Global Observations of the Unique BL Lac Object 0820+225

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1. Introduction

The object 0820+225 was observed as part of our ongoing study of the 34 sources in the complete sample of BL Lacertae objects defined by Kühr & Schmidt (1990). Although it had not been studied previously using VLBI, it has proved to be one of the most interesting sources in the sample. Our 6 cm global VLBI observations at epoch 1992.23 showed that it has a very rich total intensity (I) and linear polarization (P) structure, with a heavily resolved jet extending more than 30 mas to the southwest (Gabuzda, Pushkarev & Cawthorne 2001). Rather atypically compared to other BL Lac objects in the sample, although a large fraction of its integrated emission is present in the VLBI images, only a small fraction of this emission is present in the VLBI core. The large extent of the source is especially interesting given that its redshift is relatively large for a BL Lacertae object ($z = 0.95$). In addition, later multi-frequency VLBA polarization observations have shown that there are substantial rotation-measure gradients over the length of the jet (Gabuzda, Pushkarev & Garnich, in prep.).

2. Observations and Results

We present here new 6 cm images for two epochs: 1995.36 (a 10-station global array; Fig. 1, top) and 1997.11 (the 10-station VLBA; Fig. 1, bottom). The global array used for the 1995 observations included the Medicina (32 m), Effelsberg (100 m), St. Croix (25 m), Hancock (25 m), Green Bank (43 m), North Liberty (25 m), Owens Valley (25 m), Brewster (25 m), and Mauna Kea (25 m) antennas and the Westerbork phased array ($\sqrt{14} \times 25$ m). The data reduction and imaging were done in the Brandeis VLBI package (1995.36) and the AIPS package (1997.11) using standard techniques. The contour levels in the images shown here increase in multiples of either 2 or $\sqrt{2}$. Note that the superposed polarization sticks have *not* been corrected for the rotation-measure distribution over the source. The restoring beam is shown by a cross or ellipse in a corner of the image.

There appear to be several roughly stationary, long-lived features in the jet: a gap in the jet emission about 8 mas from the core, near the first westward bend; a less pronounced dip in the emission about 7–8 mas further down the jet; and a large, complex, bright knot of emission near the end of the visible jet. The general polarization structure is also similar at the two epochs. The polarization data at epoch 1995.36 are relatively limited, with the result that the sensitivity attained was not sufficient to detect the polarization in the inner part of the jet. It is interesting that the region surrounding the first gap in the jet emission is relatively weakly polarized. In addition, the magnetic field inferred by the observed polarization vectors after correction for the local rotation measure distribution is *transverse* to the jet to the left of this gap (upstream) and predominantly *longitudinal* to the right of the gap (downstream). It seems likely that this change in magnetic field structure is related to this gap in the observed emission, and possibly also to the sharp bend in the jet at this location. The 6 cm images presented here clearly show that the jet continues beyond the bright knot of emission. There appears to be a dramatic change in the polarization structure in this region; we are in the process of a more detailed analysis, taking into account the rotation-measure distribution.

We are currently modelling the I and P structures of the images presented here to estimate possible structural changes and component motions throughout the complex jet structure. A more complete analysis of these 6 cm images, together with the 4 and 2 cm images for epoch 1997.11, is in preparation (Gabuzda, Pushkarev & Garnich, in prep.).

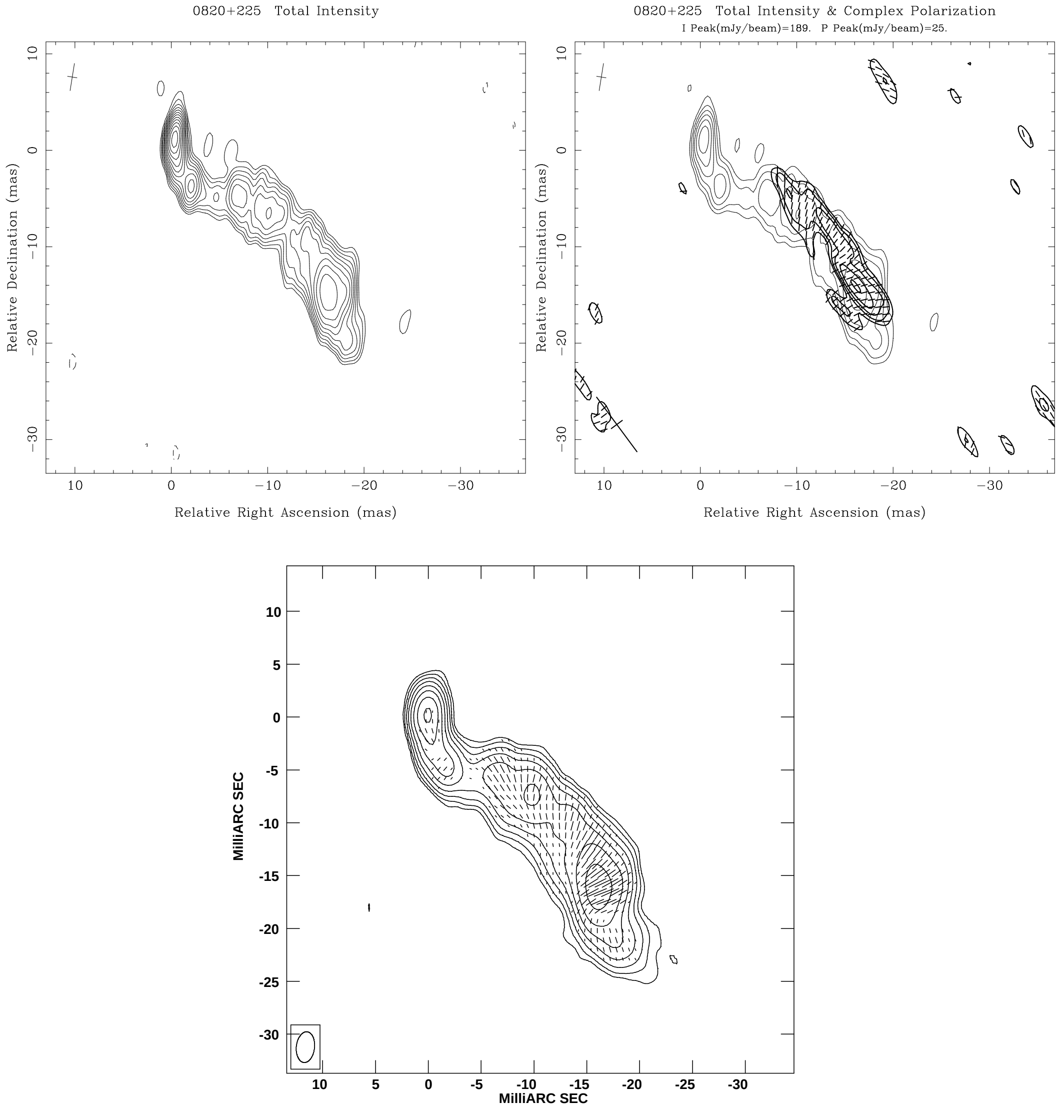

FIGURE 1. Top : Global I map (left) and superposed I and P maps (right) of 0820+225 at epoch 1995.36. The I and P peaks are 190 mJy/beam and 25 mJy/beam, respectively. Bottom: VLBA I map at epoch 1997.11 with superposed polarization vectors. The I peak is 167 mJy/beam.

REFERENCES

GABUZDA, PUSHKAREV & CAWTHORNE 2001, *MNRAS*, in press.

KÜHR & SCHMIDT 1990, *AJ*, **90**, 1.