Third Rome meeting of astrophysics on 'Cosmic background radiation and fundamental physics' 1984 December 11-15

This series of international meetings on astrophysics was started two years ago; the first two meetings were on the experimental tests of general relativity and on the dark matter in the universe. The present meeting covered such topics as the spectrum and anisotropics of the cosmic background radiation (CBR), galaxies, the early universe, background astronomy, and so on. There were about 40 contributions of varying duration ranging from reports of the latest work to reviews of the state of art in the above areas.

The first talk by K. B. Partridge highlighted the ways in which data on the spectrum and isotropy of CBR can be used to put constraints on the evolutionary physics of the universe from 10^{-35} to 10^{13} s, *i.e.*, from GUTs to the recombination epochs.

The major issue about the spectrum has been the significance of the distortion from the Planckian spectrum near and on the high frequency side of the peak, found by D. P. Woody & P. L. Richards about five years ago. The papers reporting recent observations now claim that the distortion is not present and that a Planckian curve of temperature 2.73–2.78 K gives a good fit to CBR. The indirect measurements included making more accurate determinations of the

background temperature causing excited states of the CN molecules in the atmospheres of ζ Per, ζ Oph, α Vir, and O Per. D. Meyer who presented the work emphasized the considerably improved accuracy of the reticon system (S/N > 2000) over the photographic and photoelectric measurments used more than a decade earlier. In particular the temperature at the higher rotational transition [the R(2) line at $\lambda = 1.32$ mm] can be measured with some confidence. The R(1) line at $\lambda = 2.64$ mm gives a background temperature of $2.74 \pm .04$ K while the less accurate R(2) line gives a temperature of 2.76 ± 0.20 K.

Partridge presented the radio measurements of the White Mountain collaboration group at $\lambda = 0.33$ cm, 0.91 cm, 3 cm, 6.3 cm and 12 cm. The weighted mean is 2.73 ± 0.05 K. G. Smoot also discussed these observations as well as the recent new observations by Richards and his colleagues. The latter show consistently lower temperatures at the wavelengths studied earlier by Richards & Woody, the new average being 2.78 ± 0.11 K.

With the spectral distortions gone, the attention is now focused more on $\Delta T/T$, the anisotropy of large and small scales The only positive measurement so far is still that of dipole anisotropy. P. Lubin reported recent measurements at 3 mm using a balloon-borne liquid helium cooled randiometer, giving a dipole temperature of $\sim$ 3 mK, in agreement with earlier observations. He finds the quadrupole parameter of the temperature to be less than 6×10^{-5} at 90% confidence level. While part (or whole) of the dipole anisotropy can be explained by the earth's motion against the cosmological rest frame, there was some diseussion as to whether part could come from emission by Galaxy itself. J. Negroponte discussed dust models which thermalize stellar radiation to far-infrared and to microwaves, in the light of the Japanese observations in the waveband 2μm–5μm and the IRAS data in the range 100μm–1000μm. It is still too early to say whether a coherent picture emerges from theory and observations.

The small scale anisotropy of $\Delta T/T$ and its relationship to various galaxy formation scenarios were highlighted by many speakers including J. Silk, N. Vittorio, F. Occhionero, K. Olive, E. Vishniac, G. Gelmini, and others. The lack of a positive mesurement of $\Delta T/T$ restricts or rules out many galaxy formation scenarios including adiabatic growths in baryon-dominated and neutrino-dominated models. Models with hot/cold, matter/radiation-dominated components with all kinds of inputs from particle physics for dark matter like quark balls, heavy neutrinos, strings, monopoles came in for discussion. The somewhat different approach using hydrodynamics of shock waves first initiated by J. Ostriker has its own share of difficulties. If luminous matter is only 10% of the total contents of the universe, then, concluded Silk, astronomers are wasting their time.

As a reaction to all this 'mass', D. Schramm gave a spirited talk against all these 'ugly' scenarios originating in Princeton and California claiming that it is not the astronomers but theoretical astrophysicists misguided (?) by particle physicists who were wasting their time. Schramm proposed a scenario in which scale-free fluctuations in a universe made of baryons, neutrinos and strings played the key role in forming structures like galaxies, clusters and superclusters. He seemed willing to accept the notion of 'strings' as gift from particle physics, however !

V. Castellani gave the only talk on observations of primordial helium. His latest studies using CCD spectroscopy on the RR Hydrae-poor globular cluster NGC 6752 gives the age of the cluster as 13 ± 2 billion years and $y = 0.23 \pm 0.01$ at 1σ. It seems from the present assessment of primordial nucleosynthesis that the standard model with at most 3 neutrinos is consistent with data. A brief 'nonstandard' talk by D. Lindley showed, however, that even these values get disturbed if massive neutrinos or gravitons decay and reheat the universe.

Olive also presented the current speculations on supersymmetric (SUSY) inflation. He began by pointing out why two attempts at GUTs-inspired inflation (the first by Guth in 1981 and the second by several others based on the Coleman-Weinberg flat potential) had failed to deliver the goods. The SUSY-inspired inflation might succeed largely because it has more free parameters to adjust.

One of the duo whose observations in 1965 started the big bang bandwagon rolling was present for one day and delivered the evening talk after the conference banquet. Arno Penzias highlighted the ugly mess that particle physics has brought into cosmology with the wide range of speculative ideas. He pointed out, however, that contrary to the proclaimed objectivity of sciences, physicists have largely been guided by their intuitions and prejudices. He mentioned Galileo's example, who ignored Kepler's elliptical solution to planetary orbits and insisted on adding two more epicycles to the Copernican solution. The simple and the elegant solution, said Penzias, still eludes the galaxy of experts working on the very early universe.

Among others there were conference talks on quantum cosmology (by J. V. Narlikar), on Kaluza-Klein inflationary cosmology (by Lindley), on SUSY and the early universe (by J. Ellis), on x-ray background (by E. Boldt), and on superheavy nuclei, the so called aborigines of the nuclear desert (by A. de Rajula).

It was an enjoyable conference that served the useful purpose of bringing together updates on observations and the continuing attempts of theorists in a highly speculative frontier area. To the criticism of supersymmetry theories that they have yet to make a testable prediction, Ellis had the following reply in the last line of the last transparency shown in the conference :

'Be patient; SROME was not built in a day'.

The critics would say : 'We know that Rome exists; but where is SROME ?'

(J. V. Narlikar)