N-Galaxy Fluctuations May Settle Quasar Arguments

The arguments over the distance of quasars may be resolved by observed rapid changes in brightness of some N-type galaxies. Measurements made with the 200-inch telescope at Mount Palomar are reported independently by John B. Oke and Allan Sandage (both of Cal Tech) in *Astrophysical Journal* **150**, L5 and L9 (1967). Galaxy 3C 371 has been found to vary by about one magnitude over the last two years and by about 0.10–0.15 magnitude within a few days. Changes in its color have also been seen.

N galaxies resemble quasars in that they are distant objects with intense emission lines. They were discovered as radio sources, but it is believed that some radio-quiet blue compact galaxies are of the same type. They differ from quasars by their color and by the nebulous envelope that surrounds the bright nucleus (quasars are indistinguishable from stars in photographs).

An important feature of the dozen or so N galaxies that have been identified and studied is that they fit well on the same Hubble diagram that includes normal diffuse radio galaxies. This diagram is a plot of brightness against spectral-line red shift; a straight-line graph shows that these galaxies follow Hubble's Law, which states that the speed of recession of a galaxy is proportional to its distance from us. So we can be sure that N galaxies are at cosmological distances of the order 10^{10} light years; they lie toward the limit of the observable universe.

Quasars have also been found to vary rapidly in their radio and optical emission, and these variations have cast doubt on the great distances predicted by their red shifts. Rapid fluctuations in brightness suggest a comparatively small object that can act collectively rather than an immense, loosely organized cloud. It is easier to imagine these small objects as relatively close and dim rather than very distant, as predicted by the red shift, and immensely luminous.

We know now that N-type galaxies, different from but closely related to quasars, are at great cosmological distances, and we suspect, from their rapid fluctuation, that they are very small (Oke calculates their diameter as 10^{11} km or less). The conclusion is that quasars are also at great distances. How they can be so luminous and at the same time so small is not yet clear. However, we now have further evidence for the "big-bang" theory; the quasars that we now see at cosmological distances are examples of the make-up of the universe around 10^{10} years ago. The nearby (and therefore recent) universe appears not to contain quasars; so there is no support for the steady-state theory. —JTS

Electrons Cause Fission Less Effectively than Do Photons

In efforts to understand fission better, at least two groups are measuring cross sections for electron-induced fission. Their values are considerably smaller than corresponding cross sections for photon-induced fission as is to be expected.

Yu. N. Raniuk and his colleagues reported last March in *Yadernaya Fizika* (**5**, 531, 1967) the results of measurements with the linear electron accelerator at the Ukrainian Physical-Technical Institute. Their electrons had energies from 35 to 260 MeV. By interposing increasing thicknesses of copper between two 100-micrograms/cm^2 films of uranium deposited electrically on aluminum backing, they compared electron and photon cross sections. They conclude that photons are more effective than electrons by a factor equal to the fine-structure constant $\alpha^{-1} = 137$, and that this result shows that uranium fission is caused by the absorption of dipole (E1 or M1) photons.

With 250- and 500-MeV electrons from the Stanford Mark III Linear Accelerator some Berkeley–Stanford associates (Harry Bowman, R. C. Gatti, R. C. Jared, G. Kilian, L. G. Moretto and Stanley Thompson, Berkeley, Michel Croissiaux, J. H. Heisenberg, Robert Hofstadter, L. M. Middleman and Mason Yearian, Stanford) measured fission cross sections of U^{238}, Bi^{209} and Ta^{181}. They find a fission-energy spectrum for U^{238} quite like that of the spontaneous fission of Cf^{252}. With three independent checks they eliminated the influence of bremsstrahlung impurity in their beam and, like Raniuk, find an electron cross section considerably smaller than that for photons of the same energy. Fission fragments appear to be emitted isotropically. Typical of their results are their cross sections for fission of U^{238}: 6×10^{-27} cm^2 with 250-MeV electrons and 9.4×10^{-27} with 500-MeV electrons. A report on the work was given at the Tokyo Nuclear Structure meeting last fall and another will be published in *The Physical Review*.

The work will be carried on with refinements in the future to test the relation of fission to the giant resonance. At this resonance all nuclei have large cross sections for photonuclear reactions, both γ,p and γ,n. An advantage of electron-induced fission over photofission as a test is that, by varying the angles at which one detects the recoils, the experimenter can vary the wavelength of the electron

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. . . also of Interest: Cyclotron, Tandem and a Twist

Music is the name of a 112-MeV sectored isochronous cyclotron being built at the University of Maryland. The $3-million accelerator, which will be the largest of its type in the world, is being built by Raytheon. Experiments should start in January 1969.

Ohio University has an AEC contract to purchase a high-current 8-MeV tandem accelerator. The machine, due to be completed in 18–24 months, will be used for studies of neutron polarization, stripping reactions and particle-gamma correlations. Research will be directed by Raymond O. Lane, Roger Finlay, Charles Brient and Richard Koshel.

Gas molecules give a warm nonmagnetic rod a strange twist when experimenters apply a weak magnetic field that is parallel to a rod suspended in cool gas. Gifford Scott and Harry Sturner (General Motors Research Labs) and Robert Williamson (Oakland University, Rochester, Mich.) find that, depending on the gas used, the torque can be clockwise, counterclockwise or nonexistent.