ASTROPHYSICS

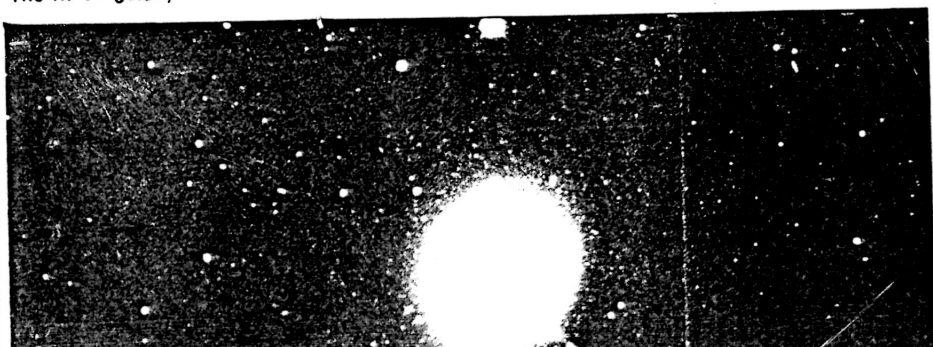
New Evidence for a Black Hole?

BLACK holes have fired the imagination of theoretical astrophysicists in the last decade. The observational evidence for black holes is still scanty. The X-ray source Cygnus X-1 provides what is generally claimed to be the best evidence for a black hole but even this is not of the "conclusive" type. Any new claim for the existence of a black hole thus attracts immediate attention.

Two independent investigations of the galaxy, M-87 (Messier Catalogue Number 87), have concluded that there is a supermassive object in the nucleus of the galaxy. These investigations (*Astrophysical Journal*, **221**, 721 and 731) were carried out by astronomers at the Hale Observatories, California, the Kitt Peak National Observatory, Arizona, the Jet Propulsion Laboratory, California, University College, London, and the University of Victoria, Canada.

The first of these investigations (by P. J. Young, J. A. Westphal, J. Kristian, C. P. Wilson and F. P. Landauer) used photometry with two dimensional digital detectors SIT and CCD. The idea was to make accurate measurements of the intensity profiles of the galaxy. Donald Lyndon-Bell had, in 1969, suggested that a supermassive black hole with mass exceeding $10^8 M\odot$ ($M\odot$ = mass of the Sun $\cong 2 \times 10^{33}$ gm) in the nucleus of a galaxy may be responsible for many of the high-energy-production phenomena (like strong radio emissions) associated with the galaxy.

The M-87 galaxy



Kitt Peak National Observatory

Indeed, if the conversion of the black hole's gravitational energy to dynamical or electromagnetic energy is not efficient, an even larger black hole may be presumed. The black hole would affect the motion of stars in the nucleus and their distribution. This may show up in the intensity distribution of light across the galaxy.

The team have reported a sharply rising intensity of light as the scanners approached the centre. Normal galaxies do show increasing brightness towards the centre, but in the case of M-87, the rise is too sharp to be accounted for by the conventional star-distribution models. When the investigators tried a black hole model, the data fitted well. They assumed a supermassive object of mass of about $5 \times 10^9 M\odot$ within about 300 light years of the centre which, together with a central luminosity source, can account for the sharp peak (a cusp) in luminosity. The authors, however, point out that their black hole does not necessarily mean the relativists' black hole; they define it as a nearly point-like object much smaller than their seeing disc, whereas the relativists' black hole of mass $5 \times 10^9 M\odot$ would have a radius of about 0·0015 light year.

The second investigation used the spectroscopic approach (with the University College, London, image photon counting system). The investigators, W.L.W. Sargent, P. J. Young, A. Boksenberg, K. Shortridge, C. R. Lynds and F. D. A. Hartwick, have converted the spectroscopic data into Doppler radial velocity measurements and measurements of velocity dispersion. Velocity dispersion is expected to increase towards the centre. However, the rise from about 278 km s^{-1} at the core (angular radius = 24·21 cm) to the central region (angular radius = 3·8 cm) value of 350 km s^{-1} was so rapid that again only a supermassive object could account for it. What is interesting is that the estimate and location of this object given by the second group agree with those given by the first group.

The mass-to-light ratio also rises rapidly at the centre, corroborating the existence of a supermassive object there. Both the groups agree that the data seem to fit with the supermassive/black hole interpretation better than with any other theoretical scenario so far thought of.

Data-starved black hole physicists may take this as a *conclusive proof* and press their bandwagons ahead. The second group cautions : " It is not possible to prove from our data that this object is a black hole. " Thus,

very careful and accurate though these observations are, the 'proof' is still elusive. There is hope, though (as the second group points out), of improving the data when the space telescope is launched soon.

J. V. NARLIKAR

[Dr. Narlikar is Professor of Astrophysics at the Tata Institute of Fundamental Research, Bombay.]