Atlantic, Indian, and southwest Pacific. The tracks probably (but not certainly) show a wider distribution, as we have described, and suggest that these animals, in some regions, may be quite common.

It would be interesting to know how, in these places, acorn worms divide the spoils with other detritus feeders. We might also ask why, in an environment suitable for so many sedentary forms, they are free living. Conceivably, like the *Glandiceps* Ikeda (*7*) saw, some of these abyssal worms can swim, and choose good feeding grounds. Perhaps, though, the explanation is simply negative; that is, that for them, burrowing in this habitat is seldom necessary (*13*).

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13. After this paper was completed, F. Jensenius Madsen of the University Museum, Copenhagen, showed one of us (D.W.B.) a number of photographs made by the Scripps Institution of Oceanography in the southwestern Pacific. Spiral tracks are plentiful in some of them, and in one case an animal resembling an enteropneust has been photographed together with its spiral.
14. Lamont Geological Observatory, Columbia University, Contribution No. 841. Woods Hole Oceanographic Institution Contribution No. 1639. We thank Dr. Sydney Smith, University of Cambridge, for his criticisms and advice. Rockne Anderson and Charles Hollister, Lamont Geological Observatory, provided valuable assistance. Work supported in part by NSF grant G-20702 to the Woods Hole Oceanographic Institution, under contract Nonr 266(48) with Columbia University, and by the ONR.

10 May 1965

Spectrum of the Intensity Variations in 3C 273B

Abstract. *The intensity variations in radio source 3C 273B have been measured at wavelengths of 31.3, 21.2, and 10.6 centimeters. At 31.3 centimeters the variation is quite small, indicating that the variable component of the source is optically thick at this wavelength. Study of several different model sources shows that the observed dependence of the intensity variations on frequency can best be explained by an increase of the electron density in a source region about 2 parsecs in diameter. This interpretation is consistent with the distance to 3C 273 determined from Hubble's law and the observed red shift.*

Dent (*1*) has observed an increase of 17 percent per year in the intensity of the radio source 3C 273B at a wavelength of 3.75 cm. His interpretation of this intensity variation brings into question either (i) the production of the radiation by the synchrotron mechansm or (ii) the distance of about 470 megaparsecs determined from Hubble's law and the observed red shift (*2*) of $\Delta \lambda / \lambda = 0.158$.

We have observed changes in the intensity of 3C 273B at wavelengths of 31.3, 21.2, and 10.6 cm, as shown in Fig. 1. The measurements plotted in Fig. 1 come from several observers, as indicated in the legend. All but two (*3, 4*) were taken with the interferometer at the Owens Valley Radio Observatory. The Owens Valley observations were all made with a linearly polarized antenna feed in which the electric vector pointed north-south. Also shown in Fig. 1 is a line representing the intensity increase at 3.75 cm reported by Dent (*1*). Dent gave intensity ratios to the source Virgo A. These have been converted to fluxes; a value of 45 flux units for Virgo A at 3.75 cm was used (*1*).

A straight line has been fitted to the data for each wavelength. There is some indication in the data for 21.2 cm that the rate of increase was less between 1960 and 1963 than it has been in the subsequent period; however, the individual points have fairly large uncertainties and the straight line provides an adequate fit.

The spectrum of the intensity changes is shown in Fig. 2. There is a sharp cutoff between 20 and 30 cm, with a gradual increase in the rate of change as the wavelength decreases from 20 to 3.75 cm. The sharp long-wavelength cutoff suggests strongly that the intensity changes are occurring in a component of the source which is optically thick at wavelengths greater than 20 cm.

If the time scale of the intensity variations is set by the dimensions of the variable component, we can say that the component diameter is about 2 parsecs. At the cosmological distance of 3C 273, this would correspond to an angular diameter of about 0.001 second of arc. Using the synchrotron emission and absorption coefficients given by LeRoux (*5*), we find that an object subtending 0.001 second and having an apparent flux of 10 to 20 $\times 10^{-26}$ watt m^{-2} (cy/sec)$^{-1}$ would become optically thick at some wavelength between 3 and 30 cm. The exact value depends slightly on the strength of the magnetic field and the energy spectrum of the relativistic electrons.

Thus the observed intensity variations in 3C 273B are *not* in conflict

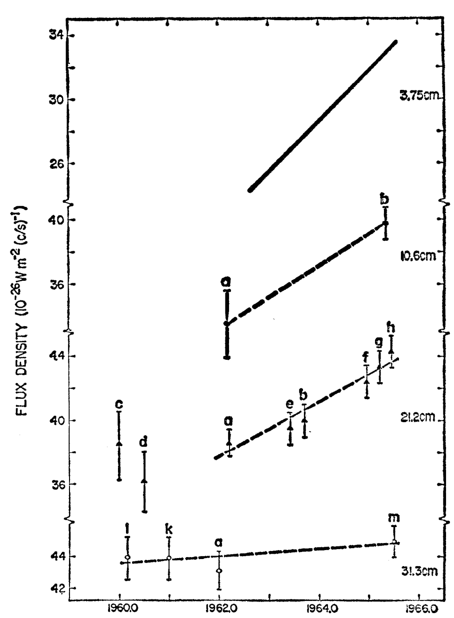

Fig. 1. Measured intensities of 3C 273 versus time at 31.3, 21.2, and 10.6 cm. For comparison, the intensity variation measured by Dent (*1*) at 3.75 cm is shown (top). The various observations were made by (*a*) Kellermann (*8*); (*b*) Moffet; (*c*) Lequeux (*3*); (*d*) Goldstein (*4*); (*e*) Morris; (*f*) Fomalont, Rogstad, and Wyndham; (*g*) Fomalont; (*h*) Rogstad and Whiteoak; (*i*) Moffet (*9*); (*k*) Maltby (*10*); (*m*) Maltby and Moffet.

