EXTRAGALACTIC VLBI AT 89 GHZ +

D. C. Backer
Radio Astronomy Laboratory
University of California, Berkeley

Radio interferometry at 89 GHz with transcontinental baselines can probe the region of active galaxies and quasars where collimation of relativistic outflows occur on length scales of 10^{17-18} cm. Three experiments have been conducted recently to demonstrate the feasability and importance of this investigation. Highlights of the three pioneering experiments are discussed below. Results obtained for the luminous sources 3C84, 3C273 and 3C345 are then summarized.

The technical requirements for millimeter VLBI are demanding. The apertures used are small, 6-11 m, and the system temperatures are high, 350-1000 K SSB, in comparison with most cm-wavelength VLBI. Use of the full 50 MHz bandwidth capability of the MkIII recording system is essential. Coherence of independent oscillators requires hydrogen maser frequency standards, the best available synthesizers, and careful checking of local oscillator stability. Our three experiments are summarized below:

Date	Stations	Baseline Range	Sources
Oct'81	HCRK-OVRO	$0.7-1.4\times 10^8\lambda$	3C84
May'82	HCRK-OVRO-KTPK-QBBN-ONSL	$0.7-23\times 10^8$	3C84,3C273,3C279,3C345
Apr'83	HCRK-OVRO-KTPK	$0.7-4\times 10^8$	3C84,OJ287,3C273,3C345, OV-236

Where possible, we have included cm-wavelength VLBI, either sequentially or simultaneously as a MkIII track pair, to determine the clock at the various stations. Accurate clock determination removes one source of ambiguity in coherent fringe searches over 50 MHz.

The coherence time for these experiments is typically 500 s; coherent integrations for 700 s result in amplitude losses of 0.3-0.5. While we expect the coherence to be limited by tropospheric fluctuations, the coherence time does not show marked variations with zenith angle or with time of day.

+ Discussion on page 420

R. Fanti et al. (eds.), VLBI and Compact Radio Sources, 31–33.
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https://doi.org/10.1017/S0074180900077585 Published online by Cambridge University Press

The technical highlights of these experiments were: first 89 GHz fringes on 3C84 from Oct'81 run (Readhead et al. 1983); long coherence time for '82 and '83 experiments; fringe detection in both RF side-bands in Apr'83; successful demonstration of double bandwidth mode, 224 Mbit/s in '83. We were unsuccessful in obtaining fringes from the West coast to either Quabbin or Onsala; this may result either from resolution or from hardware problems. We look forward to phasing the elements of the HCRK and OVRO interferometers for added sensitivity.

3C345. Observations at cm-wavelengths of this bright quasar (z=0.595) have shown striking evidence for superluminal motion. At 89 GHz the intensity of 3C345 has been declining from 13 Jy in May'82 to 10 Jy in Apr'83. The May'82 observations are consistent with a very compact elongated, or double, source with pa = −107° and size 0.65 mas (Fig. 1). The double model is consistent with the non-radial ejection description of recent 22 and 10 Ghz VLBI observations discussed elsewhere in this volume (Moore 1984). The source expansion and intensity decrease are probably responsible for the nondetection of 3C345 in the most recent experiment.

