VERA and ALMA Observations of the Maser Burst in Orion KL

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We have been carrying out monitoring observations of the 22 GHz H_2O maser burst (supermaser) in the nearest massive star-forming region Orion KL using VERA since 2011 March [1,2]. In the present study, we have continued our monitoring of the supermaser until the end of 2013, and revealed the detailed properties of its time variation. As a result, we detect several flux maxima during our monitoring period in 2011–2013, and the maximum flux density is recorded in June 2012 with the flux density of 135000 Jy (Figure 1). This flux maximum is smaller by a factor of 10 compared with the previous bursts in 1979–1985 and 1998–1999. In addition, the time variation in each flux maximum show a symmetric flux increase/decrease with timescales of 2–7 months. The supermaser is found to consist of two spatial/velocity components with proper motions almost parallel to the northeast-southwest bipolar outflow in Orion KL (Figure 2).

With the newly obtained ALMA data, we investigate the physical properties of environment of the supermaser. We find that the supermaser is located in the Compact Ridge, which is an interacting region with the bipolar outflow and the ambient cloud. We identify the supermaser close to the methylformate ($HCOOCH_3$) line and continuum emission peaks. The velocity structure of the $HCOOCH_3$ line shows an evidence of shocked molecular gas. On the other hand, we can not detect submillimeter H_2O lines in the Compact Ridge, suggesting that the submillimeter H_2O lines are thermalized.

Our results support a scenario that the supermaser is excited in the shocked molecular gas in the Compact Ridge, and it could be explained by a beaming effect during the amplification process rather than changes in physical conditions.

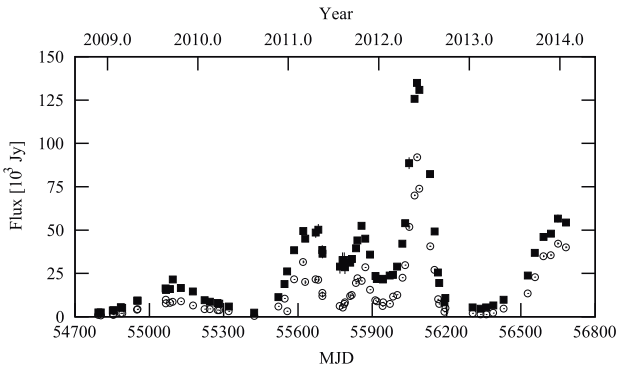

Figure 1: Flux density variation of the 22 GHz supermaser observed with VERA. Filled and open symbols represent the total and correlated flux densities, respectively, for the 7.5 km s^{-1} component.

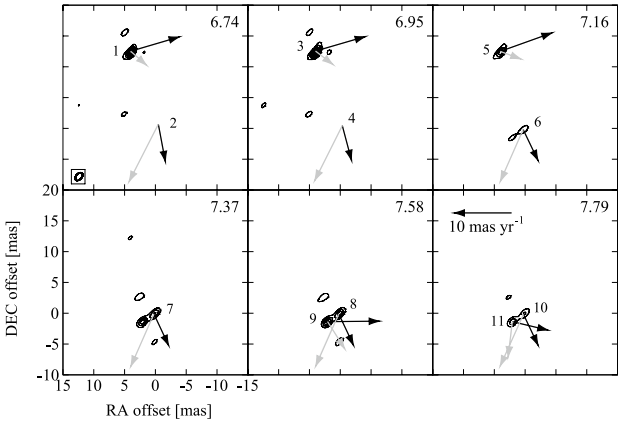

Figure 2: Channel maps of the 22 GHz supermaser observed with VERA. Each arrow indicates the proper motion vector. Contour levels are 2000, 4000, 6000, 8000, 10000, and 12000 Jy $beam^{-1}$. Gray arrows represent the absolute proper motions while black arrows indicate the proper motion with respect to the powering source of the bipolar outflow, Source I.

References

[1] Hirota, T., et al.: 2011, *ApJ*, **739**, L59.
[2] Hirota, T., et al.: 2014, *PASJ*, **66**, 106.