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The Slow Jet in the Nucleus of 3C 84

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Abstract. We report on proper motions in the core, jet, and counter-jet of 3C 84, monitored by the VLBA at 2cm and 7mm.

We have used the VLBA to image NGC 1275 (3C 84) at multiple wavelengths, to study the free-free absorption from a putative obscuring disk, (see Walker et al., these Proceedings, p. 133) and to follow the previously reported subluminal motions (Romney et al. 1995; Krichbaum et al. 1992). We summarize the structural detail and proper motion seen in the 15 & 43 GHz subset of images, with angular resolution about 0.6 & 0.15 mas respectively. (We adopt $H_\circ$=65 km s^{-1} Mpc^{-1}, so 1 mas = 0.4 pc, and 1 mas/yr = 1.25 c, at a distance of 80 Mpc.)

On scales of 0.05–5pc, we see with great clarity (Fig. 1A): a bright and complex central core; a southern cocoon-like "expanding bubble"; a faint, thin jet connecting the core to the bubble; and an inverted spectrum northern "counter-feature", taken to be the counter-jet.

From 43 GHz images in January, 1995, October, 1995, and September, 1996, we report that the inner parsec of the core (Fig 1B) has bright knots of emission along a line with multiple sharp bends, as if sprayed from a precessing nozzle with a full opening angle 40°. Components move at 0.05c, 0.08c, and 0.2c (±0.03c), for components at increasing distances from the core, indicative of acceleration in the first parsec along the jet. However, there are rapid and progressive flux changes in these slow-moving knots, corresponding to a "phase velocity" of 0.9±0.1c.

Analyzing the 15 GHz images from January, 1994, January, 1995, October, 1995, and September, 1996, we conclude that the "bubble" continues to move south relative to the core, at 0.5c±0.1c, consistent with the uniform motion seen since its ejection in the flux outburst starting around 1960. The counter-jet moves north relative to the core at 0.3±0.1c. The jet/counter-jet velocity ratio agrees roughly with their separations from the core.

Further monitoring is expected to refine the constraints on $\beta \cos\theta$ from proper motions & flux ratios, and address such questions as: Is the fluid motion ballistic or along a helical channel? Do individual plasma blobs survive the sharp bends? What is the physical nature of the transition region where the jet apparently accelerates to its terminal velocity of 0.5c? Which components are moving? Is there a counter-jet in the core?

From October, 1995 onward, we began phase-referencing to a calibrator 1.2° away, in an ongoing attempt to get astrometric component locations at both frequencies.

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References

Krichbaum, T. P., et al. 1992. *A&A*, **260**, 33–48.
Romney, J. D., et al. 1995. *Proc. Natl. Acad. Sci. USA*, **92**, 11360–11363.

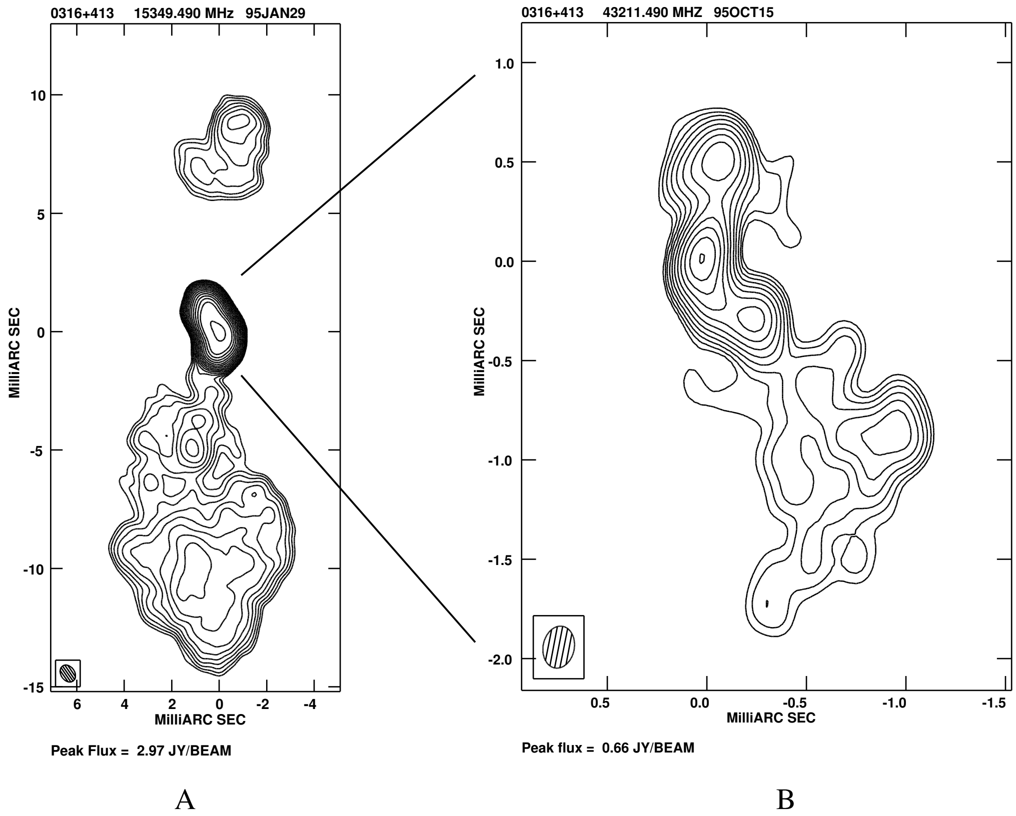

Figure 1. **A:** 15 GHz image of 3C 84 from January, 1995. Contours=(−10, 10, 14, 20, ... 2560)mJy/beam; rms=0.33mJy/beam; beam=0.77x0.58mas. **B:** 43 GHz image of 3C 84 from October, 1995. Contours=(−20, 20, 28, 40, ... 640)mJy/beam; rms is 0.8mJy/beam; beam=0.2x0.15mas.