9 - Beckman, J. and Pagel, B.E.J.: 1987, Proc. of the IAU Symp. 134. G. Cayrel and M. Spite (eds.), to be published.
10 - Gallagher, J.S.(III), Schramm, D.N. and Steigman, G.: 1987, Astrophys. J., in press.
11 - Spite, F. and Spite, M.: 1982, Astron. Astrophys. 115, pp. 357.
12 - Hobbs, L.M. and Duncan, D.K.: 1987, Astrophys. J., in press.
13 - Rebolo, R., Beckman, J. and Molaro, P.: 1987, Astron. Astrophys. 172, pp. L17.
14 - Kawano, L., Schramm, D.N. and Steignman, G.: 1987, Astrophys. J., in press.
15 - Kajino, T., Toki, H. and Austin, S.M.: 1987, MSUCL 574 preprint
16 - Steigman, G., et al.: 1987, Phys. Lett., in press.
17 - Vangioni-Flam, E. and Audouze, J.: 1987, Astron. Astrophys., in press.
18 - Delbourgo-Salvador, P., Salati, P., Reeves, H. and Audouze, J.: 1987, in preparation.
19 - Audouze, J., Lindley, D. and Silk, J.: 1985, Astrophys. J. 293, pp. L53.
20 - Salati, P., Delbourgo-Salvador, P. and Audouze, J.: 1987, Astron. Astrophys. 173, pp. 1.
21 - Scherrer, R.J. and Turner, M.S.: 1987, Astrophys. J., in press.
22 - Matzner, R.A.: 1986, P.A.S.P. 98, pp. 1049.
23 - Alcock, C.R., Fuller, G.M. and Mathews, G.J.: 1987, UCRL 95896 preprint.
24 - Reeves, H.: 1987, Proc. of the Varenna Summer School, J. Audouze and F. Melchiorri (eds.), to be published.
25 - Applegate, J.H., Hogan, C. and Scherrer, R.J.: 1987, Phys. Rev. D, in press.
26 - Delbourgo-Salvador, P., Audouze, J. and Vidal-Madjar, A.: 1987, Astron. Astrophys 174, pp. 365.

Background Radiation in the Universe

(G. De Zotti)

MICROWAVE BACKGROUND

a) *Spectrum*. A collaboration between US and Italian groups performed accurate observations at five wavelengths[1]. The experiment was particularly conceived to achieve the highest possible *relative* accuracy, allowing an effective search for spectral distortions. The Berkeley and the Milano groups further improved the spectral coverage[2].

Johnson and Wilkinson[3] avoided the main problems of ground-based experiments (primarily the atmospheric emission) by flying a special radiometer operating at $\lambda = 1.2$ cm on a balloon. Thus they arrived at the most precise measurement reported to date: $T_o = 2.783 \pm 0.025$ K.

Accurate determinations of T_o at 2.64 mm and estimates at 1.32 mm were also obtained through high-resolution observations of the CN absorption lines[4].

The good agreement between all results listed above, involving very different systematic effects, is encouraging. The brightness temperature in the Rayleigh-Jeans region is now known to better than 1%; Bose-Einstein distortions with a chemical potential larger than a few times 10^{-3} are ruled out. The ensuing constraints on processes of cosmological interest have been recently reviewed[5].

The information on the Wien tail of the spectrum has also been growing fast in the last few years. The balloon-borne photometer flown by Peterson and co-workers[6] has made measurements at five wavelengths, ranging from 3.5 to 1 mm. The new results do not confirm the strong excess around the peak[7]. Most recently, a rocket-borne radiometer, designed to measure the background radiation in six passbands between $\simeq 1$ mm and $\simeq 100$ μm, was launched by a collaboration between the Nagoya and Berkeley groups. According to preliminary reports, the brightness temperature at 1 mm is consistent with that measured at lower frequencies. At .68 mm and .46 mm, however, a strong excess is observed, that might be interpreted in terms of a Comptonization distortion by a non-relativistic plasma. It remains to be seen whether the data may also be consistent with the distortion produced by a mildly relativistic gas that could produce the X-ray background[8].

b) Isotropy. The two independent maps at 3 mm [9] and at 12 mm [10] have been combined to produce a combined map which is better connected than either and has a sky coverage increased to ≃ 90%[11]. The small discrepancy in the dipole amplitudes (~ 2σ) does not affect the direction significantly: the two experiments agree within 1.6°. The results are in excellent agreement with those from the RELIKT experiment[12]. No signals were found for higher harmonics. The tightest upper limits were set by the RELIKT experiment; for the quadrupole they find (95% confidence) $\Delta T/T < 3\ 10^{-5}$.

Significant fluctuations with an observed standard deviation of $3.7\ 10^{-5}$ on scales of ~ 8°-10° have recently been reported[13]. While recognizing that structure in the radio continuum emission from our galaxy may contribute appreciably, the authors argue that a substantial part of the signal is probably intrinsic. Similar fluctuations were previously observed at $\lambda = 1$ mm [14]. Again the interpretation depends on an uncertain correction for the galactic contribution.

