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Superluminal Motion in the Gamma-Ray Blazar 3C 279

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Abstract. The blazar 3C 279 is one of the strongest extragalactic sources of γ-rays, and is also one of the best studied superluminal radio sources. Definitive testing of models of the broad-band spectral energy distribution, especially in the X-ray and γ-ray regions requires knowledge of the evolution of the spectrum with time. Within the context of the relativistic jet model, multi-wavelength monitoring of the parsec-scale radio jet is also required. We present here the first steps toward such a test, using extensive VLBI monitoring over a 13 year interval at 22 GHz, and γ-ray observations between 1991 and 1996.

1. VLBI Images of the Jet in 3C 279

The blazar 3C 279 ($z = 0.538$) has been the focus of one of the most extensive campaigns of monitoring with VLBI, covering the frequency range 5–43 GHz. Routine monitoring at 43 GHz, made possible by the NRAO VLBA, began in 1995. The most extensive dataset is a series of 18 images at 22 GHz, spanning the period 1984.75–1997.04. Figure 1 shows this series, omitting four additional images from 1984–1988, for which the time-sampling of the jet evolution is poor. Previous VLBI monitoring results are given by Wehrle et al. (1996). Points to notice: (1) the outermost component, moving at 4.3 $h^{-1}c$ is extremely long-lived, showing no sign of fading after 13 years. (2) This component has a flat spectrum, as it shows strongly on 43-GHz images. (3) Even with dense time-sampling, structure variations near the core are complicated, apparently with a shorter timescale than the evolution farther out.

During multiwavelength monitoring in Jan-Feb 1996, 3C 279 reached its highest recorded level in γ-rays (Wehrle et al. 1997). A new component may have emerged from the core near that epoch - this component is well separated in the final epoch image (1997.04), but further monitoring is required to confirm its emergence in early 1996. The 1991 flare (Hartman et al. 1996) may be associated with blob that emerged from the core in mid-1991. Thus the evidence for associations is tentative, and likely to remain so until more is known about the long-term behavior of the source in γ-rays.

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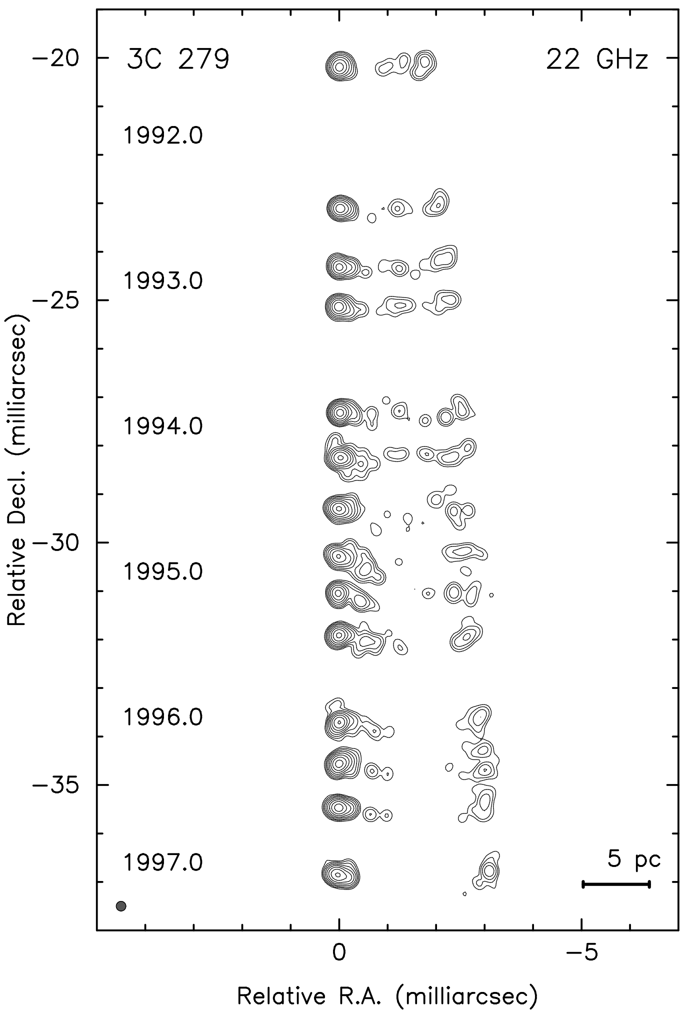

Figure 1. Multi-Epoch VLBI imaging of 3C 279 at 22 GHz (Wehrle et al. 1997). Vertical displacement is proportional to observing epoch (1 year ≡ 3 mas). Images were rotated 30°, to align the jet horizontally. Contours are in factors of 2, starting at 75 mJy/beam. Restoring beam is 0.2 mas (dot at lower left); the resulting super-resolution implies that north-south structure, perpendicular to the jet direction, is poorly constrained.

References

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