HIGH DYNAMIC RANGE MAPPING OF A COMPLEX RADIO SOURCE - M87

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The well known jet in M87 (Virgo A) has been extensively studied in the radio regime using conventional arrays with resultant resolutions in the range 0.22-1 arcsecond. We present here the results of a VLBI experiment to map the jet over its entire length (30 arcseconds) to high resolution. The observations were made in April 1984 at 1.67 GHz with a 'World Array' containing 18 VLBI telescopes. In addition, simultaneous observations were performed with the 6 station MERLIN array.

The spatial frequency coverage together with surface brightness constraints and computational limitations have restricted the use of the full resolution data set (5 mas) to the inner few arcseconds. The full (∿30 arcsecond) jet can be studied at 75 mas resolution: and for this image we have used only the data from the MERLIN and European stations. The data were globally fringe-fitted and calibrated within the AIPS package. Subsequent telescope phase and gain corrections were performed with the difference-mapping program (1) of the Jodrell Bank OLAF system. This method provides a saving in computational resources by Fourier transforming only the difference between the current source model structure (the transform of the clean components) and the corrected UV data set. New clean components are obtained from this residual map and are then added into the current model. A full transform of all the clean components at each correction cycle is thus avoided. Telescope corrections are made in the usual way (2) every cycle. Interactive graphics facilitate user control at each major cycle; thus regulating the growth of the model structure where required. The corrected data were then mapped within the AIPS package to provide a new starting model for further difference-mapping cycles. Finally, the data were corrected for non-closing (baseline) errors. The overall mapping scheme is shown in Figure 1.

Figure 2 shows a contour plot of M87 at 1.67 GHz with a FWHM beam size of 75 mas. Detailed structure within the knots can be seen. The transverse ridge structure of knot A is clearly visible and is suggestive of an oblique shock. The deconvolved thickness of the leading edge is ∿160 mas, and that of the more complex trailing edge 300-400 mas; similar to those values found in the 15 GHz VLA image (3). Knot I, immediately preceding A, appears to be a precursor and is joined to A

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by a 'cone' of emission. Knot D is extended transverse to the jet with a deconvolved width of ∿200 mas, consistant with a constant jet opening angle between the core and knot A. Knot B, which follows Knot A, is complex in form although there is some suggestion of helical structure.

The features in the jet have in the past been explained in terms of shocks and Kelvin-Helmholtz instabilities. However, it is clear that the structure is so complicated that neither of these explanations can alone be responsible for the observed morphology.

(1) Cornwell, T.J. & Wilkinson, P.N., 1983 'Indirect Imaging', ed. J.A. Roberts, Cambridge University Press.

(2) Cornwell, T.J. & Wilkinson, P.N., 1981. Mon.Not.R.astr.Soc., 196, 1067.

(3) Biretta, J.A. Owen, F.O. & Hardee, P.E., 1983. Astrophys.J. 274, L27.

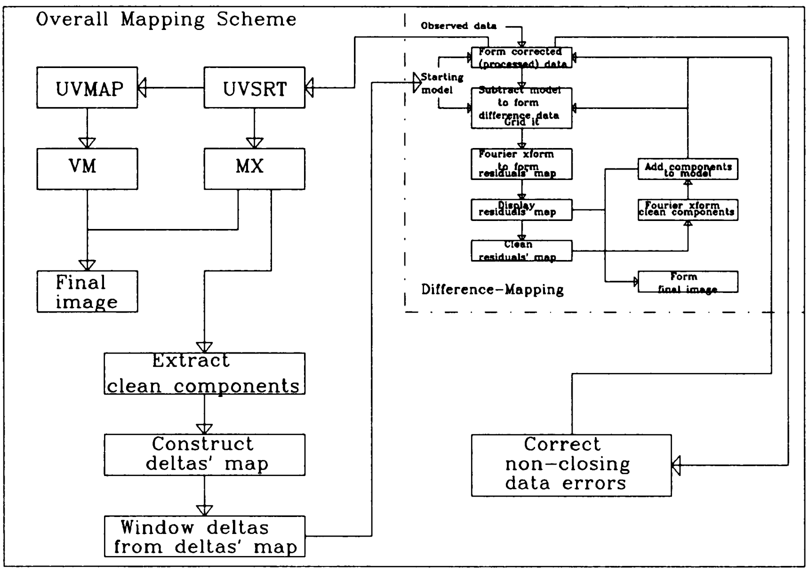

Figure 1 (left)

Figure 2 (below)

Virgo A (beam=75mas)

Peak=0.364 Jy/pixel

pixel spacing=25mas

Contour values:

1,2,3,4,5,6,7,8,9,10,11,12

13,14,15,16,17,18,19,20

50,100,200,500,800

x 200uJy/pixel