A Giant Step: from Milli- to Micro-arcsecond Astrometry
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The distance to an outer Galaxy star forming region

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Abstract. We performed phase-referencing VLBI astrometric observations of the H_2O maser source IRAS 02395+6244, located well beyond the solar circle. We measured its heliocentric distance to be 5.49 ± 0.80 kpc, implying a Galactocentric distance of 12.5 ± 0.5 kpc and a distance of 270 ± 40 pc above the Galactic plane.

Keywords. Galaxy: structure, masers, astrometry

1. Introduction

In the past, the structure and size-scale of our Galaxy have been mainly determined by translating measured radial velocities into distances with the help of a kinematic model – "the rotation curve". (e.g. Nakanishi & Sofue 2003). Such methods originally proved the existence of the Milky Way's spiral structure and are still in use today. However, the resulting "kinematic distances" strongly depend on the Galactic rotation model chosen and peculiar motions may render them questionable (see, e.g., Xu *et al.* 2006). This is particularly true for the outer galaxy, since the Galactic rotation speed there has still a larger uncertainty than in the inner Galaxy (Brand & Blitz 1993). Consequently, many uncertainties remain on the structure and distance scale of the outer Galaxy.

Recently, distances of Galactic maser sources have been determined by annual parallax measurement using the phase-referencing VLBI technique (e.g. Hachisuka *et al.* 2006 and see contribution by M. Reid in these proceedings). This method can measure the annual parallax of Galactic objects out to many kiloparsecs with errors of a few percent at a kpc (scaling with distance), allowing *direct* distance measurements for objects located near the edge of the stellar disk of our Galaxy.

Wouterloot *et al.* (1993) searched for H_2O maser sources in the outer galaxy associated with ^{12}CO emission and found a number of them, for which their kinematic distances indicated large distances from the Galactic center. We selected one of these, associated with IRAS 02395+6244, as the target source for an annual parallax measurement.

2. Observations

We used the VLBA to observe the IRAS 02395+6244 H_2O maser source using phase-referencing VLBI techniques. The observations were performed at 5 epochs spread over a year. For position reference we used an ICRF source separated by 0.5 deg from the target source. See Xu *et al.* (2006) for a description of the data reduction procedures.

3. Results

Several H_2O maser components could be imaged after the calibration. We determined their positions and traced individual maser components between different epochs carefully, monitoring their intrinsic variations. We found an H_2O maser component that was stable over the course of the observations and determined its annual parallax.

Figure 1 shows the change in position versus time of that H_2O maser component. We estimate the annual parallax to be 0.182 ± 0.026 mas, which corresponds to a heliocentric distance of 5.49 ± 0.80 kpc, or 12.5 ± 0.9 kpc from the Galactic center for $R_0 = 8.0$ kpc (Reid 1993). The Galactic latitude of the source is 2.8 deg, hence it is located 270 ± 40 pc above the Galactic plane.

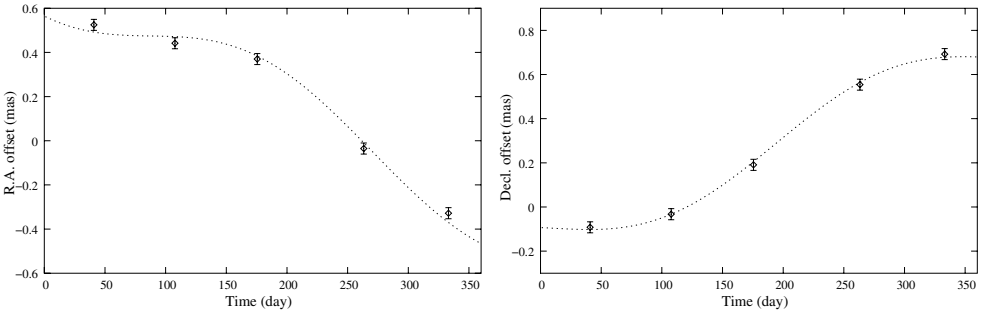

Figure 1. Change of the position with time for an H_2O maser component associated with IRAS 02395+6244 with respect to a background extragalactic source. Displacements in right ascension (left panel) and declination (right panel) are shown. Dotted lines show the best-fit result for a proper motion and an annual parallax.

The kinematic distance of our H_2O maser source with an LSR velocity of -72 km s^{-1} is 8.7 kpc from the Sun, assuming a flat rotation curve and the IAU recommended values of Θ_0=220 km s^{-1} and R_0= 8.5 kpc. The kinematic distance is significantly larger than the parallactic distance of 5.49 ± 0.80 kpc. Such discrepancies between kinematic and annual parallaxes have been found for other Galactic maser sources in the outer Galaxy (Hachisuka *et al.* 2006, Xu et al 2006; see contribution by M. Reid). Also, after removing the effects of Galactic rotation, we find a very large peculiar motion at ≈ 30 km s^{-1}. More observations like these should lead to better a understanding of the size, dynamics, and dark matter halo of the Galaxy.

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References

Brand, J. & Blitz, L., 1993, *A&A*, 275, 67
Hachisuka, K., Brunthaler, A., Menten, K. M., Reid, M. J. *et al.*, 2006, *ApJ*, 645, 337
Nakanishi, H. & Sofue, Y., 2003, *PASJ*, 55, 191
Reid, M. J., 1993, *ARAA*, 31, 345
Wouterloot, J. G. A., Brand, J., & Fiegle, K., 1993, *A&AS*, 98, 589
Xu, Y., Reid, M. J., Zheng, X. W., & Menten, K. M., 2006, *Science*, 311, 54

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