Astrophysical Phenomena Revealed by Space VLBI
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Polarization-Sensitive VSOP Observations of Bright Quasars and γ-Ray AGN

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Abstract

Polarization-sensitive VLBI is an effective probe of local jet flow and pattern structure via compression or stretching of tangled field lines in shocked or boundary regions in the synchrotron plasma. In sources thought to have jets most closely aligned with our line of sight, projection effects can exaggerate 3-dimensional bending and when combined with aberration, yield complex apparent polarization structure in VLBI images. HALCA represents a unique opportunity to better resolve and model this complex structure at lower frequencies where the jet material remains strong, yet where ground-only VLBI hasn't sufficient resolution. We present some initial results of polarization-sensitive 5 GHz VSOP observations of the bright quasar 3C 345 and the γ-ray blazar 0234+285. Both sources reveal interesting polarization structure which is relevant to jet models.

1 3C 345

The bright quasar 3C 345 has been regularly monitored with VLBI for more than 2 decades (e.g., Lobanov 1996, and references therein), revealing a succession of apparently superluminal components emerging along curved (and different) trajectories. It was one of the first superluminal sources to be monitored in detail with polarization-sensitive VLBI (at 5 GHz, Brown et al. 1994). The 5 GHz VSOP observation presented here was made on July 28, 1998 using HALCA, the VLBA, the phased VLA, and Effelsberg. The total intensity data was shared with the MPIfR collaboration and is described in detail by Klare et al. 2000 (these proceedings). Figure 1 shows our full-resolution total intensity image and the corresponding polarization image. Remarkably consistent with the higher frequency results of Ros et al. (2000), the polarization position angle changes rapidly over inner 2 milliarcseconds, and there

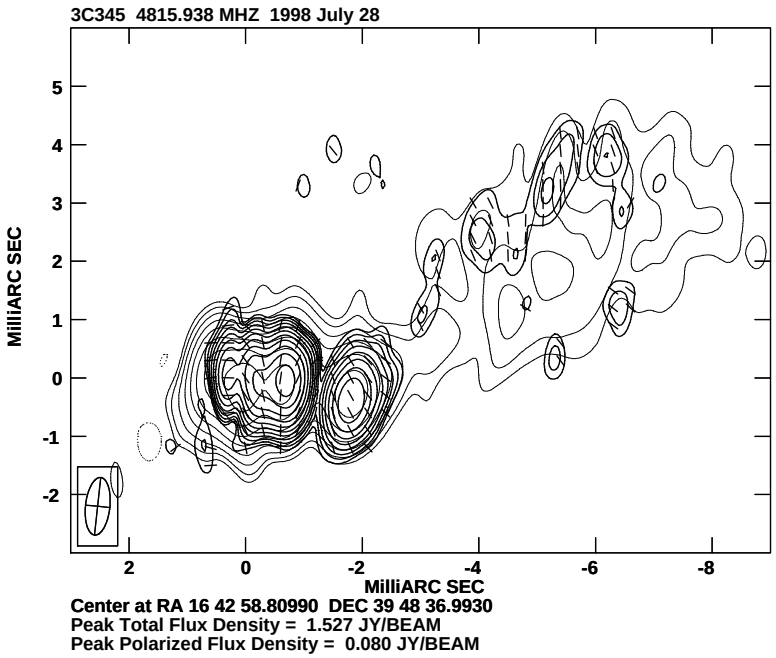

Figure 1: Total intensity (I) and polarization (P) VSOP image of 3C 345. The I contours are spaced by factors of 2, beginning at 7.5 mJy/beam. The P contours (bold) are spaced by factors of $\sqrt{2}$, beginning at 2.1 mJy/beam and the electric vectors are of constant length for clarity.

