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# VLBI Observations of Supernova 1993J: The First 1000 Days

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**Abstract.** We report on phase-referenced 5 and 8.4 GHz VLBI images of supernova SN 1993J in M81, tracking the evolution of the source from 50 to 1000 days after the explosion.

VLBI images of supernova SN 1993J in M81 from 50 to 1000 d after shock breakout (Figure 1) show an expanding shell with an increasingly complex brightness distribution (see also Bartel et al. 1995, Marcaide et al., these Proceedings, p. 353, and references therein). The shock is decelerating, with the radius $\Theta \propto t^{0.837\pm0.025}$. Combining this result with model fits to the radio light curve (Van Dyk et al. 1994) gives a power-law index for the circumstellar density profile ($\rho \propto R^{-b}$) of $b = 1.69^{+0.10}_{-0.23}$ which is consistent with equipartition and supported by X-ray observations. Phase-referencing with respect to the nucleus of M81 (cf. Bietenholz et al. 1994, 1996, these Proceedings, p. 201) suggests that the center of the shell is offset slightly from the origin of the explosion, although the shell itself remains highly circularly symmetric (cf. Bartel et al. 1994a, b, Rupen et al. 1994). In the 8.4 GHz image from 17 December 1995 we find enhanced emission near the explosion center; however the corresponding 5 GHz image shows no such enhancement, and any central source if present at other times must be considerably fainter. It is intriguing that spectral index maps made from 5 and 8.4 GHz data show a consistently flatter spectrum towards the center than around the rim of the shell. Finally, data taken at 5 and 8.4 GHz on 10 May 1995 set limits to the linear polarization of 10% at both frequencies on scales of 1 mas ($5 \times 10^{16}$ cm), suggesting that either the magnetic field is tangled on such scales or the material along the line-of-sight depolarizes any initially-aligned emission.

These observations provide a detailed picture of the evolution of a radio supernova from birth to the present. With phase-referencing, we should be able to continue to image this source for several years at 8.4 GHz and even longer at lower frequencies.

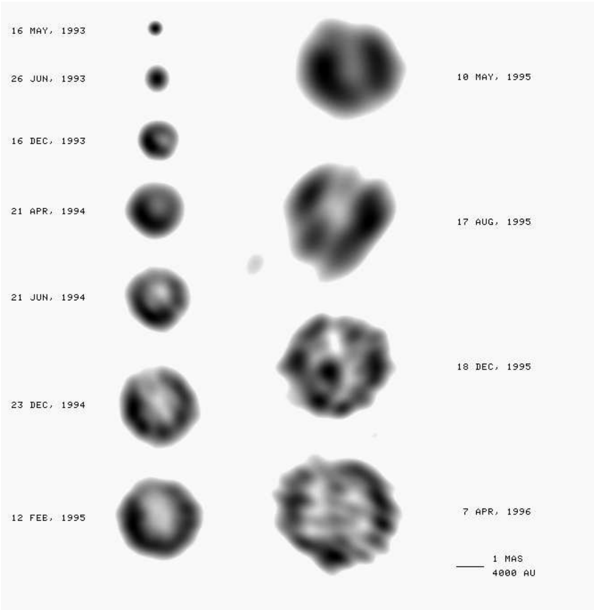


**Figure 1.** Images of SN 1993J at 8.4 GHz, phase-referenced to the core of M81. The relative position of the 10 May 1995 image is arbitrary. The CLEAN/MEM models were restored using a Gaussian beam with a typical width of 0.6 mas. The total flux densities range from $\sim 90$ to $\sim 20$ mJy, with peak intensities between $\sim 90$ to $\sim 1$ mJy/beam. The rms background noise is $\sim 0.05$mJy/beam.

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