VLBI Phase-Referenced observations on Southern Hemisphere HIPPARCOS Radio Stars

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Abstract. We present multiepoch Very Long Baseline Interferometry (VLBI) observations on Southern Hemisphere radio stars phase-referenced to background radio sources. Our differential astrometry analysis results in high-precision determinations of proper motions and parallaxes. Both the astrophysical implications (size and brightness temperature of the radio emitting region) and the astrometric consequences (linkage between the extragalactic and HIPPARCOS reference frames) of our results are discussed.

1. Introduction

Interleaved observations of radio stars and extragalactic radio sources along with phase-reference mapping techniques permit both the detection of radio stars with flux densities as low as a few milliJanskys and the estimate of their relative position. These techniques are useful in determining the unknown rotation of the HIPPARCOS reference frame with respect to the VLBI extragalactic reference frame (Lestrade et al. 1992). Such a rotation will be used to unify the radio and optical reference frames and facilitate the registration of radio and optical images for a further astrophysical interpretation. This link has to be based on objects common to both systems, i.e., radio stars. Since the majority of the radio stars selected for the link are in the northern hemisphere, the measurement of the position, proper motion, and parallax of Southern-Hemisphere radio stars constitutes an important constraint for this link as well as a check of the validity of the rotation parameters for the whole celestial sphere.

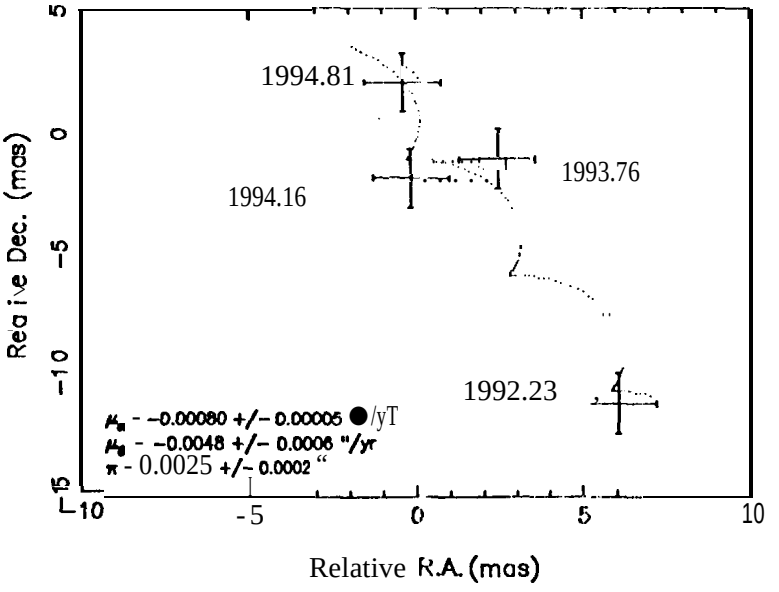

Figure 1. Positions of HD 32918 relative to the reference source, *0530-727,* for the observing epochs. Dotted line shows the trajectory of the star on the sky based on the estimates of proper motion and parallax from a weighted-least-squares fit to the relative positions. Error bars represent the standard deviation of the relative positions scaled so that the reduced-χ^2 of the fit was unity. The rms of the postfit residuals was 0.75 mas.

2. Observations and Results

From 1992 to 1994 *we* performed phase-referenced observations of the radio stars HD 32918, AB Dor (HD 36705), and HD 196818 and angularly nearby (less than 4 degrees on the sky) extragalactic reference sources. The VLBI array was composed of the 70m NASA tracking antenna at Tidbinbilla, the ATNF 64m antenna at Parkes, and the 26m antenna of Mount Pleasant Observatory at Hobart. We used the Mark III system recording at λ=3.6 cm. The data were correlated at the MkIII correlator of the US Naval Observatory in Washington, DC. We followed an astrometric analysis identical to that described by Lestrade et al. (1990) to obtain the phase-reference map of each star at each epoch, in contrast to earlier astrometry VLBI observations in the Southern Hemisphere that used the bandwidth synthesis techniques (Reynolds et al. 1995). Through the analysis of several epochs of observation, we estimated the radio position, proper motion, and parallax for HD 32918 and AB Dor. Unlike the two stars above, HD 196818 turned out to be barely detectable in our array at the time of observations.

Our submilliarcsecond-precise estimates of the proper motion and parallax of HD 32918 (see Fig. 1) can be used in the tie between the HIPPARCOS and VLBI reference frames. The parallax is in excellent agreement with the optical value of Collier (1982). This star shows frequent, intense, and long radio flares (Slew et al. 1987). We have detected radio flares in three of our observations that reached correlated flux densities up to ~50 mJy. Since the star was unresolved for our interferometer, we can put a lower bound on the brightness temperature

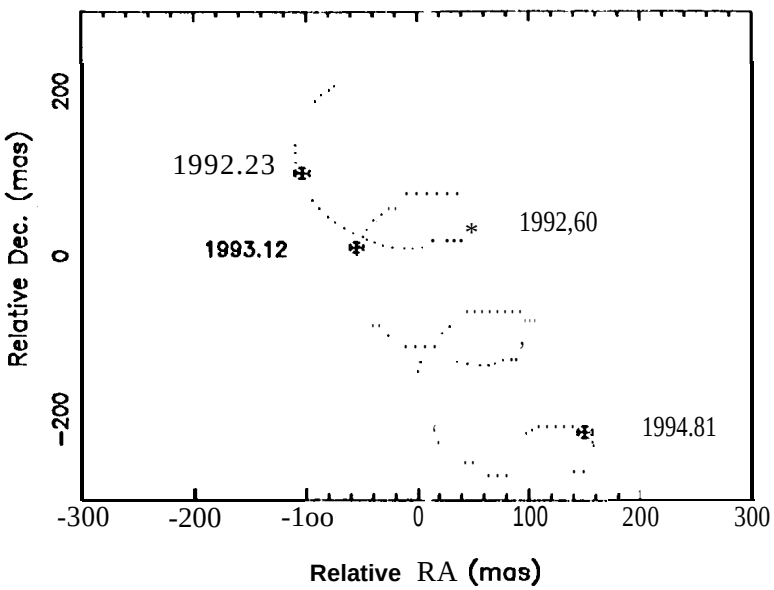

Figure 2. Same as Fig. 1 for A BDor. Note the different scale. The reference source is 0516-621. The rms of the postfit residual is 3.8 mas.

of 107 K, compatible with the existence of gyrosynchrotron emission processes.

We show in Fig. *2* preliminary results for ABDor. The higher rms of the postfit residuals led to uncertainties in proper motion and parallax larger than those of 111) 32918. ABDor possesses a closely-spaced radio companion, the star Rst 13711; both stars were observed simultaneously for our radio telescopes as they arc separated only 10" on the sky. The data were processed independently, and parallax and proper motion derived independently. our preliminary results show that both stars have common proper motions, to within 10 mas/yr, and common distances, to within 3 parsecs. More VLBI observations would confirm this result, which constitutes an important argument in favor of the hypothesis of the physical association between tile two stars (e.g. Innis et al. 1986). The same bound to the brightness temperature of 1 II) 32918 applies to these two stars, as they arc unresolved by our interferometer.

Acknowledgments. This work was performed while JCG held a National Research Council-NASA Resident Research Associateship award at the Jet Propulsion laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

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