Bull. Astr. Soc. India (2003) **31**, 433–435

Magnetic Field Geometry of 3C111 on pc-scales

P. Kharb[1,*], D. Gabuzda[2,3], P. Shastri[a]
[1]*Indian Institute of Astrophysics, Bangalore-560 034*
[2]*Physics Department, University College Cork, Cork, Ireland*
[3]*Astro Space Center, Lebedev Physical Institute, Moscow, Russia*

Abstract. Multi-epoch Very Long Baseline Polarimetric observations of the Broad Line Radio galaxy 3C111 performed at 8 and 43 GHz after a large millimetre outburst, reveal rapidly evolving parsec-scale radio structure and the corresponding evolution of the magnetic field geometry.

1. Introduction

The broad-line radio galaxy 3C111 (0415+739) is the nearest (z = 0.0485) classical FR II radio galaxy with a strong compact core at cm/mm wavelengths (Wills 1975). Following a large mm-outburst (Alef et al. 1998), multi-epoch Very Long Baseline Interferometric (VLBI) observations of the source were made using a network of the 10 Very Long Baseline Array[1] (VLBA) antennas and the 100 m Effelsberg antenna in dual-polarization mode at 8 and 43 GHz in 1996, 1997 and 1998. A preliminary analysis of the total intensity and polarization images for the July and September, 1996 observations was presented by Alef et al. (1998) and Kharb et al. (2003). We present images from two more epochs, which reveal the evolution of the total-intensity and magnetic-field structure as well as possible Faraday and optical depth effects, based on a comparison of the polarization images at the 8 and 43 GHz.

2. Results

The VLBI images are shown in Fig. 1. The data were convolved with a single synthesis beam at each frequency. Uniform weighting was used.

- The polarization structure is rapidly evolving at both 43 and 8 GHz.

*e-mail:rhea@iiap.ernet.in

[1]The VLBA is run by the National Radio Astronomy Observatory which is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

