbaryonic dark matter. The dip in the spectrum of Crab Nebula in the range 30 mm-10 cm could very well be due to absorption by such particles.

If we are located off center in a 'local hole' with respect to luminous matter, we may see a dipole anisotropy of the MBR temperature. Thus the observed dipole anisotropy may not be entirely due to the Earth's motion with respect to the MBR. This may account for the different directions of observed anisotropy of Hubble flow in our neighborhood and that of the temperature of the MBR.

4. CONCLUSION

In view of some of the difficulties of the primordial interpretation, it is worthwhile exploring alternative ideas for the origin of the microwave background radiation. Further work is going on getting more precise answers to questions ii) and iii) above.

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[3] Rana, N. C. 1983, Ph.D. Thesis, University of Bombay.

[4] Hoyle, F. and Wickramasinghe, N. C. 1988, *Astrophysics and Space Sciences*, 147, 245.

[5] Arp, H. C., Burbidge, G., Hoyle, F., Narlikar, J. V. and Wickramasinghe, N. C. 1990, *Nature*, 346, 807.