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The Core-Jet Radio Source in the Center of M81

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Abstract. The spiral galaxy M81 hosts the closest extragalactic AGN besides that in Cen A that can be imaged with VLBI. Ground and Space-VLBI observations have shown that M81's center consists of a stationary core and a short, jittery, one-sided jet. The jet appears wavy, reminiscent of a helical structure. The central engine of M81 has qualitative similarities to those of powerful AGN of radio galaxies and quasars, and may represent a scaled-up version in power and size of the largely hidden nucleus of our own Galaxy.

Twenty-three VLBI observations were made from 1993 to 2000 using between 11 and 18 telescopes with a total time of 12 to 18 hours for each run (Bietenholz, Bartel & Rupen 2000). M81*, the nucleus of M81, was observed as a phase reference source for the continuing multi-frequency program of VLBI observations of SN1993J, located $\sim 170''$ away towards the south south-west in a spiral arm of the galaxy (Bartel et al. 2000). In addition space VLBI (VSOP) observations were made in 1998 and 1999.

M81* is extremely compact. Figure 1 (left) shows the source when it appeared most extended at 8.4 GHz, $\sim$ 8000 AU at the lowest contour taking the distance to be 3.63 Mpc (Freedman et al. 1994). When modelled as an elliptical Gaussian and a point source (crosses in Figure 1, left) the position of the point source w.r.t. the geometric center of the radio shell of SN1993J jitters over the course of 7 years by $\sim$ 0.7 mas or 2500 AU (Figure 1, right). The position of the Gaussian is more stable. The most stable point is located $\sim$ 0.3 mas south-west of the Gaussian and is stationary to within 720 kms^{-1}. This is most likely the core of M81* and probably also the gravitational center of the galaxy.

VSOP 5 GHz observations with HALCA and 12 ground stations resulted in the map shown in Figure 2 (see also Bartel & Bietenholz 2000). The structure is wavy, changing its orientation over 3.5 mas from about 70° for the dominant component to about 60° and back to 70° for the structure further to the north-west. The wavy structure probably starts close to the stationary core, with a p.a. from the 8.4 GHz data of about 55-60° and oscillates in its orientation along the jet with a period of about 2 mas or 7000 AU. A wavy structure may indicate a helical jet emanating from the vicinity of an accretion disk and a black hole. In terms of the length of the jet and its luminosity, M81* appears to be a scaled-down version of the core of radio galaxies and quasars — but probably a scaled-up version of the nucleus of our own Galaxy, Sgr A*.

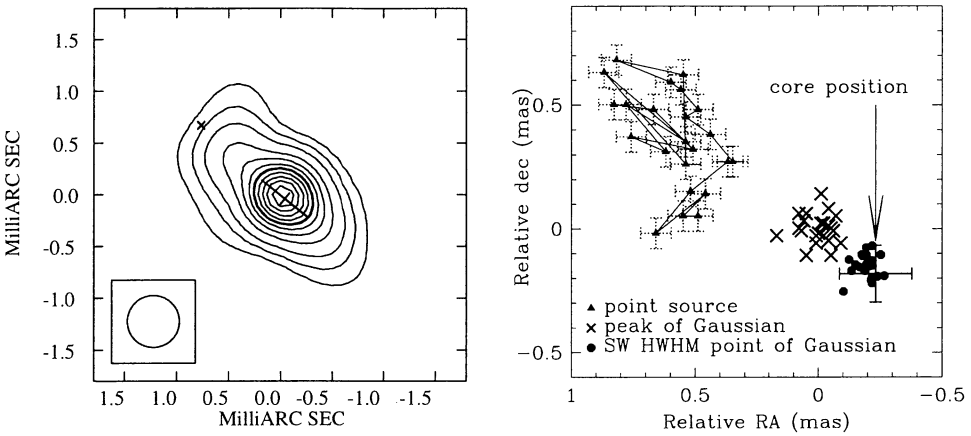

Figure 1. Left: CLEAN image of M81*, 1995 May 11, 8.4 GHz. The contours are at 2, 5, 10, 20, ..., **50**, ..., 90% of the peak brightness of 99 mJy/beam. North is up, east to the left. Right: Positions at each epoch of three points in the two-component model plotted w.r.t. the geometric center of the model radio shell of SN1993J. Uncertainties are standard errors. For more information, see Bietenholz et al. (2000).

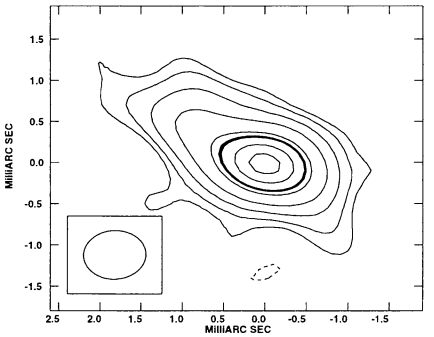

Figure 2. CLEAN image at 5 GHz from the VSOP data set. The contours are at −2.5, −5, 5, 10, 20, 30, **50**, 70, 90% of the peak brightness of 75 mJy/beam. North is up and east to the left.

References

Bartel, N., et al. 2000, Science, 287, 112

Bartel, N. & Bietenholz, M. F. 2000, in Astrophys. Phenomena Revealed By Space VLBI, ed. H. Hirabayashi, P. G. Edwards & D. W. Murphy (ISAS), 17

Bietenholz, M. F., Bartel, N., & Rupen, M. P. 2000 ApJ, 532, 895

Freedman, W. L., et al. 1994, ApJ, 427, 628

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