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 Observations of GRS 1915+105

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Abstract. During quasi-periodic flux variations, the core of this galactic superluminal source shows: (a) a flat radio spectrum between 13cm and 2cm; (b) elongation of the core along the axis of arcsecond-scale ejecta; (c) a time-delay of ~4 mins at 3.6cm, relative to 2cm; (d) progressively less variation of the flux at 2cm, 3.6cm & 13cm; and (e) scatter-broadening to 1.9mas at 8.4GHz (135mas at 1GHz).

GRS 1915+105 is an X-ray binary discovered in 1992 by the *Granat* satellite (Castro-Tirado et al. 1994). VLA monitoring of a flux outburst in 1994 showed ejecta separating by 26mas/day, fit by an ejection velocity of 0.92c at 70° to the line of sight (Mirabel & Rodríguez 1994). A distance of 12.5 kpc was derived from the H I absorption (Rodríguez et al. 1995).

Radio emission from GRS 1915 has 2 states, *steady* (quasi-periodic) 20–100 mJy with an optically thick core; and *flaring*, when optically thin plasmoids are ejected. VLBI has been attempted six times, triggered by radio flares. No extended jets have been detected, probably because of their rapid expansion. However, in May and August 1996, we successfully used phase-referencing to image the core, which is elongated with major axis (22°W of N), aligned with the arcsecond-scale ejecta. We take this as evidence for a quiescent jet.

The minor axis size scales as λ^2, interpreted as galactic scattering (135 mas at 1 GHz, at l=45.37, b=-0.22, D=12.5 kpc). The scattering is enhanced and clumped on scales of ~50 pc, by comparison with the OH maser in G45.5+0.05 (8.4 mas at 1 GHz, Diamond et al. 1988).

Flux oscillations in GRS 1915 have been previously modeled by an orbiting hot-spot of $T_B \sim 10^{16}$ K, embedded in absorbing plasma, (Rodríguez & Mirabel 1997). New data (Fig.1) show that the variability is less at longer wavelength, contrary to absorption by a plasma. Here, we propose that a more conventional model, (e. g., Hjellming & Johnston 1988), with incoherent synchrotron emission ($T_B \sim 10^{11}$ K) in an optically thick jet of size 20–100 AU (2.5–15 mas), inclined to the line of sight, may account in a unified way for (a) the flat spectrum; (b) the elongation along the axis of ejection; (c) the time delay by geometry, as longer wavelengths emanate from further along the expanding jet; and (d) less variability at longer wavelengths, due to convolution over a larger region.

The radio variations may be associated with x-ray bursts of the same period, corresponding to activity in the accretion disk at ~1 light second radius, ~30 minute Keplerian orbit.

Acknowledgments. The National Radio Astronomy Observatory is a facility of the NSF, operated under a cooperative agreement by Associated Universities, Inc.

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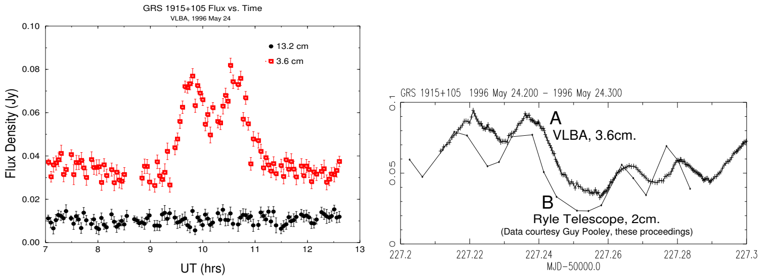

Figure 1. **Left:** Simultaneous light curves at 13.2cm, and 3.6cm, (raised by 20mJy) Note the 30min risetime at 3.6cm, and the lack of variation at 13.2cm. **Right:**Note ∼4 minute time delay and reduced variation for the 3.6cm light curve, compared to 2cm. (2cm data courtesy Pooley & Fender, these Proceedings, p. 333). The ∼40 minute period is often seen in the X-rays and 2cm emission, though simultaneous X-ray data are not available.

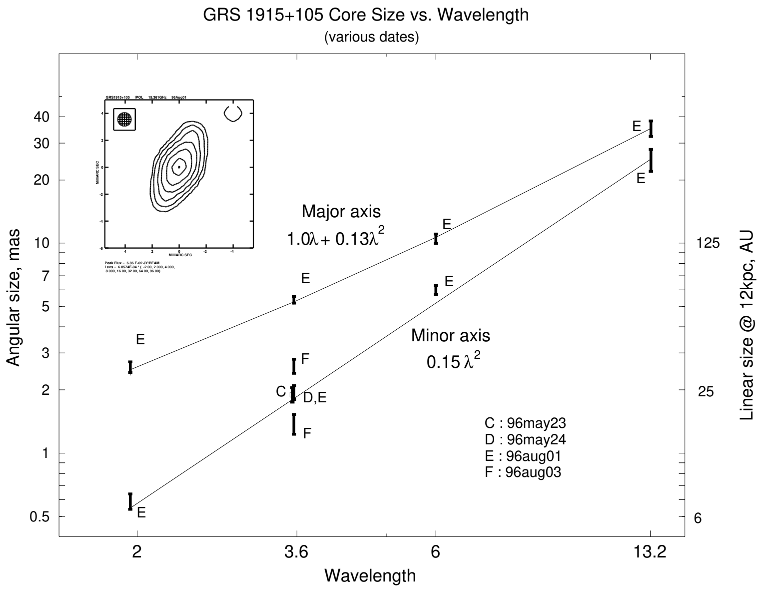

Figure 2. Deconvolved core size vs. wavelength, showing galactic scattering along the minor axis, and intrinsic elongation plus scattering of the major axis. Inset is the image at 2cm, restored with the 1x1mas beam. Contours are −2, 2, 4, 8, ..., 96% of the peak = 65 mJy/beam, and ticks are spaced at 2 mas.