KaVA Large Programs of Circumstellar Masers

KaVA Evolved Stars sub-Working Group

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Specification of the Large Programs

Phase 1: ESTEMA
(Expanded Study on Stellar Masers) during 2015—2016, ~200 hours
Snapshot imaging of H2O and SiO masers in circumstellar envelopes (Figure 1) around ~80 stars
● statistics of stellar masers
   i. maser spot sizes and phases
   ii. distributions of H2O masers with respect to locations of SiO masers
   iii. correlation with kinematic parameters of circumstellar envelopes and stars
● yielding a larger sample of stars as targets of the Phase 2 project

Phase 2: Intensive monitoring campaign during 2016—2024, 400—500 hours/year
16—20 pulsating stars (P=300—1600 days) monitoring SiO and H2O masers in every 1/20 pulsation cycle over a few pulsation cycles for “stellar maser movie” synthesis
● detecting (both or either)
  i) propagation of pulsation-driven shock waves (Figure 2)
  ii) periodic change in physical conditions affected by stellar radiation
● Comprehensive synergy with ALMA, VLTI, Nano-JASMINE

Current progress towards the Large Programs

Imaging feasibility
Image quality comparable to that with the VLBA (figure 3, 4)
Snapshot imaging feasibility
Focused image in ~2 hour integration time with a good (u,v) coverage
Feasibility of maser map registration onto a common coordinate system
Feasible in the source-frequency phase-referencing technique (Figure 5)
Now testing it in KaVA operation
Feasibility of maser source astrometry
Feasible with VERA dual beam, testing in antenna fast-nodding mode
Scheduling of single observation session
testing hybrid operation (KaVA imaging + VERA astrometry + KVN SFPR)
Modeling of long-term campaign
Confirming the reality of biweekly-monthly monitoring operation, including scheduling, array operation, correlation, data processing, and archive

Figure 3 (top left) H2O maser map in S Per taken with KaVA (by K. Kusuno, Y. Asaki)
Figure 4 (bottom left) SiO maser map in BX Cam taken with KaVA/KJCC (by H. Imai)