

eV have now been accumulated, however, and these clearly indicate, for the first time, that there is some degree of anisotropy in arrival directions. By combining together data from the four arrays Krasilnikov *et al.* (*J. Phys.*, **A7**, L176; 1974) have analysed 76 events above 10^{19} eV arriving at the Earth from the northern celestial hemisphere. In an harmonic analysis in right ascension of the arrival directions of these particles a first harmonic amplitude of roughly 40% appears with a maximum occurring about 13 h RA. The authors calculate a chance probability of only $\sim 2.6\%$ for such an effect and add supporting evidence for it being real from data accumulated on lower energy EAS.

Such an anisotropy has obvious importance in connection with the origin of the particles. Hillas and Ouldrige (this issue of *Nature*, page 609) point out that this adds weight to the Galactic origin theories, supporting arguments based on other experimental data including the absence of a cut-off in the energy spectrum below 10^{20} eV due to 2.7 K photons. Plotting the available data on full celestial coordinates Hillas shows that the anisotropy in RA arises from a definite clustering of the arrival directions in at least three regions of the sky. Such separate clustering does not suggest a single distant source but rather a Galactic origin. With this in mind Hillas and Ouldrige further suggest, to explain the total cosmic ray energy spectrum, that the mode of propagation existing below 4×10^{15} eV, consistent with cosmic rays escaping along magnetic field lines, is overtaken at higher energies continuing right up to 10^{20} eV, by a more rapid drift, perhaps radially outwards across the field lines. This suggestion leads to an explanation of the position of the most prominent of the observed clusters. But as the authors point out, to retain nuclei at about 10^{20} eV (the highest energies so far observed) would require a magnetic field extending several kpc from the Galactic plane and even then with a field magnitude of about 2×10^{-6} gauss only relatively heavy nuclei could be contained. There is some other evidence from observations at radio frequencies of the presence of such an extended magnetic field.

Unfortunately it will take several more years of EAS observation to add significantly to the statistics of the anisotropy. Meanwhile at Haverah Park and elsewhere attention is strongly directed towards determining the mass of the primary particles in the energy range $\sim 10^{19}$ eV. Evidence in favour of a high proportion of multi-nucleon primaries at these energies would give good support to the Galactic theories.

Redshifts of BL Lac objects

from R. F. Carswell

BL LAC is the prototype for a class of astronomical objects which has been the subject of a good deal of observational and theoretical work over the past two or three years. Generally, objects of this type are notable for their rapid variations in intensity and polarisation at all wavelengths where these quantities can be observed, and for the absence of any discrete features in their spectra. Some, notably BL Lac itself and, for example, AP Lib and Markanan 501 seem to be surrounded by nebulosity and so look rather like galaxies with exceptionally bright nuclei, similar to Seyfert galaxies. Others, such as OJ287, are stellar in appearance and could be related to the quasi-stellar objects, though without any of the emission lines from which a redshift can be determined. In the case of such star-like continuous objects we can only conjecture at their distance from us, since no angular size or redshift can be measured, but for objects with nebulosity we can hope to obtain estimates of their distance by looking for observable features in the galaxy component.

Just such an observation has been performed in the case of AP Lib by Disney, Peterson and Rodgers (*Astrophysical Journal Letters*, **194**, L79; 1974) using a number of spectra taken at the Mount Stromlo Observatory in Australia. They noticed that a number of features could be seen very weakly but consistently on their plate material gathered over a period of time, and found that these correspond to lines often seen in normal galaxies if AP Lib has a redshift of $Z=0.0486$. With the currently accepted value of $50 \text{ km s}^{-1} \text{ Mpc}^{-1}$ for the Hubble constant, this corresponds to a distance of about 300 megaparsecs, and the angular size of the galaxy is roughly what we might expect at that distance.

An earlier attempt to find a redshift for a BL Lac object by looking for galaxy features in an extended halo had been described by Oke and Gunn (*Astrophys. J. Lett.*, **189**, L5; 1974). They used a rather different technique, employing a diaphragm to block out the light from the central object so that the galaxy lines would stand out more clearly, and their observations was of the prototype object itself, BL Lac. The absorption features they found were also very weak, but could correspond to a redshift of about 0.07.

There is however considerable doubt about the redshift in this case. More recent observations by Baldwin, Bur-

bidge, Robinson and Wampler (*Astrophys. J. Lett.*, **195**, L55; 1975) show no absorption features, and so no evidence that the nebulosity around BL Lac is made up of a normal galaxy of stars. They suggest that perhaps one reason for the difference in the results obtained is that a nearby very faint star may have contaminated the spectrum from which Oke and Gunn determined their value. Though the true nature of BL Lac must await further observational work this disagreement between two groups does highlight some of the difficulties involved.

Another BL Lac object, PKS 0735+178, is believed to have an even higher redshift and to be more QSO-like in character. A group of astronomers working in Arizona reported in June last year (Carswell, Strittmatter, Williams, Kinman and Serkowski, *Astrophys. J. Lett.*, **190**, L101; 1974) that a strong pair of absorption lines corresponding to MgII with a redshift of 0.424 had been found in this object. A number of QSOs show sharp absorption lines in their spectrum, always at redshifts lower than, or comparable to, the emission line redshift, and it is believed that in PKS 0735+178 we are seeing the same type of thing. This does not tell us the redshift of the continuum source, however, but it is extremely unlikely that it is much less than 0.424, and probable that it is at about that value.

Apart from placing BL Lac objects clearly well outside our own Galaxy, these redshift determinations can help to test our understanding of the physics



A hundred years ago

THE *Kolnische Zeitung* of Feb. 10 gives an account of Prof. Böhm's (Dorpat) researches on revival after cases of poisoning. He succeeded in reviving cats which had been poisoned by injection of potash salts into their veins, after forty minutes' duration of a state which was in no way different from actual death, the action of the heart and respiration having completely ceased. He obtained these results by artificial respiration and simultaneous compression of the breast in the vicinity of the heart. The professor points out the importance of the latter point, which he deems as essential as the action of the lungs. In any case his researches are of high interest for the relation they bear upon the revival of poisoned persons.
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