A graininess which could not be attributed to known instrumental effects was detected, on scales ≲ 1', in recent VLA maps[15]. It is still unclear, however, which fraction of the detected signal is due to unresolved discrete sources.

High sensitivity observations by several groups have led to remarkably tight upper limits. The most stringent yet published is $\Delta T/T \lesssim 2.5\ 10^{-5}$, on a scale of 4.5'![16]

The variety of models on the origin of structure in the Universe that can be found in the recent literature reflects the lack of sufficient data to discriminate between them, and translates into a variety of predictions for $\Delta T/T$ [17]. Particularly helpful in defining the best observational strategy for testing models are the discussions of the statistical properties of radiation patterns generated by density fluctuations[18].

c) Sunyaev-Zeldovich effect. The small dips in the directions of three rich clusters of galaxies were the first small scale anisotropies for which detection at a high level of significance has been claimed[19]. Many years of experimental work, however, have revealed several astrophysical and instrumental effects that may distort the results[20]. The exploitation of the astrophysical information provided by these data is probably still premature.

d) Polarization. Until very recently both observational and theoretical studies dealt with polarization on large angular scales, introduced by anisotropic expansion[21]. On the other hand, the predicted polarization associated to small scale anisotropies induced by adiabatic perturbations is rather high, ≃ 10% [22]. Polarimetry may then be decisive in determining the origin of anisotropies in the presence of confusion from faint sources. Limits on polarization on scales from 18" to 180" are ≃ 3 times lower than those on temperature fluctuations on the same scales[23].

INFRARED BACKGROUND

The absolutely calibrated Nagoya-Berkeley rocket experiment (cf. Sect. 1) will help in establishing the IRAS zero point and, hence, to check the reality of the isotropic background component suggested by the analysis of 100 μm IRAS data[24]. The new data at 280 μm, 145 μm and 110 μm are consistent with interstellar plus interplanetary dust emissions; on the other hand, since these observations refer to a relatively low galactic latitude (b ≈ 33° ± 2°), their interpretation requires a detailed modelling of the galactic emission.

The diffuse near-IR (1 to 5 μm) radiation intensity has recently been measured with a rocket experiment[25]. A significant isotropic component was found, whose intensity exceeds by a substantial amount that predicted even by extreme galactic evolution models[26]. If it is of truly extragalactic origin, a substantial activity at early epochs would be called for[27].

THE X-RAY BACKGROUND (XRB)

Its origin is still a puzzle. Contrary to earlier expectations, the most recent estimates seem to converge in indicating a quite modest contribution from QSOs[28], consistent with the growing evidence that these objects have, on the average, X-ray spectra substantially steeper than the XRB[29]. A recent reanalysis of the HEAO 1 A-2 database[30] has led to conclude that, barring the case of unexpectedly strong cosmological evolution, low luminosity Active Galactic Nuclei are unlikely to make up the bulk of the XRB. Thus AGNs, which constitute the dominant population of extragalactic sources in the Einstein Deep Survey[31], might not be the dominant constituents of the background.

Strong constraints on the properties of sources that account for the latter come from: a) the high precision measurements of its spectrum[32]: b) the analysis of surface brightness fluctuations on data from the Einstein IPC [33] which indicates that the surface density of point sources must be ≳ 5000 $\deg^{-2}$, far in excess of the estimated surface density of QSOs.

Two classes of sources that could meet the above requirements have been proposed: precursor Active Galactic Nuclei[34] and actively star-forming galaxies[35,30].

References

1 - Smoot, G.F., et al.: 1985, Astrophys. J. 291, pp. L23.
2 - Sironi, G.F., et al.: 1987, Proc. 13th Texas Symp., in press.
Smoot, G., et al.: 1987, Astrophys. J. 317, pp. L45.
3 - Johnson, D.G. and Wilkinson, D.T.: 1987, Astrophys. J. 313, pp. L1.
4 - Meyer, D.M. and Jura, M.: 1985, Astrophys. J. 297, pp. 119.
Crane, P., et al.: 1986, Astrophys. J. 309, pp. 822.
5 - De Zotti, G.: 1986, Progress in Particle and Nuclear Physics 17, pp. 117.
6 - Peterson, J.B., Richards, P.L. and Timusk, T.: 1985, Phys. Rev. Lett. 55, pp. 332.
7 - Woody, D.P. and Richards, P.L.: 1981, Astrophys. J. 248, pp. 18.
8 - Guilbert, P.W. and Fabian, A.C.: 1986, Mon. Not. R. astr. Soc. 220, pp. 439.
9 - Lubin, P., et al.: 1985, Astrophys. J. 298, pp. L1.
10 - Fixsen, D.J., Cheng, E.S. and Wilkinson, D.T.: 1983, Phys. Rev. Lett. 50, pp. 620.
11 - Lubin, P. and Villela, T.: 1986, in "Galaxy Distances and Deviations from Universal Expansion", B.F. Madore and R.B. Tully (eds.), Reidel, Dordrecht, pp. 169.
12 - Lukash, V.N. and Novikov, I.D.: 1987, in IAU Symp. 124 on "Observational Cosmology", A. Hewitt, G. Burbidge and L. Zhi Fang (eds.), Reidel, Dordrecht, pp. 73.
13 - Davies, R.D., et al.: 1987, Nature 326, pp. 462.
14 - Melchiorri, F., et al.: 1981, Astrophys. J. 250, pp. L1.
15 - Martin, H.M. and Partridge, R.B.: 1987, Astrophy. J. Lett., submitted.
Kellermann, K.I., et al.: 1986, in Highlights of Astronomy, Vol. 7, pp. 367.

