From The IAU

OBJECTS OF HIGH REDSHIFTS
(I.A.U. SYMPOSIUM NO. 92)

This Symposium was held at Los Angeles between August 28—31, 1979. The fifty or so papers presented here demostrated perhaps for the first time, that practically the entire range of the electromagnetic spectrum can now provide observations of interest to extragalactic astronomy and cosmology.

Even in the most traditional of all astronomies, the optical astronomy, new techniques are replacing old ones as was clear from the work presented by J. A. Tyson on number magnitude counts. Plates taken with the 4m teleseope at Kitt Peak of areas at high galactic latitude through a GG 385 filter (which gives the greenJ-magnitudes) were digitized on a micro-densitometer. Then a computer technique was used to single out 'galaxies', 'stars' and noise. The star count drops rapidly at faint magnitudes ($J \gtrsim 23$) and the galaxy count in the 17-24 magnitude range shows a rise with a sub-Euclidean slope of 0.41 ($\log N = 0.41\ J + \text{constant}$). Cosmological models without evolution give a reasonable fit whereas those with the generally used luminosity evolution give large discrepancies at the fainter end of the survey. Counts and colours of faint galaxies discussed by R. Kron are in broad agreement with Tyson's conclusion. On the basis of the observed existence of galaxies with predominantly blue stars, Kron conjectured that some of the surveys may already have picked up clusters with redshifts exceeding unity. H. R. Butcher discussed the photometry of remote galaxy clusters. His earlier finding of anomalously large populations of blue objects in remote clusters seems to be holding up in his more recent survey of clusters of redshifts $\gtrsim 0.4$.

The controversies came, as expected in the session on QSOs, with the opening salvo fired on behalf of the establishment view by M. Schmidt with the statement that his recent number count (in collaboration with R. F. Green) yields a super-Euclidean slope (an increase by a factor 8.5 per magnitude over the B-magnitude range 16-18) 'which is **fatal** to the local hypothesis' of quasars. Unfortunately, the numbers are still too small and subject to too large a fluctuation to convince a proponent of the local hypothesis.

Are quasars local and associated with nearby galaxies ? At the Paris Colloquium in 1976, Arp had given a list of 17 associations where the angular separation θ between the QSO and galaxy fell aproximately inversely as the galaxy redshift. In his role as the devil's (and Arp's) advocate, G. R. Burbidge produced massive data on such associations. For nearly 120 such pairs, the (θ, z) values are now scattered round a 'best-fit' line of slope -1.17 with error bars which include the value -1 comfortably. He also showed a number of striking examples of align ment and redshift bunching which would be hard to dismiss as accidental. What does this data mean ? M. J. Rees conceeded that the evidence was beginning to look significant but stressed the need for looking for conventional explanations for the anomalous redshift rather than looking for new physics. However, the conventional alternatives to the cosmological redshift—the Doppler or the gravitational redshift—do not provide satisfactory explanations of this data. In this context, a slide shown by Burbidge generated considerable, amusement in showed a man locking the door of his room with several locks, but unaware of an intruder sawing his way in through the floor.

On behalf of radio astronomy there were several interesting papers. M.S. Longair reviewed the thorough and painstaking programme of optical identification of radio sources. A. Wolfe showed how, with patience, a radio astronomer can come up with 21-cm redshifts considerably more accurate than the redshifts obtained by the optical astronomer. He gave the redshift of 1331+170 as 1.77642 ± 0.00002. These absorption line redshiit measurements of course lead to the problem of interpretation : is the absorption in the source or in an intervening galaxy ? Here again we are back to the 'local vs cosmological' controversy.

Example of what modern radio techniques are capable of were provided by A. O. Readhead and D. S. Heeschen. Readhead discussed the VLBI mapping of radio sources which can now tell us about the source structure down to $\backsim$ 1 p.c. Such radio maps will doubtless provide food for thought to the theoreticians who are still trying for viable models of radio sources. Heeschen described the VLA in New Mexico—a system of 27 dishes, with 9 each on the three arms of a 'Y', each arm having 21 km long rails on which the dishes can slide. Although the instrument will be completed by 1981, already it is partly in use and the detailed source-maps are turning out to be very informative. D. H. Roberts described the radio map of the double quasars 0957+561. The earlier explanation of a gravitational lens although not ruled out, seems to be more difficult to sustain in view of the asymmetries of the radio data. Considerable (but inconclusive ?) discussion was generated by this double quasar.

The significance of X-ray astronomy for cosmology was highlighted by the discussion of HEAO II observations by R. Giacconi and by a theoretical discussion of the X-ray background by Rees. The indication that most quasars may be X-ray sources has raised the very important issue of the contribution to the total X-ray background.

It is already clear that the background places significant limits on the number counts of quasars whether they are local or cosmological. Rees emphasized the need to get a bivariate (X-ray+optical) luminosity function to enable one to make realistic estimates of the contribution of X-ray quasars to the X-ray background. Rees also discussed the probable future use of the X-ray background data as a probe of the large scale inhomogeneities of the universe.

