Discovery of Hot Water Vapor Gas Disk around a Massive Protostar Candidate Orion KL Source I

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We have discovered a definite evidence of a hot molecular gas disk around a massive protostar candidate located in the nearest massive star-forming region Orion KL by using VERA, the Japanese very long baseline interferometer network operated by NAOJ, and ALMA, a newly constructed millimeter/submillimeter interferometer [1].

In the ALMA observations, we focused on the submillimeter water lines and detected two lines at 321 GHz (excitation energy of 1800 K) and 336 GHz (excitation energy of 2900 K) for the first time in Orion KL. As a result, the 321 GHz line is found to be tracing the jets similar to the SiO masers detected with VERA. In contrast, the 336 GHz line, which is a vibratioanlly excited line, is though to be emitted from a closer vicinity to the central protostar Source I. According to the velocity structure, the 336 GHz line can be explained by a rotating gas disk observed in the edge-on view (Figure 1). Furthermore, we have found that (1) the temperature of the disk is higher than 3000 K, (2) the central star should have at least 7 Solar masses, and (3) the diameter of the disk is estimated as about 80 astronomical units with the ring-like structure. This is the first time to reveal physical and dynamical properties of the rotating disk around Source I in Orion KL. The present study settles the long-standing problem about a nature of Source I, providing a definite evidence of a rotating gas disk. Our results suggest that the massive protostar like Source I could be formed via disk accretion as predicted for low and intermediate mass stars (Figure 2). Future higher resolution observations with ALMA will be able to uncover more detailed properties and evolutionary scenario of Orion KL Source I.

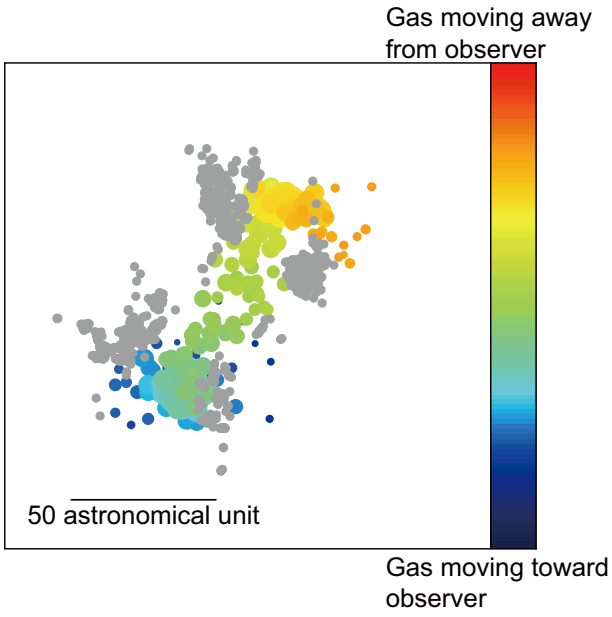

Figure 1: Distributions of the hot water vapor gas detected with ALMA (color) and the SiO masers observed with VERA (grey) associated with Source I. The colors indicate the radial velocity of the 336 GHz water line. The blue in the lower left side means that the gas is moving away from the observer, while the orange in the upper right side does that it is moving toward. The SiO masers are though to be tracing the root of the jet emanating from the disk surface.

Figure 2: An artistic view of a massive protostar candidate Source I in Orion KL (see Figure 1).

Reference

[1] Hirota, T., Kim, M. K., Kurono, Y., Honma, M.: 2014, *ApJL*, **782**, L28.