SUPERLUMINAL EXPANSION OF THE QUASAR 3C 345

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VLBI hybrid maps of the compact radio structure in 3C 345 at 5.0 and 10.7 GHz show a core-jet morphology, with two components in the jet separating from the core with apparent transverse velocities $\simeq 8/\underline{h}$ c (for $H_o = 100\ \underline{h}$ km/s/Mpc and $q_o = 0.05$). These "knots" decay as they move down the jet, with lifetimes $\simeq$ 2 - 3 years.

We have been monitoring the structure of 3C 345 at 5.0 and 10.7 GHz using arrays of 4 and 5 telescopes, at approximately 6-month intervals beginning in 1977. Hybrid maps (Readhead and Wilkinson 1978) were made from each observation, and excellent fits to the visibility amplitudes and closure phases were obtained. Since 1979, the increased angular resolution provided by the telescope at Effelsberg FRG has enabled individual components in the jet to be mapped at 5.0 GHz for the first time. At most epochs the source comprised a dominant compact core, with a curved one-sided "jet" extending to the west. Any compact emission on the eastern side is at most 5% of the core. The hybrid maps show very clearly that the jet is curved, with the innermost parts of the jet in P.A. -85°, and the outer components in P.A. -73°. The jet continues to bend out to $\simeq$ 2 arcsec (Cohen and Unwin 1982), although most of the rotation occurs within a few milliarcsec (mas) of the core.

Figure 1(a) shows 5.0-GHz profiles along the jet of 3C 345. It illustrates the triple structure found at most epochs, and the expansion of the two jet components relative to the core. These knots decay as they move out, with half-lives $\simeq$ 3 years at 5.0 GHz and $\simeq$ 1 year at 10.7 GHz; the spectrum of a knot steepens with time from $\alpha \simeq -0.5$ at the point where it is resolved from the core to $\alpha \simeq -1.0$ at the sensitivity limit. Figure 1(b) shows the increasing separation of the knots from the core with time; there is no significant difference in the slopes: 0.33 ± 0.07 mas/yr beginning in 1975.2 ± 1.0 for the inner knot, 0.39 ± 0.07 mas/yr beginning in 1969.5 ± 1.9 for the outer. If the implied expansion speed of $\simeq 8/\underline{h}$ c is the result of relativistic beaming (Scheuer and Readhead 1979) then the jet must lie within 6° of the line of sight. There were no obvious features in the flux-density

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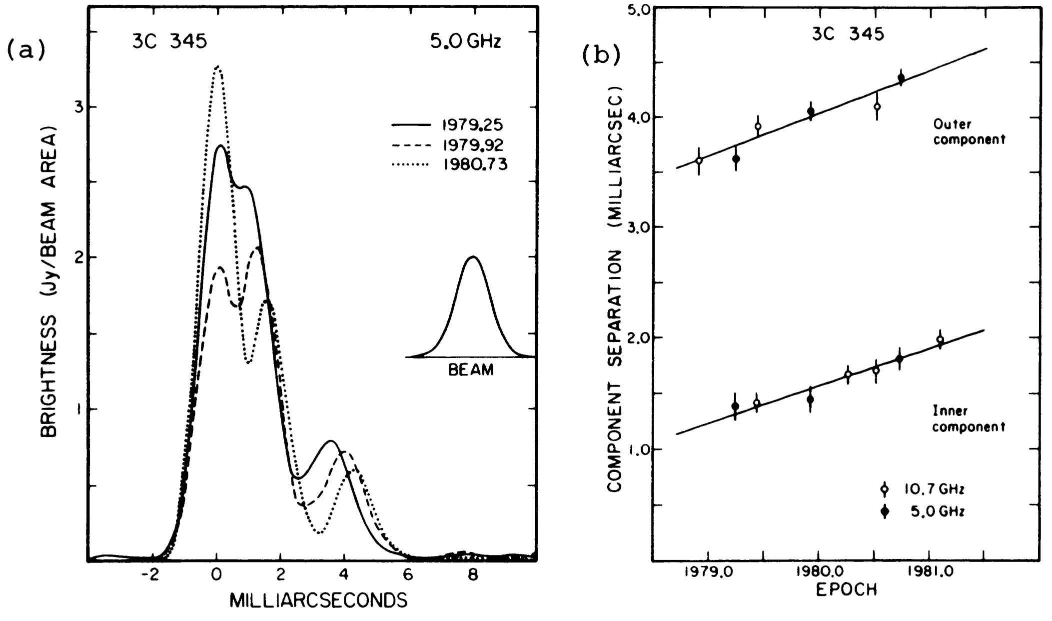

Figure 1. (a) Profiles across the 5.0-GHz hybrid maps of 3C 345 in P.A. -78°. Zero separation is taken as the eastern "core", to which the profiles are aligned. The restoring beam is a Gaussian with FWHM 1.2 mas; 1 Jy/beam area = 3 x 10^{10} K. (b) Core-knot separations as a function of time, measured directly from hybrid maps. The estimated error bars allow for finite dynamic range and resolution of the components. Straight lines represent least-squares fits to the expansion.

history of 3C 345 at the extrapolated epochs of zero separation. The spectrum of a knot probably evolves rapidly at first, delaying its contribution to the total flux. There is no evidence for acceleration during the period in which these knots have been monitored. The component separations are frequency-independent, and hence there are no strong spectral gradients across a knot.

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