SUB-LUMINAL MOTIONS IN THE NUCLEUS OF M 87 +

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We have observed the nucleus of the elliptical galaxy M87 with VLBI arrays at 18 cm wavelength at two epochs separated by about two years. The results of the first epoch observations taken at 1980.12 are described in detail by Reid et al (1982, Ap. J. 263, pp 615-623). They indicated that the nucleus of M87 exhibited a highly asymmetric emission pattern with a bright "core" and long, thin "jet" extending for more than 0.05 arcsec towards the 20 arcsec jet seen in radio, optical, and X-ray radiation. This morphology is remarkably similar to that seen in the quasar 3C273. Asymmetric core-jet structures, possibly coupled with super-luminal motions as in 3C273, have been interpreted in the framework of relativistic beaming models (cf. Blandford, Mckee, and Rees: 1977, Nature 267, pp 211-216). Therefore, we conducted second epoch observations of M87 at 1982.27 to look for such motions.

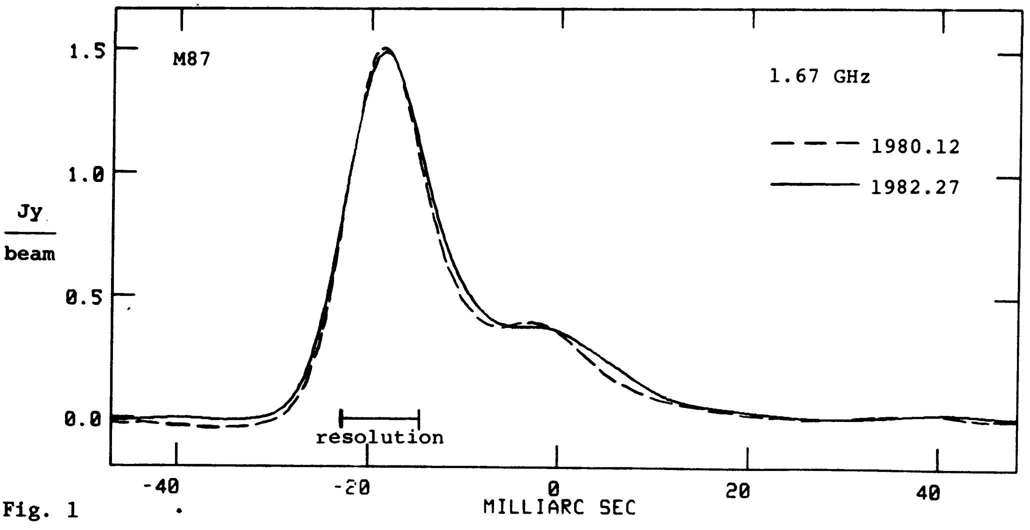

Fig. 1

+ Discussion on page 437

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Our maps of the nucleus of M87 for the two epochs are remarkably similar. In Figure 1 we present the intensity of the emission seen in our maps along the position angle of the jet (288° E of N). While the emission from the second epoch appears slightly more extended than from the first epoch, the differences are probably not significant at the two-sigma level. We estimate any component expansion to be < 0.5 milli-arcsec/year, which corresponds to < 0.2 c. Under the simplest assumptions, the absence of a detectable counter-jet requires that the ratio, R, of the observed intensity of the jet and counter-jet is given by

$$R > [\ (1+\beta\cos\theta)\ /\ (1-\beta\cos\theta)\ ]^{2.5} \qquad (1),$$

where β is the flow speed of the jet in units of c and θ is the angle the jet makes to our line-of-sight. Our limit on relative proper motions, β_{ob}, of components in the jet requires that

$$\beta_{ob} < \beta\ \sin\theta\ /\ (1-\beta\cos\theta) \qquad (2).$$

As shown in Figure 2, most of the parameter space for θ (plotted in equal solid angle intervals) and β are excluded by relations (1) and (2).

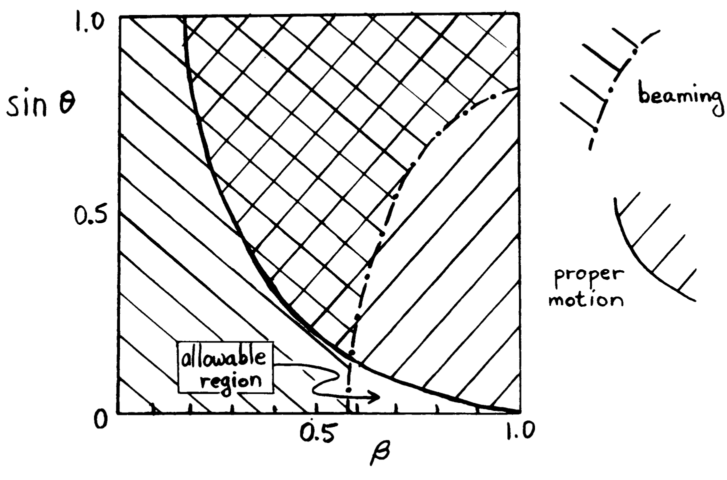

Fig. 2

Therefore, the most straight-forward implementation of a beaming model appears unlikely to hold for M87. However, some reasonable combinations of β and θ are still allowed and we cannot exclude these possibilities at this time.

Alternatively, it may be that the simple beaming model requires alteration to allow for smooth jets with relativistic flows but stationary apparent images. This would require jets which do not form a small number of discrete condensations, and whose central energy source is very stable. Finally, were jets intrinsically one-sided, there would be much greater freedom in choosing β and θ. This possibility deserves further study.

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