There were several contributions which extend the hope that infrared astronomy will help filling in important gaps in our knowledge of the extragalactic space. One example is the possible identification of infrared sources in the 'empty' fields, as was discussed by G. Rieke. M. Lebofsky indicated how infrared magnitudes in the H and K bands can be used to determine the Hubble's constant and the deceleration parameter, showing results based on the data for 6 galaxies. Incidentally, the largest galaxy redshift of 0.947 for the elliptical galaxy 1305+2952 was also included the list of six galaxies.

The IUE data on the spectrum of galaxies in the ultraviolet was discussed by M. Penston. The drop in intensity over 2000Å—3000Å range for normal galaxies is as expected, although there is a rise at wavelengths shorter than 2000Å. In some cases the spectra have been extended to 1150Å. This information is important to cosmologists in estimating the K-corrections to the magnitudes of high redshift galaxies. Two high redshift quasars of 17 magnitude were detected with a rest frame wavelength of 300Å. The spectrum of 3C-273 does not show any ultraviolet absorption lines except those in our own Galaxy ?

The final session of the symposium was on the cosmic microwave background. The departure from the Planckian form was discussed by D. Woody and P. Richards. The departure is significant and needs an explanation in order to sustain the usual interpretation of the origin of the background in a big bang. The speakers pointed out that so far only one explanation has been advanced, that by Segal in his chronometric cosmology. P.E. Boynton discussed small scale anisotropy. In the discussion that followed, it turned out that theoreticians still disagree on the level of small scale anisotropy at which inhomogeneities in the structure of the universe can be detected. G. Smoot reviewed large scale anisotropy, pointing out that the apparent discrepancy between the directions and magnitudes of the background anisotropy and the anisotropy of the Hubble flow (the Rubin-Ford Effect) still remains to be explained.

It was a well organized and stimulating symposium which ended with a barbeque on Mt Wilson. This informal gastronomical occasion (instead of a formal conference dinner) not only provided the delegates with opportunities to carry on their (often heated !) discussions but also demonstrated the powerful local background radiation and large optical depth which have driven the observers away from Mt Wilson.

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THE 16TH INTERNATIONAL COSMIC RAY CONFERENCE

The 16th International Cosmic Ray Conference was held at Kyoto, Japan between August 6-18, 1979 and was attended by about 570 participants of whom 300 were from Japan. The Conference papers, comprising of 11 volumes, were distributed to the participants at the time of registration. They included original contributions in the areas of (i) cosmic ray composition, origin, sources, acceleration and propagation, (ii) modulation of cosmic rays in the solar system, (iii) geophysical effects on cosmic rays, (iv) solar particles, (v) high energy physics at energies greater than about a TeV, (vi) extensive air showers produced by cosmic rays in the Earth's atmosphere, (vii) cosmic ray muons and neutrinos, and (ix) techniques. In the present article I will attempt to summarise important contributions of interest to astronomers.

1. Gama Ray (GR) Astronomy

(a) COS-B RESULTS : The Gamma Ray Experiment in the European Space Agency's satellite COS-B launched in 1975 has yielded very rich dividends. Some of the important results are the following :

(i) Sources :—From the latest analysis of the data, 30 peaks consistent with their being discrete sources have been detected. Of these, 29 are seen at energies in excess of 100 MeV and include 25 which have galactic latitudes b less than $\pm$ 5°. The mean value $|b|$ is 1.7°. The identified sources are the Crab and Vela pulsars, 3C 273 and ρ Oph. The remaining peaks are yet unidentified. 3C273 has a spectral shape

$$\frac{dN}{dE} = 2.7 \times 10^{-8}\ E^{-2.7}\ \text{ph. cm}^{-2}\ \text{s}^{-1}\ \text{GeV}^{-1}$$

and has a luminosity above 50 MeV of $L = 2\times 10^{48}$ ergs s^{-1} (assuming d = 790 Mpc).

In an interesting paper to understand these peaks, Montmerle of France reported that he has found a strong correlation between the unidentified GR sources and supernova remnants that are associated physically with H II regions and OB associations; such objects are given the name of SNOB. Some of the interesting consequences of this correlation have also been pointed out.

(ii) Galactic diffuse emission:—Compared 'o the US gamma ray satellite SAS-2 which recorded a total of 14,000 photons, COS-B has already recorded 64,000. In Fig. 1 is shown at the middle the sky map at energies between 70 MeV and 5 GeV. Additional information on the longitudinal and latitudinal distribution are given in the curves at the top and bottom of this figure. This is only the foreunner of what GR astronomy is likely to bring out in the future with better statistics and improved angular resolution; the latter is only about 1° at present. Very little interpretative work has been so far carried out with these data.

(b) GAMMA RAY BURSTS (GRB) : In a collaborative experiment between French and Soviet scientists, they have mounted identical GR detectors in two Venus