Report on the activity of the KaVA Evolved Stars Sub-Working Group in 2012-2013

KaVA of Evolved Stars Sub-Working Group

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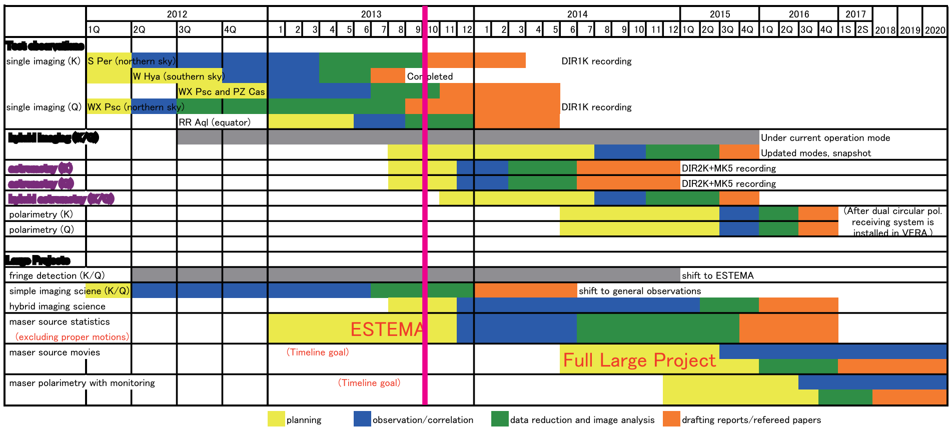

Figure 1 Timeiine of the Evolved Stars sub-WG activity, including planning the Large Project(ESTEMA and Full) and test observations for commissioning.

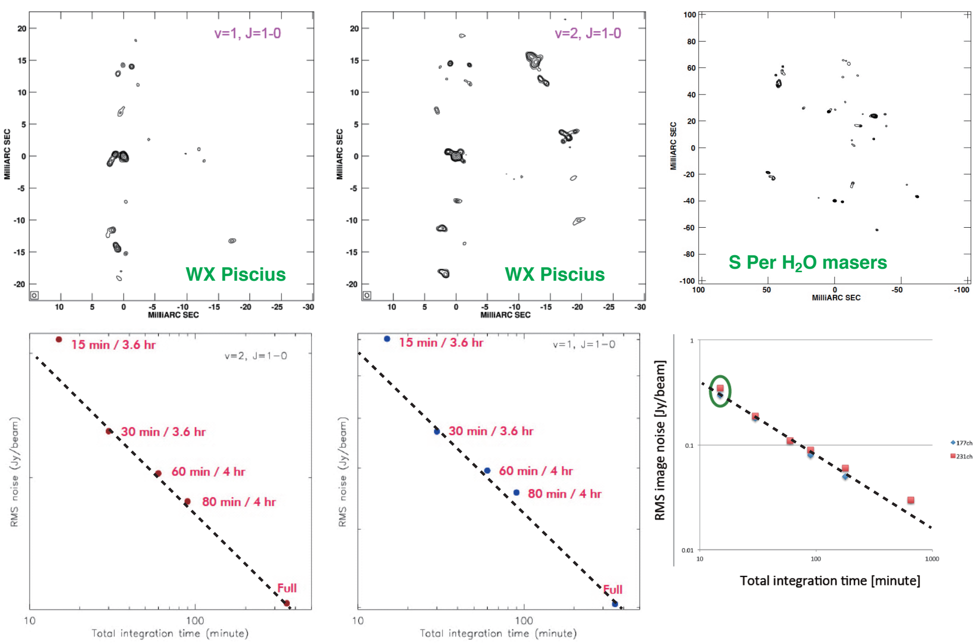

Figure 2 KaVA imaging results for stellar masers. Left and middle panels: the SiO *v*=2 and 1 *J*=1→0 masers, respectively, in WX Piscius (by Y. Yun and S.-H. Cho). The top panels shows the velocity-integrated intensity map, while the bottom ones show the plots of root-mean-squares noise against integration time in the specific time baseline in the observation session. A dashed line indicates a power-law fitted one (index ~-0.5) to the longer integration data points. The deviation of the shortest integration data point from the power-law line indicates the exisitence of intense sidelobes on the maser image cube. Right: Same as SiO but for the H_2O masers in S Persi (by K. Kusuno and Y. Asaki).

Demonstration results

A. Snapshot imaging for integration time of >15 min (H_2O masers) and >30 min (SiO) is feasible. (see Fig. 2)

B. Fringe-rate mapping can determine absolute coordinates of H_2O masers in snapshot imaging (for W Hya at δ~-29°).

C. Sub-array mode of VERA in KaVA (i.e. 3 KVN + 2 VERA telescopes might not be feasible for imaging SiO masers (appearing dummy peaks of maser emission) (under reconfirmation).

Main scientific interest

Stellar and interstellar astrophysics in final stage of stellar evolution probed by H_2O and SiO (43 GHz) masers

mainly O-rich, intermediate and high mass stars with pulsation periods > 200 days

0. excitation mechanisms of masers
1. periodic behaviers of circumstellar envelopes linked to stellar pulsation
2. asymmetric stellar mass loss as seen in water fountain sources

Major issues in planning of a KaVA Large Projects

Understanding observed properties of stellar masers and actual specifications of KaVA operation (see Figure 1.)

Demonstrated currently

a. distributions of spot sizes and lifetimes of stellar maser spots
b. flux density variation of masers associated with target stars
c. capability of snapshot imaging (mainly presented in this poster)

Demonstrated in this season

d. capability of multi-band imaging
 d.1. multi-frequency phase-referencing
 d.2. multi-band imaging in single session
e. astrometry for image registration and trigonometric parallax distances

Planning the initial KaVA Large Project

ESTEMA (Expanded Study on Stellar Masers)

- within 200 hours in 2013--2014
- snapshot maser imaging for ~100 evolved stars hosting H_2O (~0.5 hour) and/or SiO masers (~1 hour)
- statistic of stellar masers
  - i. maser spot sizes
  - ii. distributions of H_2O masers w.r.t. locations of SiO masers
  - iii. correlation with physical parameters of circumstellar envelopes and central stars
- yielding a larger sample of evolved star as targets of future VLBI observations
- selecting evolved stars for future full Large Project (intensive VLBI monitoring, every 0.5-3 months for 3-10 years)

For proposing and running ESTEMA, we have to .....

a) Decide which mode is more feasible (sub-array or moderately fast band swithing of VERA in KaVA operation).
b) Test feasibility of phase-referencing astrometry with KaVA, indispensable for accurate maser map registration.
c) Demonstrate multi-frequency phase-referencing for masers with KVN (by-product in ESTEMA but another large project in KVN).