COSMOLOGICAL IMPLICATIONS OF THE OBSERVED ANGULAR SIZES OF EXTRA-GALACTIC RADIO SOURCES

Vijay K. Kapahi

Radio Astronomy Group, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005

Observations of lunar occultations at Ootacamund have been used to derive angular sizes of a large number of extragalactic radio sources, in the flux density range of about 0.25 to 5 Jy (1 Jy $=10^{-26}$ W m^{-2} Hz^{-1}) at 327 MHz, thus extending the size information to sources an order of magnitude weaker than have been studied hitherto by interferometry. The cosmological implications of the angular size data have been investigated using (i) the log N-log θ relation, where N is the number of sources with an angular size greater than a value θ, for the complete sample of 3CR sources and (ii) the observed relation between θ_m (median value of θ) and flux density (S), over a range of about 300 : 1 in S, derived by combining the Ooty data with data from surveys of stronger sources. The principal conclusions of our study can be summarized as follows :

(1) The log N-log θ relation for values of $\theta \geqslant 100''$ arc, depends strongly on the radio luminosity function and is practically independent of the cosmological world model and the distribution of actual source sizes. In the luminosity range of about $10^{23} \angle P_{178} \angle 10^{26}$ W Hz^{-1} ster^{-1}, the local luminosity function is derived to be of the form $\rho(P) \propto P^{-2.1}\, dP$, in good agreement with the conventional determinations based on measured redshifts or optical magnitudes of identified radio galaxies.

(2) The angular size data are incompatible with a uniform distribution of sources in reasonable world models, and provide independent evidence of strong evolutionary effects in source properties with cosmic epoch. It is hard to explain the data on the simple steady state theory.

(3) It is found that the local luminosity function must steepen considerably for $P_{178} \geqslant 10^{26}$ W Hz^{-1} ster^{-1}, and evolution is required both in the space density and in source sizes with epoch. The simplest evolutionary scheme, that fits the data, suggests density evolution for high luminosity sources of the form $\sim (1+z)^{5.5}$ and size evolution of the form $\sim (1+z)^{-1}$.

(4) Similar evolutionary effects appear to exist in QSOs as well as radio galaxies.

THE GRAVITATIONAL SEARCHLIGHT EFFECT

S. M. Chitre and J. V. Narlikar

Tata Institute of Fundamental Research, Bombay 400 005

and

R. C. Kapoor

Indian Institute of Astrophysics, Hebbal, Bangalore 560 006

The gravitational redshift of the radiation emitted by charged particles following orbits very close to the null ray orbit ($a=3m$, $m=GM/c^2$, $M=$mass of the central black hole) about the black hole may appear to be overcome by the Doppler blueshift to a distant observer ($r \gg R_s$) situated in the plane of the orbit whenever the forward cone of radiation sweeps past him. The frequency shift has been calculated in the Schwarzschild geometry with signature $+ - - -$ for the $\theta=\pi/2$ orbits within $3m \leq r \leq 3m(1+\delta)$ where $\delta \ll 1$ (Chitre et al., Nature, **252**, 460, 1974). In the limiting case $\delta \rightarrow \theta$ i.e. $r \rightarrow 3m$ the blueshift diverges according to

$$1+z \simeq \tfrac{2}{3}\, \delta^{-\frac{1}{2}}$$

Freely falling matter with some angular momentum relative to the central object will spiral round the object many times before the splashdown. Radiation emanating from a ring, consisting of such particles near the null ray orbit, is then seen to obey a power law of the from

$$F_\nu \backsim \nu^{-1}$$

The ν^{-1} dependence of the continuous spectrum resulting from purely geometric consideration has wide applications in astrophysics. For instance, a ν^{-1} spectrum is common to numerous extragalactic objects and QSOs.

MOTION OF SPINNING PARTICLES IN RELATIVITY

Eric A. Lord

Division of Physics & Mathematical Sciences, Indian Institute of Science, Bangalore 560 012

and

Ramesh Chander Kapoor

Indian Institute of Astrophysics, Hebbal, Bangalore 560 006

The generalization of Einstein's theory of gravitation due to Cartan incorporates torsion terms into the field equations of general relativity and was later independently worked out by Kibble and Sciama. We have shown that the equations of the Kibble-Sciama theory lead to the equations of motion of spinning particles in a curved space similar to those obtained earlier by Papapetrou. In addition, in a de Sitter space, rest mass and spin of a particle are not separately constant. It is the Casimir operators of the de Sitter group I_1 and I_2 which are constants of motion.