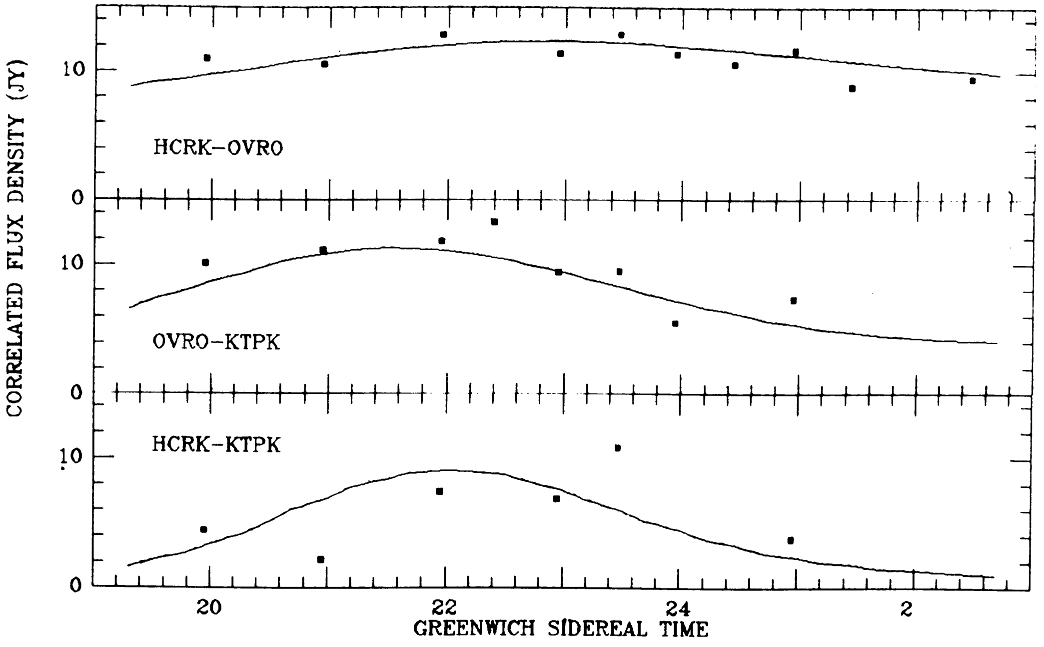

Fig.1 Observations of 3C345 in May'82 (squares) and elliptical gaussian model discussed in text (solid line).

3C84. Over the past decade VLBI observations of the nucleus of this nearby erupting galaxy have shown the presence of a non-collinear series of emission knots along a basically N-S axis. The most compact emission is located at the northern end of the source and is assumed to be associated with the energy production region. Our observations require the presence of at least three components: 14 Jy in structures

https://doi.org/10.1017/S0074180900077585 Published online by Cambridge University Press

resolved by our minimum resolution of 5 mas; an unresolved core, < 0.2 mas, whose flux density has declined from 16 Jy in May'82 to 5 Jy in Apr'83; a 0.7 mas halo surrounding the core which has remained constant. Closure phases indicate the presence of asymmetry in the source which has not been modeled. Future transcontinental VLBI at 89 GHz will be directed to resolution of the core whose physical size must be less than 3 x 10^{17} cm.

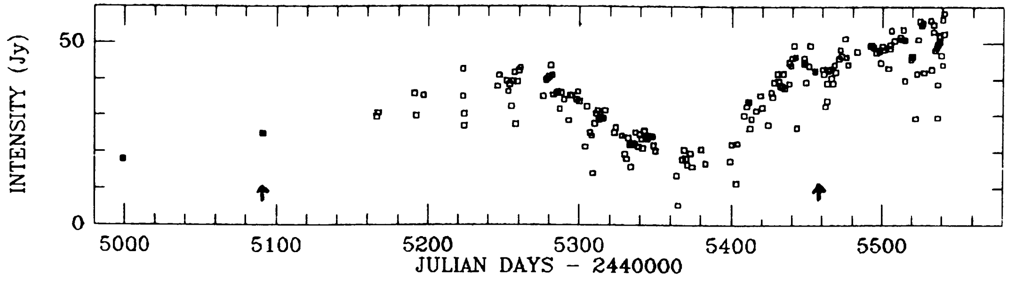

Fig.2 Intensity variations of 3C273 during 1982-83 at 89 Ghz. Open symbols are from HCRK baseline data; filled squares are from other measurements. Arrows mark May'82 and Apr'83 VLBI observations.

3C273. The intensity of 3C273 at 89 GHz has peaked several times over the past several years. Our May'82 observation occurred at the beginning of an increase that took place during 1982 (Fig.2). The brief observation indicates that 3C273 was unresolved with a resolution of 0.8 mas. The Apr'83 observations coincided with the peak of a rapid outburst which was first detected at infrared wavelengths in Jan'83 (Ade et al. 1983). The 89-Ghz light curve in Figure 2 suggests that an 'old' component had decayed to 10 Jy by Apr'83 and the 'new' component associated with the infrared outburst had risen by 35 Jy. The visibilities from the HCRK-OVRO-KTPK observations indicate strong resolution of the source on all baselines. The old intensity is heavily resolved on the short HCRK-OVRO baseline indicating a size of 0.7 mas (1 pc). If we assume a component age of 1 year, a superluminal expansion with $\gamma = 3$ is required. The correlated flux density on the HCRK-KTPK baseline is much less than the new component flux in the '83 outburst. The required source size of 0.2 mas for a source age of 120 days also requires a superluminal expansion with $\gamma = 3$. Future observations of 89 GHz outbursts will require frequent sampling.

These observations resulted from a large effort by a team including Baath, Masson, Moffet, Moran, Pearson, Plambeck, Predmore, Readhead, Rogers, Ronnang, Seielstad, Webber, and Wright with generous technical assistance from the Jet Propulsion Laboratory, the Smithsonian Astrophysical Observatory, and the National Radio Astronomy Observatory.

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https://doi.org/10.1017/S0074180900077585 Published online by Cambridge University Press