Poster: Understanding high-mass star formation through KaVA observations of water and methanol masers

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We have initiated a four-year large program with KaVA (KVN and VERA Array) since 2016 to conduct systematic monitor observations of 22 GHz water and 44 GHz methanol masers in high-mass star-forming regions, which are known to be a tracer of high-velocity jets and low-velocity outflows, respectively. The primary science goal is to understand the dynamical evolution and circumstellar structures of high-mass young stellar objects (HM-YSOs) through obtaining spatial distributions and measuring 3-dimensional (3D) velocity fields of both maser species. Our sample consists of 87 HM-YSOs in various evolutionary stages. Combined with observations of 6.7 GHz methanol masers with JVN (Japanese VLBI Network) and thermal molecular line and sub-mm continuum emissions with ALMA, we will address key issues in high-mass star formation as follows: 1) Establish an evolutionary sequence of three maser species in our statistical sample, 2) Reveal driving mechanism and how to develop the collimation of jets/outflows ejected from HM-YSOs. Here, we will present the initial results in the first year that conducted the snap-shot VLBI imaging observations of 25 water and 19 methanol maser sources. Toward 22 GHz water masers, 16 sources showed both red- and blue-shifted maser features in their spectra, and we obtained their spatial distributions classified into morphology of compact, linear evoking a bipolar jet/outflow, and so on (see also the presentations by Jungha Kim et al.). Toward 44 GHz methanol masers, 16 sources were succeeded in VLBI imaging. These VLBI images were obtained for the first time except G 18.34+1.78SW (Matsumoto et al. 2014), but only single spectral feature was detected on each image in most sources. These VLBI data provided the size of 1.1-3.6 milliarcsecond of individual methanol maser spots. We will also show the progress of the second year observations, which have been initiated since Mar 2018 to measure 3D velocity fields.

Outflows and Disks