EVOLUTION OF THE COMPACT RADIO SOURCE 3C 345

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The quasar 3C 345 is recognized as a strong, variable, superluminal radio source, an optically violent variable, and a weak X-ray source. We present results of VLBI monitoring between 1979 and 1984 at 2.3, 5.0, 10.7, and 22.2 GHz using antennas of the U.S. and European VLBI Networks. These results are interpreted in terms of a relativistic jet model (Biretta 1985; Biretta *et al.* 1986).

Maps made at 22.2 and 10.7 GHz show development and position angle changes of the new superluminal component C4. The 10.7 and 5.0 GHz maps show superluminal motion of C2 and C3, and they also show curvature of the jet.

Positions of component centroids relative to the "core" (component D) were determined by modelfitting and are shown in Figure 1. The new component C4 (Biretta *et al.* 1983; Moore *et al.* 1983) changes position angle from $-135°$ to $-87°$ as it moves away from the core. Components C3 and C2 are at position angles $-86°$ and $-74°$, respectively, and the 3-arcsecond jet has a position angle of $-30°$. The jet curvature cannot be explained as precession of the central engine; this mechanism cannot account for the position angle change of C4. Furthermore, the curvature between C3 and C2 would require a precession period too short to be explained by known mechanisms. The observed curvature may however be caused by pressure gradients in an external atmosphere if there is pressure balance. Component C5 is a westward extension from the core visible after 1982. Its position angle, $-90°$, indicated that either the jet does not have a fixed path near the core, or more likely, that components initially fill only part of the jet's width.

Component C4 accelerates from $v/c = 1.3$ to 6.5 ($H_0 = 100$). This may reflect a true acceleration, but part or even all of it may be due to bending of the jet away from the line of sight, which can produce an apparent acceleration while the intrinsic velocity remains constant. Component C3 moves with $v/c = 6$ but C2 is faster with $v/c = 9$, which requires a Lorentz factor > 10 and an angle between the jet axis and the line of sight $< 12°$. Both C4 and C3 are systematically farther from the "core" at higher frequencies.

The core and C4 have flat spectra which fall off sharply below 5 GHz, while the spectra of C3 and C2 are steep. The flux decay of C3 is too slow to be explained as adiabatic expansion, and too rapid to be explained by synchrotron radiation losses.

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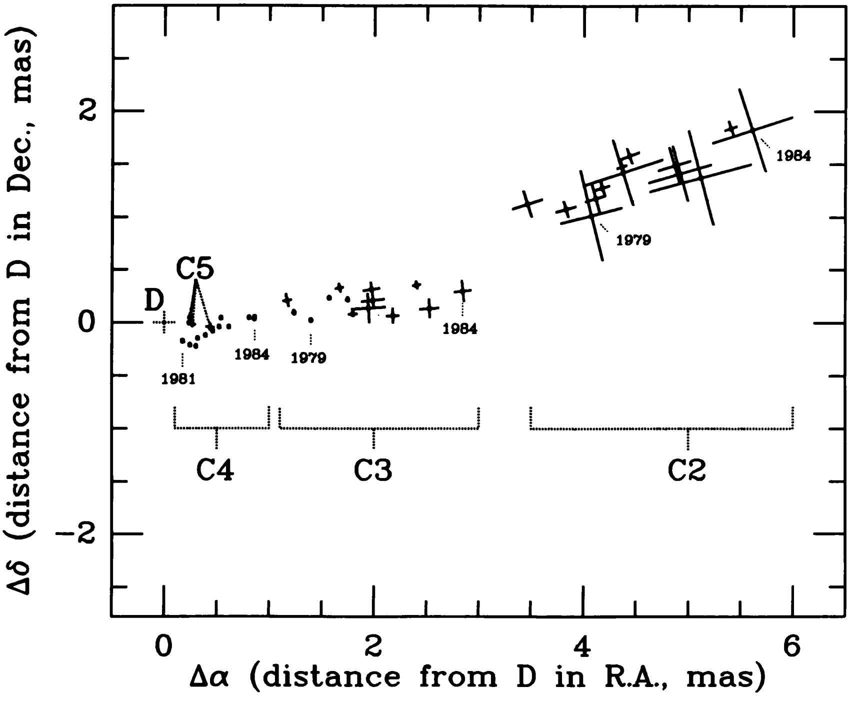

Synchrotron-Compton models for the superluminal components require minimum relativistic Doppler factors of 7, 3, and 5 for C4, C3, and C2, respectively, to explain the weak X-ray flux. The energy density of the electrons is greater than that of the magnetic field, unless the Doppler factor exceeds 15. The observed self-aborption turnovers for C4, C3, and C2 indicate that the magnetic field falls off approximately inversely with distance along the jet.

For component D we have applied a conical jet model with magnetic field $B \propto r^{-1}$ and electron density $n \propto r^{-2}$, where r is distance along the jet. This model requires the jet axis to be within 8° of the line of sight, and gives a Doppler factor of 7. It predicts frequency dependent shifts in the position of D which agree in both sign and magnitude with the shifts observed between D and C4, and D and C3.

REFERENCES

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