KaVA ESTEMA (Expanded Study on Stellar Masers)

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Time line and specification of the KaVA Large Programs on circumstellar masers

Phase 1: ESTEMA (approved) during 2015 autumn—2016, 2 years × 120 hours

Snapshot imaging of H2O and SiO masers in circumstellar envelopes (Figure 1) around ~80 stars (source list in public)

- statistics of stellar masers
  - maser spot sizes and shapes
  - distributions of H2O masers with respect to locations of SiO masers
  - 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)
  - propagation of pulsation-driven shock waves (Figure 2)
  - periodic change in physical conditions affected by stellar radiation

- Comprehensive synergy with ALMA, VLTI, Nano-JASMINE

ESTEMA operation design

Scan patterns in each session (Figure 3, 4)

Two-day pairs of blocks for K&Q-bands with VERA for K/Q/W/D bands with KVN

This yields a good (u,v) coverage (~60 min + ~120 min integration with VERA and KVN, respectively)

Baseband channel allocation (Figure 5)

Covering 1 H2O and 5 SiO (3, 1, 1 lines at Q-, W-, D-bands, respectively) lines

Data analysis mission for multiple scientific outcomes

1. KaVA snapshot images of 1 H2O and 2 SiO (v=1 & J=1, 2) maser lines

2. Astrometry (VERA dual beam & slow antenna nodding)

3. mm VLBI with KVN (SiO v=1 & J=2 and J=3 maser lines, with SFPR)

Data analysis processing (using AIPS/ParselTongue/Python)

a. ESTEMA ingest pipeline: amplitude calibration and data splitting for each mission

b. Standard data calibration pipelines for KaVA imaging and astrometry

c. Advanced data processing: SFPR
d. Data archiving: calibrated visibilities, image cubes, important plots, pipeline inputs