various subsets of radio QSOs constructed, leading to a value of $q_0 = +1.38$. The authors of this paper are Fang Li-zhi, Zhou You-yuan, Cheng Fu-zhen and Chu Yao-quan from the University of Science and Technology of China—names quite unknown in the West.

Confining their attention to those QSOs with resolved radio components, these authors propose that the linear separation D between the components be used as a luminosity indicator. (They eventually back up this suggestion by actually deriving a value for the rate of change of the optical luminosity with D). Since D is not directly observable, a rather subtle statistical argument was used in getting plausible estimates of D. Starting with observed angular separation θ and redshift z, and assuming a distance–redshift relation $r = r(z)$, one calculates the projected distance $r\theta$, which differs from D by a projection factor $\sin \psi$, say. Now, in an isotropic distribution of directions in space, $\sin \psi$ is concentrated near its large end value of 1. The authors argue that what one can do here is to take only those quasars with $r\theta$ values at or close to the observed maximum $r\theta$ value at the given z, and then simply set $D = r\theta$ for such objects. In this way, from a sample of some 90 radio quasars with known θ and z, they picked out 26 for which such indicative values of D can be assigned. Separate Hubble diagrams were then constructed for various ranges in D.

Rather tight correlations consistently appear in these diagrams, which typically have 10 data points and a scatter of about 0.6 magnitudes. But the linear regression coefficient of m upon $\log z$ departs significantly from 5, which means that the classical Hubble relation $r(z) \propto z$ is no longer valid. In a self-consistent series of calculations, the authors then found that, in order to recover a slope of 5, the regression analysis must be made between m and $\log (z - 0.19 z^2)$. This is equivalent to saying that the correct distance-redshift relation is of the form $r(z) \propto z - 0.19 z^2$, and that is how the formally precise value of $q_0 = +1.38$ was obtained, because in relativistic models, the coefficient of z^2 here is equal to $\frac{1}{2}(1 - q_0)$.

Although the true uncertainty in this determination must be very much larger than the formal value implies, it is probably not as large as in the derivation by Davidsen *et al.*, because the sample is larger and the sample points more evenly distributed. The two results complement each other in that one deals with flat-spectrum objects and the other, mainly steep spectrum objects. They agree in saying that the Universe is probably closed.

On the other hand, because of consistent failure in detecting sufficient mass in one form or other, astronomers in recent years have become more and more disposed towards the opposite alternative of an open Universe—this, for example, was very much the general feeling in the recent Symposium on Large-Scale Structure of the Universe, held at Tallinn, Estonia.

The determination of q_0 tacitly assumes that no change of luminosity has taken place in time. Hence the challenge now is to find a physically plausible model of luminosity evolution that will account for both a low mass density and a high value of q_0.

The evaluation of q_0 is only one of several results obtained by Fang Li-zhi *et al.* Many astrophysicists may find their result that the optical luminosity of a quasar decreases by 2.3 magnitudes for every megaparsec increase in the linear separation between its radio components to be even more important. □

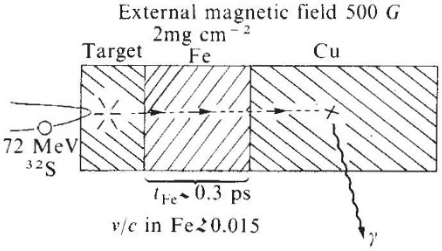
Magnetic moments of short-lived nuclear states

from P. E. Hodgson

A NEW method of measuring the magnetic moments of nuclear states of very short lifetime has recently been developed by N. Benczer-Koller and colleagues at Rutgers University, and some preliminary results have just been reported at the recent conference on nuclear structure held in Tokyo in September. They have applied the method to several isotopes of iron, nickel and zinc and obtain results that are important for testing nuclear models.

In this method, a 72 MeV beam of ^{32}S ions hits the target material, which is deposited on a 2 mg cm^{-2} layer of magnetised iron backed by 10 mg cm^{-2} copper, as shown in the figure. Some of the target nuclei are excited, and these recoil through the iron and stop in the copper, where they decay by gamma emission. The energy of the gamma ray identifies the state of excitation of the recoiling target nucleus.

The gamma rays are detected in coincidence with the ^{32}S ions recoiling in the direction opposite to that of the incident beam. This ensures that the knocked-on target nuclei pass perpendicularly through the magnetised iron so that the length of their path in that material is accurately known. As the target nuclei pass through the magnetised iron their magnetic moments precess and the angle of precession is measured by the rotation of the angular distribution of the de-excitation gamma rays, $\Delta \theta \sim g \int B dt$. The value of $\int B dt$ and the constant of proportionality are determined by a subsidiary experiment using ions of known magnetic moment, so that a measurement of $\Delta \theta$ enables g to be found. It is sufficient for practical purposes to use an empirical relation describing the dependence of B on the velocity of the ion; this is quite different from the theoretical relation, but this lack of understanding of the process does not affect the determination of the magnetic moments.



As an example of the results obtained, the magnetic moment of the lowest 2^+ state of ^{54}Fe, that has a mean life of only 1.4 ps, is found to be 1.68 ± 0.38. Magnetic moments have also been determined for the lowest 2^+ state of ^{58}Fe, and for the same states of four isotopes of nickel and four isotopes of zinc. In some cases the magnetic moments were already known from other work, and the new and old values are in good agreement.

This method has many advantages over those used previously. The high magnetic field inside a ferromagnet enables the magnetic moments of states with lifetimes in the ps region to be measured, whereas the methods using laboratory magnetic fields are limited to states with lifetimes in the ns region. Since the ion is moving rapidly through the magnetised iron and does not stop there the results do not depend on the rate of energy loss at low velocities. This is a major source of uncertainty in the methods in which the ions come to rest in the iron. Furthermore, $\Delta \theta$ is independent of the lifetime of the ion providing it is sufficient for the ion to pass through the magnetised region.

The magnetic moments of excited states can be calculated from the shell model, and provide a searching test of its validity. The new results for the nickel isotopes disagree with shell model calculations that take no account of core excitation, but are in good accord with newer calculations that include $f_{7/2}$ core excitation. □

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