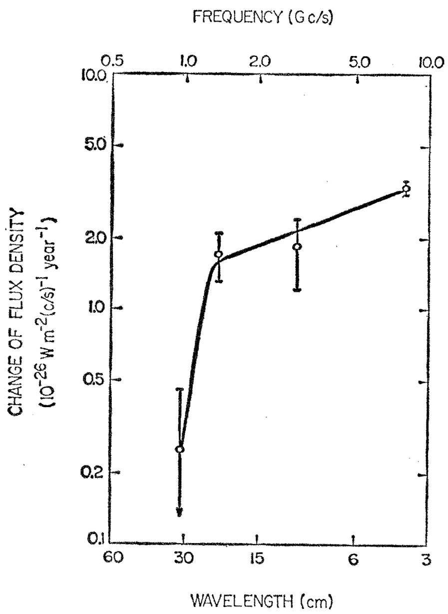

Fig. 2. Observed change in flux density per year for 3C 273 plotted against the wavelength (frequency).

with its cosmological distance of 470 megaparsecs. On the other hand, the source *could* be very much nearer to us; if it were, the dimensions of the variable component would be proportionately reduced (to maintain the same cutoff wavelength), and the time scale of the variation would be determined by some other property of the source.

In an effort to simulate the "change spectrum" of Fig. 2, we have investigated the effect of changing various physical conditions in several types of model sources. The best fit to the observations was obtained when we increased the density of relativistic electrons in a fairly simple spherical source region which becomes optically thick at 20 cm. The slope between 20 and 3 cm is well reproduced if we assume that there are moderate inhomogeneities in the source. There might, for instance, be regions of higher than average density or magnetic field strength occupying about a tenth of the total volume. These condensations would become optically thick in the 3- to 20-cm wavelength range.

A disadvantage of this model is that the energy density in relativistic particles is appreciably larger than the energy density of the magnetic field. Under such conditions the particles would not be confined but would explode outward at a velocity approaching that of light. Hoyle and Burbidge (*6*) have proposed a family of models with a strong radial dependence of the magnetic field. In such a model the imbalance of particle and field energy densities could be reduced. Hoyle and Burbidge's requirement that the source be optically thin at all wavelengths can be modified on the basis of our observations.

In any case it is necessary to account for the longer wavelength radiation from 3C 273B by adding another, larger-diameter component which has a constant intensity from about 20 cm to at least 2 m and which decreases in intensity at shorter wavelengths. At epoch 1965.0 the contribution from this latter component might be one-third to one-half of the total intensity observed at 3.75 cm.

The difference between our interpretation of the variations in 3C 273B and that of Dent comes from Dent's assumption that the source contains a single, homogeneous component. Under this assumption, Dent required that the source be optically thin to wavelengths of at least 2 m and yet be small enough to display a significant intensity change in a few years. Our measurement of the spectrum of the intensity variation indicates that 3C 273B is not homogeneous; the component which varies is optically thick at wavelengths greater than 20 cm. Calculations based on our model indicate that such a condition is physically plausible. The radiation from 3C 273B at longer wavelengths must, of course, come from another component which has a larger diameter.

The large red shifts recently reported for quasi-stellar objects (*7*), of which 3C 273 is the prototype, promise to give us unique information about the evolution of the universe—provided we can be certain that these red shifts are of cosmological origin. We conclude that the spectrum of the intensity variations in 3C 273B is entirely consistent with the cosmological distance and luminosity as derived from Hubble's law and the observed red shift.

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11. A detailed description of our observations and model calculations is in preparation. We thank E. B. Fomalont, D. H. Rogstad, J. B. Whiteoak, and J. D. Wyndham for permitting us to use their observations. Research supported by ONR contract Nonr 220(19). P.M. is on leave of absence from the Institute of Theoretical Astrophysics, Oslo, Norway; A.T.M. is an Alfred P. Sloan Research Fellow.

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Erythrocyte Membrane: Chemical Modification

Abstract. *Erythrocytes treated with 1-fluoro-2,4-dinitrobenzene become permeable to Na^+ and K^+, but not to small water-soluble nonelectrolytes or hemoglobin, and eventually lyse in isotonic buffer. Erythrocytes treated with 1,5-difluoro-2,4-dinitrobenzene become permeable to Na^+ and K^+ but do not lyse in buffer or in water, even after extraction with lipid solvents. The difluoro compound cross-links the membrane and increases its strength. Both reagents appear to remove the positive fixed charge responsible for the cation impermeability of the normal cell.*

This report concerns the reaction of human erythrocytes with 1-fluoro-2,4-dinitrobenzene (Sanger's reagent) and with 1,5-difluoro-2,4-dinitrobenzene. These reagents react readily by displacement of fluorine with free amino, sulfhydryl, tyrosyl, or histidyl groups to form stable dinitrophenyl derivatives. The monofluoro compound reacts with one such group, but the difluoro compound reacts with two groups, provided they are about 5 Å apart, to form a dinitrophenylene cross-link (*1*).

The starting point was the observation that cells treated with the difluoro reagent fail to lyse when suspended in distilled water. Cells obtained from fresh, oxalated, human venous blood were washed repeatedly at 23°C with 0.9 percent NaCl and then with a Krebs buffer (*2*). One milliliter of cells was added to 200 ml of buffer, and a control sample of 40 ml was withdrawn. To the remaining 160 ml, 0.9 ml of a 10-percent methanolic