is significant depolarization within the beam just east of the western-most compact component. The eastern-most polarized component has a transverse inferred magnetic field (assuming the emission is optically thin), consistent with it being a shock newly emerged from the unresolved core. The peak in total intensity does not coincide with a peak in the polarized image, and the fractional polarization increases just downstream of it. An interpretation similar to that of Wardle et al. (1994) for this source, where transverse shocks are postulated to dilute an underlying longitudinal magnetic field, may be applicable. However, the detailed polarization position angle distribution within this region (often oblique), suggests that interpretation exclusively in terms of shocks must invoke the existence of highly projected curvature (observed in the component trajectories), opacity effects, or Faraday rotation (Taylor 1998 measures integrated rotation measures in this region consistent

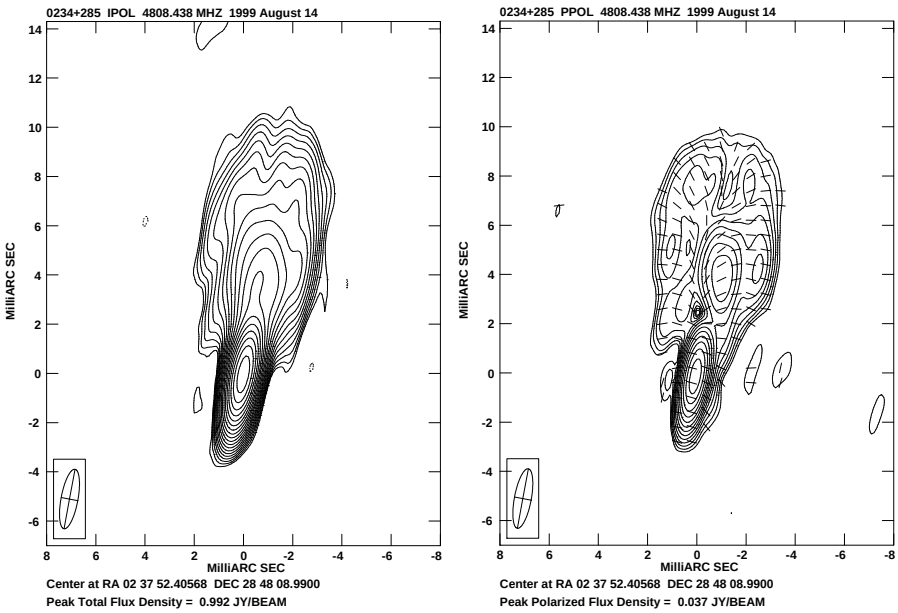

Figure 2: Total (left) and polarized (right) intensity images of 0234+285. The minimum contours are 1.5 mJy/beam and 0.45 mJy/beam for I and P, respectively, and are spaced by factors of $\sqrt{2}$ in both. The polarization E vectors are of constant length.

with rotation $\leq 30°$). Contemporaneous high-frequency observations at matched resolution (being reduced) will help resolve this issue.

2 0234+285

The HPQ 0234+285, detected in γ-rays by EGRET (Mattox et al. 1997), is a challenging target for studies of projection effects since its jet (at least where the γ-rays originate, assuming current models for their emission) must be very well aligned with our line of sight. Our 5 GHz VSOP observation took place on August 14, 1999 and used HALCA, the VLBA, and Effelsberg. The space-VLBI image (Figure 2) reveals a diffuse, edge-brightened jet with inferred magnetic field running longitudinally along each limb, suggesting that field lines are stretched out along the jet boundary. Between the limbs, the inferred field is largely transverse. Combined with our finite resolution, this creates a spine of beam depolarization beginning $\sim$2 milliarcseconds north of the core. Except for the

core and a rather diffuse (and obliquely polarized) knot, the polarized emission is weakest between the limbs of the jet over the entire visible length. While still rather diffuse, the jet resolves into more concentrated components at higher observing frequencies (Moellenbrock 1999) and the overall jet structure oscillates from limb to limb. Due to the elongation and orientation of the beam, this effected is only marginally detected in the VSOP observation, but is consistent with the jet being highly projected.

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