IAU Colloquium 164: Radio Emission from Galactic and Extragalactic Compact Sources
ASP Conference Series, Vol. 144, 1998
J. A. Zensus, G. B. Taylor, & J. M. Wrobel (eds.)

VLBA Monitoring of Three Gamma-Ray Bright Blazars: AO 0235+164, 1633+382 (4C 38.41), & 2230+114 (CTA 102)

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Abstract. We have been monitoring gamma-ray blazars with the NRAO VLBA at 22 and 43 GHz since late 1993. We present results on three sources: AO 0235+164, 1633+382 (4C 38.41), and 2230+114 (CTA 102).

1. AO 0235+164

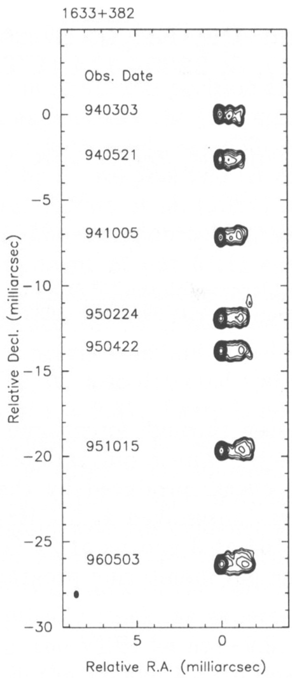
0235+164 is a BL Lac object (z = 0.94) seen through foreground galaxies. It is one of the most violently variable objects. The rapid variability observed in 0235+164 may be due to microlensing events produced by the foreground galaxies (Stickel et al. 1993). 0235+164 was unresolved at 5 GHz at pc scales (Wehrle et al. 1992). We observed 0235+164 at 3 epochs at 22 GHz and at 5 epochs at 43 GHz. It was unresolved during our monitoring program from Nov. 1993 to Aug. 1996.

2. 1633+382 (4C 38.41)

1633+382 is among the first group of AGNs detected by EGRET. It is identified with a quasar (z = 1.814). Strong variations at radio and optical wavebands have been detected (e.g., Barthel et al. 1995). We observed 1633+382 with the VLBA at 22 GHz at 7 epochs between March 1994 and May 1996. The maps (Fig. 1) show that the jet has a sharp leading edge. During our observations, the jet "edge" moved at a constant speed of (0.26 ± 0.02) mas/yr, i.e. (9.9 ± 0.7)$h^{-1}c$, while maintaining roughly the same brightness. This velocity is much faster than the (6.1 ± 1.1)$h^{-1}c$ reported by Barthel et al. (1995). This may indicate that 1633+382 produced a faster component over the last decade.

3. 2230+114 (CTA 102)

2230+114 is identified with a quasar (z = 1.037). Bååth (1987) reported that the components detected at 932 GHz separated at an apparent velocity of (0.65 ± 0.15) mas/yr, i.e. (18 ± 4)$h^{-1}c$. Wehrle & Cohen (1989) found no detectable motion much near the core at 5 GHz, with an upper limit 0.5 mas/yr. Recently, Rantakyrö et al. (1996) concluded that the apparent motion appears to increase with distance from the core, from 0c near the core to (15 ± 6)$h^{-1}c$ at 10 mas from the core. We observed 2230+114 at 22 GHz at 4 epochs between May 1994 and April 1995, and at 43 GHz at 5 epochs between Feb. 1995 and Aug. 1996 (Fig. 2). The two outer components, at ~8 mas (not shown) and ~1.7 mas southeast to the core respectively, have complex structures, and seem to be stationary compared to previous observations (Rantakyrö et al. 1996; Wehrle & Cohen 1989). However, the structure within 1 mas of the core changed dramatically. It is clear that several new components were produced during the period between Feb. 1995 and Aug. 1996. Our results indicate that these components moved at high velocities (12–21 c). We suggest that the jet in 2230+114 moves along a helical path, and that the two stationary components



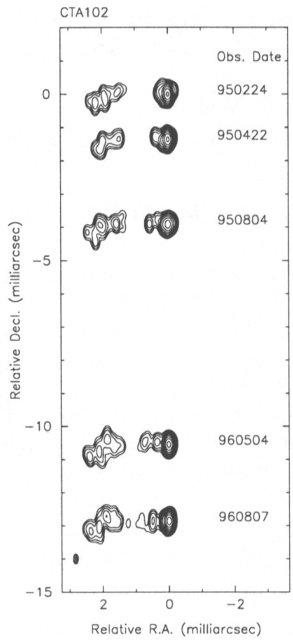


Figure 1. (left) VLBA monitoring of 1633+382 at 22 GHz. Restoring beam is FWHM 0.40 x 0.25 mas, p.a. 0°. Contours are in factors of 2. The lowest contour is 4.7 mJy/beam.

Figure 2. (right) VLBA monitoring of 2230+114 at 43 GHz. Maps are rotated by 48° clockwise. Restoring beam is FWHM 0.30 x 0.15 mas, p.a. 0°. Contours are in factors of 2. The lowest contour is 3.3 mJy/beam.

are where the jet curves towards the line of sight. The jet bending at ~10 mas from the core (Wehrle & Cohen 1989) is consistent with this scenario.

Acknowledgments. This work was supported partly by the NASA Long Term Space Astrophysics Program and and the NASA Gamma Ray Observatory Guest Investigator Program. WX is supported by the National Research Council Associateship Programs. The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under a cooperative agreement by Associated Universities, Inc.

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