

Submillimeter H₂O masers in high-mass star-forming regions

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Molecular masers have been employed to investigate dynamical structures of circumstellar disks and outflows in young stellar objects (YSOs). In particular, some representative centimeter radio lines such as the 1.6 GHz OH, 6.7 GHz CH₃OH, and 22 GHz H₂O masers are widely used for high resolution interferometric observations. In contrast, higher frequency masers have not been well studied until recent developments with ALMA (Atacama Large Millimeter/submillimeter Array).

Here we will present observational results of submillimeter H₂O masers toward high-mass star-forming regions. We will review recent progress of our ALMA observations of submillimeter H₂O lines toward the nearest high-mass YSO, Source I in Orion KL [e.g. 1,2], which shows a rotating outflow driven from the Keplerian disk. We will also show tentative results from ALMA observations of the 321 GHz H₂O masers toward high-mass YSO samples associated with the 22 GHz H₂O masers observed with VERA (VLBI Exploration of Radio Astrometry) [e.g. 3]. We find that the higher excitation 321 GHz H₂O masers are in general co-located with those of the 22 GHz H₂O masers while in some sources they are emitted from inner part of the outflows traced by the 22 GHz masers. The results suggest that multiple maser lines at different excitation conditions can be unique probes of physical and chemical properties of high density and temperature regions in the close vicinity to high-mass YSOs associated with disk/outflow systems.

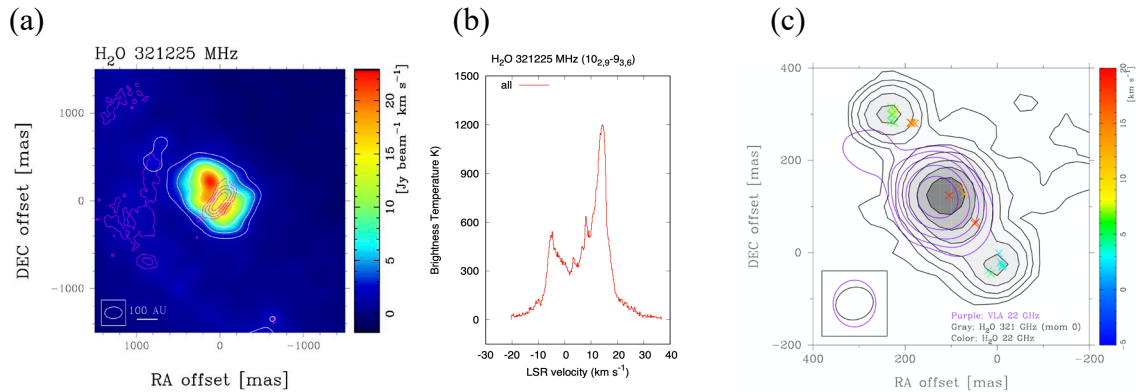


Figure 1: (a) Moment 0 map of the 321 GHz ($10_{2,9} - 9_{3,6}$) H₂O maser (color) and ALMA Band 10 continuum emission (contour) toward a high-mass YSO Orion Source I [1,2]. (b) Spectrum of the 321 GHz H₂O maser toward Source I [1,2]. (c) Moment 0 map of the 321 GHz H₂O maser (gray), VLA 22 GHz continuum emission (contour), and positions of the 22 GHz ($6_{1,6} - 5_{2,3}$) H₂O maser (cross) toward a high-mass YSO S255 NIRS3 [3].

References

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