news and views

Controversy over the extragalactic distance scale

from M. Rowan-Robinson

THE redshift-distance relation for galaxies discovered by Hubble and Lundmark in the 1920s is the most tangible evidence we have for an expanding universe. The constant of proportionality, the Hubble constant, can be interpreted as the expansion time-scale of the universe. Yet in spite of the consumption of many thousands of hours of telescope time, the extragalactic distance scale remains a subject of controversy, highlighted by a disappointingly inconclusive International Astronomical Union symposium at Paris in September.

At the symposium Tammann summarised the massive programme of galaxy distance measurements that he and Sandage have been pursuing, culminating in a value for the Hubble constant, H_0 , of around 50 km s^{-1} per Mpc (for a recent review see *Nature*, **262**, 97; 1976). Yet almost all other workers reporting at the symposium disagreed with the Sandage and Tammann distance scale, preferring a value for H_0 closer to 80. For example, van den Bergh and de Vaucouleurs reported significantly lower distances for members of the Local Group of galaxies, to which our Milky Way galaxy belongs. Hanes' work on globular clusters in galaxies in the Virgo cluster, the nearest of the great clusters of galaxies that determine the Hubble relation on the large scale, led to a distance estimate for Virgo of 12.5 Mpc (1 Mpc = 3.26 million light years) instead of the Sandage and Tammann value of 22. And Tully and Fisher used their 21-cm neutral hydrogen line method to obtain a value for H_0 of 75.

It is therefore fascinating to see in the latest *Astrophysical Journal* (**210**, 7; 1976) Sandage and Tammann's version of this last method. They take Tully and Fisher's data, reanalyse and recalibrate it, and emerge with a Hubble constant of 50.3 ± 4.2 . The 21-cm method depends on a correlation found by Tully and Fisher between the 21-cm hydrogen line

width and the optical luminosity of a spiral galaxy (one has to have some galaxies with distances known more directly to calibrate this relation). The apparent optical brightness of a galaxy then gives the distance through the inverse square law.

Sandage and Tammann use the method to obtain the distance of the Virgo cluster, and compare the result with six other methods (including, ironically, an earlier estimate by Hanes which agreed with theirs). The adopted Virgo distance, 22 Mpc, is then combined in three different ways with the mean velocity of the cluster

to yield $H_0 = 50.3 \pm 7.0$, 50.3 ± 4.2 , 50.3 ± 4.2 . The authors remark "That the values of H_0 from all three methods are the same is clearly fortuitous". If the agreement between these three means at so high a significance level is indeed simply good luck, then heaven protect these authors from bad luck.

Do these disagreements over H_0 , which appear even when the same data is used, matter? Well, first, the actual value of H_0 matters to cosmologists, because by comparing it with the age of our own and other galaxies they can deduce how long

Precise Lamb shift interval

from Peter Knight

FOR two years now, we have had two slightly different theoretical values for the hydrogenic $n=2$ Lamb shift interval. The more recent value, due to P. J. Mohr (*Phys. Rev. Lett.*, **34**, 1050; 1975) is 1057.864 ± 0.014 MHz, and should be compared with the earlier value of 1057.912 ± 0.011 MHz due to G. W. Erickson (*Phys. Rev. Lett.*, **27**, 780; 1971). Published experimental values up to 1975 lacked the ultra-high resolution needed to support one value rather than the other. The 100 MHz natural linewidth of the Lamb transition imposes severe limitations on precision experiments, and great care is needed in the lineshape analysis.

At Harvard, S. R. Lundeen and F. M. Pipkin (*Phys. Rev. Lett.*, **34**, 1368; 1975) used a Ramsey-type separated-oscillatory-field technique combined with a fast atomic beam to achieve resonance widths of one-third the natural width, and an improvement of a factor of 3 in the precision of the experimental value for the $n=2$ hydrogenic Lamb shift, obtaining a value of 1057.893 ± 0.020 MHz. Unfortunately this still overlaps with and is consistent with both theoretical values. This situation and future prospects were

recently reviewed by Pipkin (*Comments Atom. molec. Phys.*, **5**, 45; 1975).

More recently D. Andrews and G. Newton at the University of Sussex report the results of a new high-precision single-loop experiment, which whilst consistent with the Harvard experiment, manages to discriminate in favour of the new value of Mohr. The Sussex experimental value is 1057.862 ± 0.020 (*Phys. Rev. Lett.*, **37**, 1254; 1976).

It is unlikely that the precision of the Sussex technique can be improved significantly, since (as they say) they are at the limits of available microwave technology. Similarly the lineshape analysis of the separated-field approach is complex. One is, after all, trying to resolve a line centre to better than a few parts per million, when the fundamental natural width is as large as one-tenth of the resonance frequency. Opportunity for further progress seems to rest with the theoreticians. The source of the discrepancy between Mohr's and Erickson's theoretical values is unknown, but presumably is connected with the different ways of computing the self-energy contribution to the Lamb shift.