Status report of KaVA SFRs WG

Tomoya Hirota (NAOJ), Kee-Tae Kim (KASI),
on behalf of KaVA SFRs sub-WG
KaVA SFRs LP summary

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

• VLBI monitoring/survey to reveal 3D velocity and spatial structures of 22GHz $\text{H}_2\text{O}$/44GHz $\text{CH}_3\text{OH}$ masers in 87 high-mass YSO (HM-YSO) samples
  – Physical/dynamical properties of disk/jet/outflow
  – Evolution of disk/jet/outflow and maser chronology

• Just submitted proposal for the second year
  – Interim review on November 22 at Daejeon (KaVA/EAVN SWG)
Why HM-YSOs?

• Major impact on astronomy
  – Strong influence on formation and evolution of stars, clusters, ISM, and galaxies

• Not understood in contrast to low-mass YSOs
Observational studies on HM-YSOs

• How they evolve? What maser tells us?
  – Need high resolution to reveal 3D velocity structure
  – Unique capability of VLBI providing proper motions
  – Complementary with high resolution ALMA/JVLA data
  – Statistical studies with large survey data from IR to cm

Orion Source I (Hirota et al. 2017)
Updated with slight modification but still controversial
Planned observations

• VLBI survey/monitoring of sources; 87
  – 22 GHz H$_2$O masers; high-velocity jet/outflow (KaVA)
  – 44 GHz CH$_3$OH masers; low-velocity outflow (KaVA)
  – 6.7 GHz CH$_3$OH masers; low-velocity outflow/disk (JVN)
  – Association of multiple masers, high velocity jets, ...
Timeline and strategy

• First year; finished
  – Snap-shot survey of 25 H$_2$O masers at 22 GHz
    • Selected from SD/archive data with no previous VLBI data
  – Snap-shot survey of 19 CH$_3$OH masers at 44 GHz
    • Based on KVN fringe-check, most of them are the first VLBI

• Second year; being proposed
  – Proper motion measurements of selected sources

• Third year and beyond; TBD
  – Continue proper motion measurements of further sources
  – Intensive monitoring for highly variable sources
First year; $\text{H}_2\text{O}$ maser at 22 GHz

- Snap-shot imaging toward 25 HM-YSOs
  - $\text{H}_2\text{O}$ maser maps toward 21 sources
  - Variety of spatial/spectral features
  - Jet-like structure, bow-shock, very high velocity features, . . .

Preliminary results of the first year survey (See presentation by Kim-san)
First year; H$_2$O maser at 22 GHz

- Collaboration with ALMA cycle 3 for 11 sources
  - Mainly for 44 GHz methanol maser sources
  - Thermal methanol, organic molecules, SiO, etc.
  - Direct comparison with spatial/velocity structures
  - Rotating disk traced by thermal lines

Preliminary results of the first year survey (See presentation by Kim-san)
First year; CH$_3$OH maser at 44 GHz

- First VLBI imaging toward 18 HM-YSOs
  - Selected from KVN SD survey (K.T. Kim et al.)
  - Resolved out in most sources but feasible for proper motion measurements in a few sources
  - Extended distributions with >arcseconds, need wide FoV

Results of from the KaVA PET
(See presentation by Sugiyama-san)
Proposal for second year; K-band

- Proper motion measurements for 16 samples
  - Multiple features to see systematic motions
  - 5 epochs, 4 sources/track, 8 hrs, need 160 hr
Proposal for second year; Q-band

- Proper motion measurements for 3 samples
  - Multiple features to see systematic motions
  - 5 epochs, 3 sources/track, 8 hrs, need 40 hrs
  - Need wide-field imaging

Results of from the KaVA PET
(See presentation by Sugiyama-san)
Follow-up projects and status

• All are complementary to KaVA results
  – VERA; partially observed, on-going (2 finished, 2 monitoring)
  – JVN; resumed from November (observed 5/22 sources)
  – ALMA cycle 3; data available for 11 sources, more proposals!
  – SD; troubles in ASTE, to be resumed soon
  – JVLA; failed -- planning collaboration with Bessel
  – Others; large survey data archive from cm to IR
Organization

- Slightly changed from original plans
  - Need more man power for science team
  - Always welcome contribution from new comer!
Schedule

- First year; finished

- Preparation for the second year
  - Proposal deadline; October 31
  - Interim review; November 22
  - Iteration between referees; within 2017?
  - New season; Early January (2018A)?

- Publication from the first year
  - About 10 at maximum (hopefully) within 1 year
  - Mainly for case studies and initial catalog
Summary

• KaVA LP for SFRs has started since early 2017
  – First year results have provided promising samples for further proper motions measurements
  – We will continue monitoring of the selected targets in the second year
  – Part of the first year results will be published within one year, mainly for case studies of spatial structures of HM-YSOs (and initial catalogue)
  – Follow-up proposals will be prepared continuously as they are also essential for our success