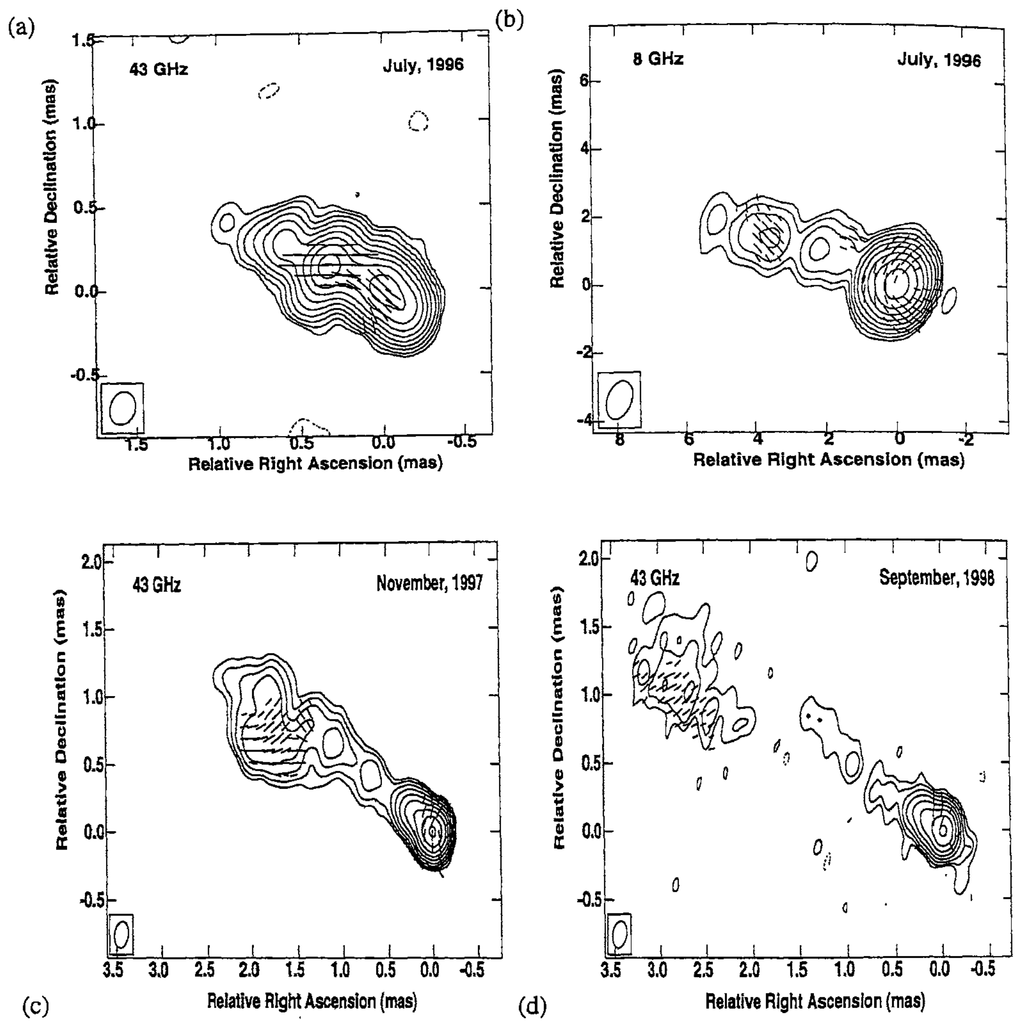

Figure 1. Total intensity maps of 3C111 with χ vectors superimposed. The surface brightness peaks in Jy/beam and the bottom contours in % of the peak are (a) 2.12, ±0.25, (b) 2.16, ±0.25, (c) 1.14, ±0.35, (d) 0.82, ±0.7; successive contours increase by a factor of two. Beams : 0.20 × 0.15 mas (43 GHz) & 1.15 × 0.70 mas (8 GHz) in $PA = -20°$.

- Our preliminary analysis suggests that the proper motion of the bright knot closest to the core as imaged at 43 GHz (at a distance of $r \simeq 0.30$ mas from it in Fig. 1a) is mildly superluminal ($v \simeq 2.1c$, see Fig. 2) which needs to be confirmed by more detailed modelling (1 mas ≈ 0.88 pc, assuming H_0=75 km s^{-1} Mpc^{-1} and q_0=0.5).

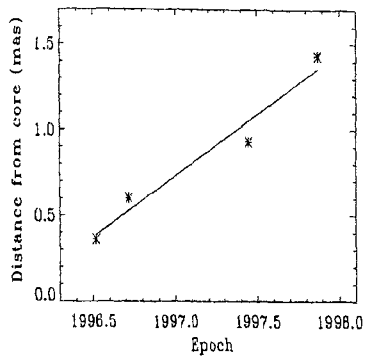

Figure 2. The separation of the bright knot from the core at different epochs.

- If the radio emission is assumed to be optically thin then the inferred B field is perpendicular to the observed orientation of the χ vectors. Assuming that the 43 GHz emission is optically thin, the B field is primarily longitudinal in both the innermost and outermost parts of the jet. In the region of substantial bending at 1–2 mas from the core, however, the B field structure is complex presumably due to a combination of bending (possibly giving rise to shocks) and interaction of the jet with its surrounding medium.
- Our tentative interpretation from the comparison of the multi-epoch dual frequency images is that, for example, in July 1996, the Faraday and/or optical depth effects were dominant at $r \simeq 0.5$ mas from the core but appear to be less important near the inner-jet/core regions. It is possible that the core was optically thick at 8 GHz but optically thin at 43 GHz in November 1997. Thus, the Faraday/optical depth effects are seen to evolve along the jet.

References

Alef, W., Preuss, E., Kellermann, K. I., Gabuzda, D. 1998, in ASP Conf. Ser. 144: Radio Emission from Galactic and Extragalactic Compact Sources, 129–130

Kharb, P., Gabuzda, D., Alef, W., Preuss, E., Shastri, P. 2003, in New Astronomy Reviews, eds. G. Brunetti, D.E. Harris, R.M. Sambruna, and G. Setti, astro-ph/0301065

Wills, B. J. 1975, *Ap. J*, 202, L59