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.)

Multi-Frequency VLBA+Effelsberg Observations of 1038+528 A/B

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Abstract. We made a November 1995 observation of the close (33 arc sec) pair 1038+528 A,B using the VLBA+Effelsberg at 2.3 and 8.4 GHz, and the VLBA alone at 15 GHz. Our analysis of the precise astrometric separation between the core peak in A and a component $\sim$ 1.8 mas from the core in B sheds new light on the observed changes with time and frequency.

1. Temporal Changes

The change in angular separation between quasars A and B at 8.4 GHz in 1995 continues the trend of previous epochs (see Fig. 1a), and confirms that an outward motion of the B reference feature is the dominant contribution (Rioja 1997). We have used various methods to better quantify this, now that we have a longer time baseline: (a) a direct estimate of the separation rate between the core and reference-component from the B quasar hybrid maps; this gives a value of 12.8 μas/yr (see Fig. 1b). (b) a decomposition of the A-B changes along two preferred PAs in the sources (PA $-53°$ in B; 0–35° in A), with a linear fit to the changes deduced in B. The best fit, with PA=25° in quasar A, corresponds to a B reference component motion of 16.6 μas/yr; for the measured inner PA in A of 15° it is 15.6 μas/yr. All these values correspond to sub- or superluminal velocities, depending critically on the choice of the cosmological parameters H_o and q_o. The difference between the estimates from (a) and (b), if real, would correspond to an outward motion of the B core of ca. 3 μas/yr.

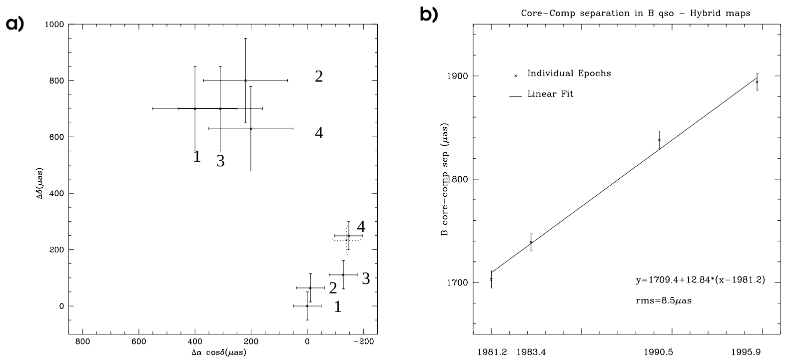

Figure 1. **a)** Relative position measurements between 1038+528 A,B. Large crosses = 2.3 GHz, small crosses = 8.4 GHz and hatched cross = 15 GHz. Numbers indicate epoch. Origin corresponds to 8.4 GHz separation at epoch 1. **b)** Linear fit to changes in core/ref-component separation in maps of quasar B at 8.4 GHz

2. Frequency Registration

As in previous epochs, the separation between the A and B reference features differs significantly between 2.3 and 8.4 GHz, with an offset from 500 to 700 μas (Fig. 1a). Our measurement at the new frequency of 15 GHz, however, gives a separation essentially identical to that at 8.4 GHz. Marcaide & Shapiro (1984) ascribe all the 2.3/8.4 GHz offset to quasar A, and a wavelength-dependent position shift of the "core" proportional to λ^{β}, with acceptable values of β between 0.7 and 2. Our new results at 2.3, 8.4 and 15 GHz are compatible with a new lower bound for β close to 1, and an infinite upper bound. However, at both 8.4 and 15 GHz the maps of A reveal very similar core-jet morphology (see Fig. 2), with a prominent knot, k1, offset from the core by an amount remarkably close to the observed 2.3/8.4 GHz offset. These two components are blended together at 2.3 GHz by the ~ 4 times larger beamwidth, so that at least part of the offset is a natural result of this blending at 2.3 GHz, enhanced by the different spectral indices of the core and k1 components. Moreover, the relative position of a second, weak knot, k2, and k1, seen at 8.4 GHz, is very similar to that between the "core" and first knot feature seen at 2.3 GHz (Fig. 2). We propose a new registration based on the identification of these features. This implies the existence of an offset of $\sim 250\mu$as between the 2.3 and 8.4 GHz positions of the B reference features.

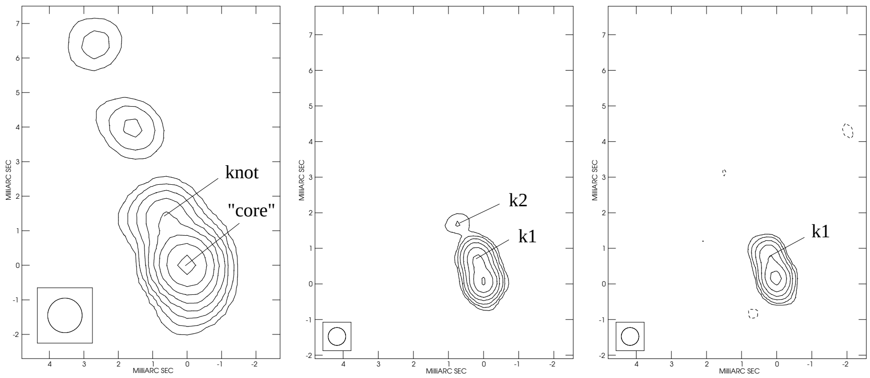

Figure 2. Super-resolved map of 1038+528 A at 2.3 GHz (left) and normal-resolution maps at 8.4 GHz (center) and 15 GHz (right).

Acknowledgments. We thank D. Graham and A. Beasley for assistance with the observations. M. Rioja acknowledges support by the EU under contract CHGECT920011. 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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