The Far Distance to G7.47+0.06 from Proper Motion Measurement of H_2O Masers

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We report a distance measurement of an ultra-compact H_{II} region G7.47+0.06 associated with IRAS 17591-2228. The kinematic distances obtained from its radial velocity suggest that G7.47+0.06 may be farther away than the distance between the Galactic center and the Sun, ≈ 8 kpc (e.g., $25.1^{+10.8}_{-4.2}$ kpc, Wink et al. 1982 [1]).

We applied a new method to determine a source distance based on absolute proper motions proposed by Sofue (2011) [2]. Given a rotation curve, and assuming circular motion of an object, a distance to the object is obtained from not only the radial velocity but also the proper motion kinematically. The distance of an object with its galactic longitude $l \approx 0°$ located farther from the Galactic center than seen from the Sun is more accurately obtained by using the proper motion rather than using the radial velocity.

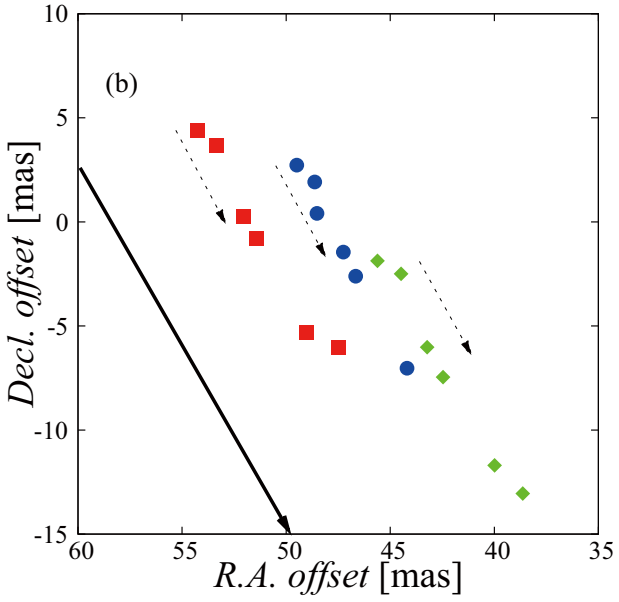

Figure 1: Yamauchi et al. (2016) [3]. Distribution of maser features (v_{LSR} = −17 – −15 km s^{-1}) throughout all epochs. Thin dashed arrows indicate proper motions per year of individual maser features. A thick arrow is parallel to the Galactic plane, and its head points to the Galactic center.

Observations of the 22-GHz H_2O maser line associated with G7.47+0.06 were conducted with VERA (VLBI Exploration of Radio Astrometry) from 2009 March to 2011 December. As a result of analysis, it turned out to be difficult to derive the distance from annual parallax measurement. Meanwhile, we clearly detected the source's proper motion parallel to the Galactic plane. The proper motion is μ = −5.03 ± 0.07 mas yr^{-1} and is approaching the Galactic center (Figure 1).

Considering uncertainties of the Galactic rotation curve and the solar peculiar motion, the detected proper motion leads to a source distance of D = 20 ± 2 kpc (Figure 2), demonstrating that astrometric observation can provide an accurate distance measurement at 10 % level even for sources too far to measure the annual parallax.

Garay et al. (1993) estimated the physical parameters of the H_{II} region using the near kinematic distance of D = 6.3 kpc [4]. Scaling their parameters from D = 6.3 kpc to 20 kpc, the H_2O maser features are associated with a massive star-forming region corresponding to the spectral type of O5.5.

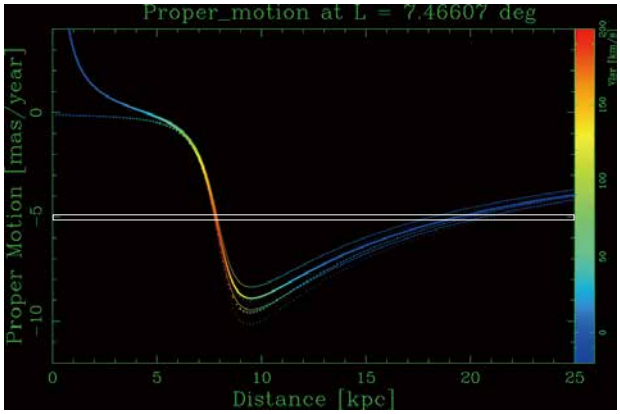

Figure 2: Yamauchi et al. (2016) [3]. Proper motion as a function of distance. Color scale indicates line-of-sight velocity. Dashed curves indicate the distances from the LSR in the cases of flat rotation. Solid curves indicate the distance from the Sun in the case of $\Theta = \Theta_0 (R/R_0)^{\alpha}$ and α = 0.05. The intersections of the curves and a white rectangle corresponding to μ = −5.03 ± 0.07 mas yr^{-1} give a source distance.

References

[1] Wink, J. E., Altenhoff, W. J., Mezger, P. G.: 1982, *A&A*, **108**, 227.
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[4] Garay, G., et al.: 1993, *ApJ*, **413**, 368.