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Water Masers Toward the Low-Luminosity YSO IRAS 05413–0104

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Abstract. We report on water maser proper motion in the jet of the YSO IRAS 05413–0104.

Water masers have been monitored using the VLBA of NRAO toward the young stellar object (YSO) IRAS 05413–0104. At a distance of about 500 pc, the resolution of the VLBA at 22 GHz ($\sim$ 1 mas) corresponds to 0.5 AU. Four epochs, each separated by about three weeks, were observed beginning on July 4, 1996. More than 30 distinct maser features were detected in each of the four epochs. The masers lie mostly along a line that has a position angle (N through E) almost exactly the same as the position of the symmetric molecular hydrogen jet (Zinnecker, McCaughrean, & Rayner 1997), on arc-minute scales. This suggests that the masers are tracing the outflow very near to the star, rather than lying in a disk around the star.

The general structure of the maser spots, shown in Figure 1, over 130 AU, is very similar over all four epochs. On close inspection the details of the maps show definite changes from epoch to epoch. Proper motions of the maser spots have been measured, and those from the first to the second epoch are shown in Figure 2. In general the proper motions are oppositely directed away from the centroid of the water maser features along the direction of the H_2 jet. The magnitude of the proper motion velocities is about 60–100 km s^{-1}. Thus we believe that we are seeing the outflow begin within 50–100 AU of the YSO.

The red-shifted maser features have been seen in monitoring single-dish observations for several years (Claussen et al. 1996), whereas the blue-shifted spectral feature (to the northeast) have only been seen for about a year previous to our VLBA observations. At the present proper motion, these maser spots would have moved about 40 AU over a year, nearly the distance that the masers are now from the centroid position. Thus these features may represent a dense "blob" of gas which has been entrained in the jet.

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References

Claussen, M. J., et al. 1996. *ApJS*, **106**, 111–132.

Zinnecker, H., McCaughrean, M., & Rayner, J. 1997. in *Low Mass Star Formation from Infall to Outflow (IAU Symposium No. 182)*, eds. F. Malbet & A. Castets, Poster contributions, 198–200.

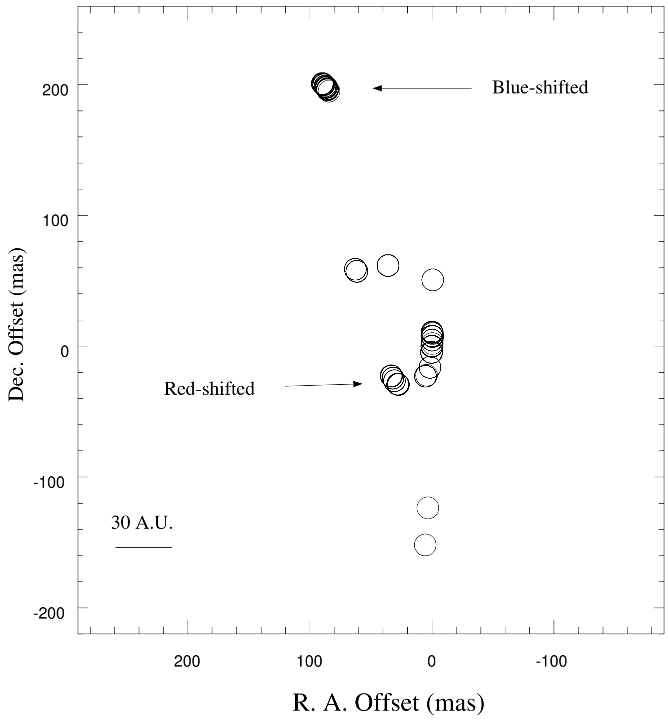

Figure 1. Water maser positions near IRAS 05413–0104 on July 4, 1996.

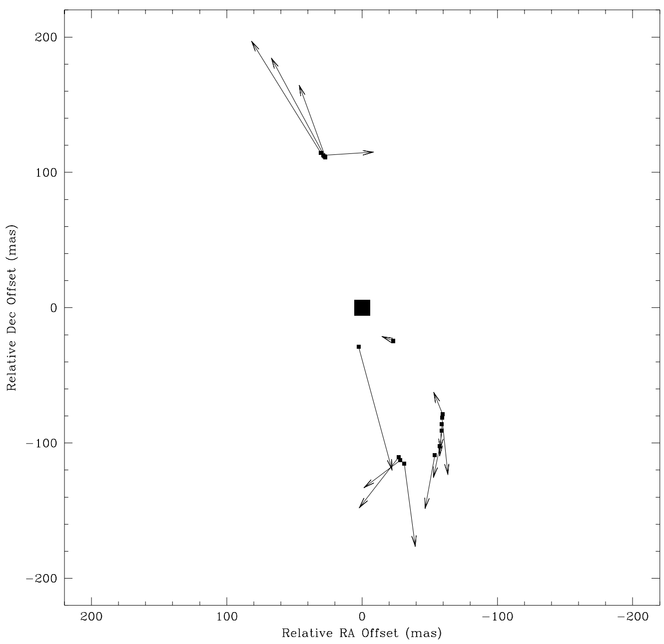

Figure 2. Proper motions of the water masers in IRAS 05413–0104 over a three week period in 1996. The length of each vector in mas is the velocity of the component in km/s. The black rectangle near the center is the midpoint of the highest velocity features.