16 - Uson, J.M. and Wilkinson, D.T.: 1984, Nature 312, pp. 427.

17 - Kaiser, N. and Silk, J.: 1986, Nature 324, pp. 529.
Efstathiou, G. and Bond, J.R.: 1986, Phil. Trans. R. Soc. Lond. A 320, pp. 585.
Fabbri, R., Lucchin, F. and Matarrese, S.: 1987, Astrophys. J. 315, pp. 1.
Lukash, V.N.: 1987, in IAU Symp. 117 on "Dark matter in the Universe", J. Kormendy and G.R. Knapp (eds.), Reidel, Dordrecht, pp. 379.
Peebles, P.J.E.: 1987, Astrophys. J. 315, pp. L73.

18 - Vittorio, N. and Juszkiewicz, R.: 1987, Astrophys. J. 314, pp. L29.
Bond, J.R. and Efstathiou, G.: 1987, Mon. Not. R. astr. Soc. 226, pp. 655.

19 - Birkinshaw, M. and Moffet, A.T.: 1986, in Highlights of Astronomy, Vol. 7, p. pp. 321, and ref. therein.

20 - Partridge, R.B., et al.: 1987, Astrophys. J. 317, pp. 112, and ref. therein.

21 - Tolman, B.W.: 1975, Astrophys. J. 290, pp. 1, and ref. therein.

22 - Kaiser, N.: 1983, Mon. Not. R. astr. Soc. 202, pp. 1169.
Milaneschi, E. and Valdarnini, R.: 1986, Astr. Astrophys. 162, pp. 5.

23 - Partridge, R.B., Nowakowski, J. and Martin, H.M.: 1987, preprint.

24 - Rowan-Robinson, M.: 1986, Mon. Not. R. astr. Soc. 219, pp. 737.

25 - Matsumoto, T., Akiba, M., and Murakami, H.: 1987, in IAU Symp. 124 on "Observational Cosmology", A. Hewitt, G. Burbidge and L. Zhi Fang (eds.), Reidel, Dordrecht, pp. 69.

26 - Yoshii, Y. and Takahara, F.: 1987, Astrophys. J., submitted.

27 - Bond, J.R., Carr, B.J. and Hogan, C.J.: 1986, Astrophys. J. 306, pp. 428.

28 - Setti, G.: 1987, in IAU Symp. 124 on "Observational Cosmology", A. Hewitt, G. Burbidge and L. Zhi Fang (eds.) Reidel, Dordrecht, pp. 579.
Giacconi, R. and Zamorani, G.: 1987, Astrophys. J. 313, pp. 20.

29 - Marshall, F.E.: 1986, Bull. AAS 18, pp. 914.
Elvis, M., et al.: 1986, Astrophys. J. 310, pp. 291.

30 - Persic, M., et al.: 1987, Astrophys. J. submitted.

31 - Murray, S.S.: 1987, Invited paper presented at AAS Meeting No. 169.

32 - Gruber, D.E., et al.: 1984, in "X-Ray and UV Emission from Active Galactic Nuclei", W. Brinkmann and J. Trümper (eds.), MPE Report 184, pp. 129.

33 - Hamilton, T. and Helfand, D.: 1987, Astrophys. J. 318, pp. 93.

34 - Boldt, E. and Leiter, D.: 1986, in "Structure and Evolution of Active Galactic Nuclei", G. Giuricin et al. (eds.), Reidel, Dordrecht, Astrophys. Spa. Sci. Library 121, pp. 383.

35 - Bookbinder, J., et al.: 1980, Astrophys. J. 237, pp. 647.

Formation and Evolution of Galaxies

(A.A. Klypin, V.N. Lukash, I.D. Novikov)

GENERAL TRENDS

At the beginning of this review period a number of arguments were put forward against the neutrino model which became popular in 1980-1983[1]: too high a rate of the structure evolution at the non-linear stage and the same difficulty in the galaxy formation. As a consequence, many other schemes of the structure origin have been elaborated: models with "cold" particles, with unstable missing mass, etc. In these models the missing mass is in the form of weakly interacting particles (axion, photino, gravitino, etc.), or of usual particles (e.g., neutrino) but with properties that are out of the ordinary (e.g. instability). However, the standard neutrino model cannot yet be regarded as rejected[2], the more so in view of the recent data on the large-scale peculiar velocities[3].

The "cold"-particle hypothesis has been actively developed. In its simplest version this hypothesis contradicts many observational data and demands biasing, a process of galaxy formation where the distribution of visible matter does not