

Possible Key Sciences in SKA-VLBI

For spectral lines



Hiroshi Imai

Graduate School of Science and Engineering,
Kagoshima University

On behalf of the SKA VLBI Working Group

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- ❖ **Ultimate angular resolution (~ 1 mas) and astrometric accuracy (\sim a few μ as)**
 - See Ivan Agudo's talk (compact continuum sources)
- ❖ **Big and a large variety of samples of sources**
 - $\sim 10\,000$ possible target maser sources

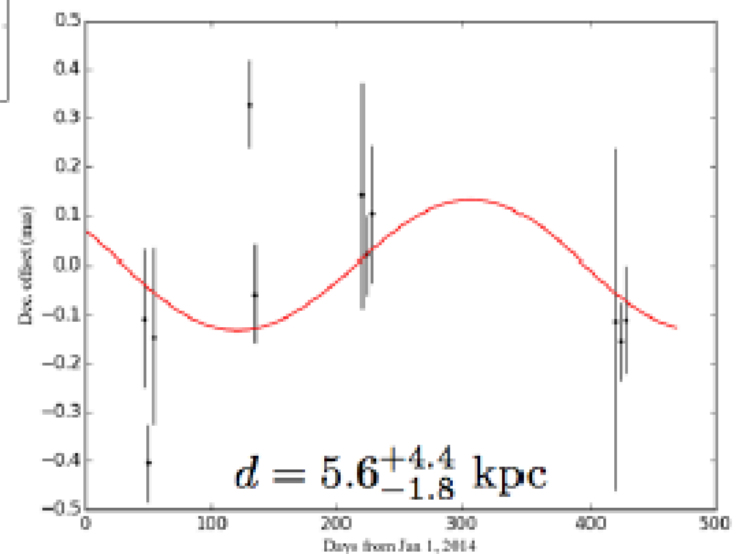
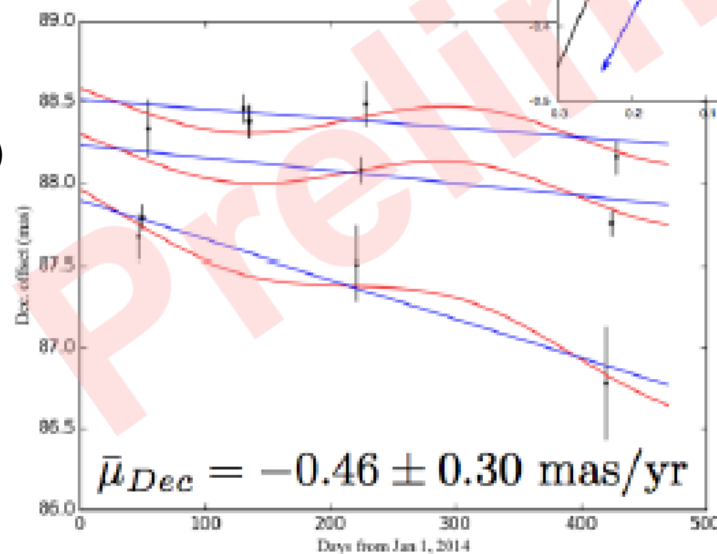
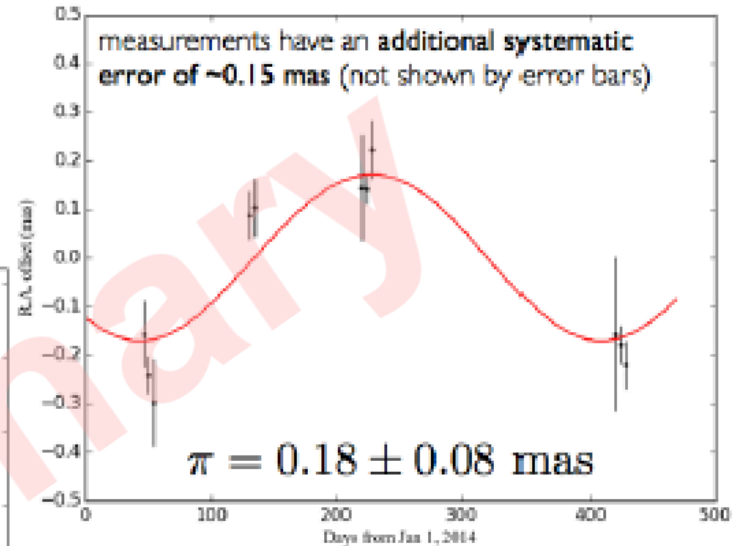
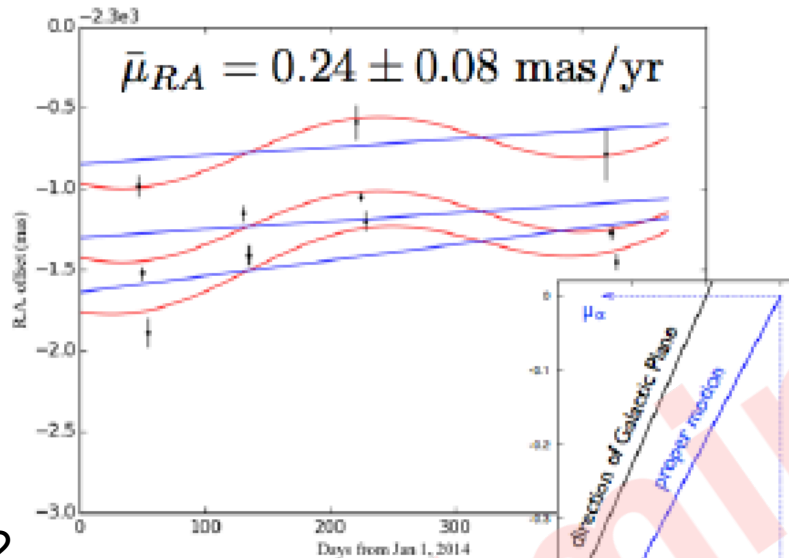
❖ **Specific to spectral line VLBI (SKA1-MID)**

- Targets
 - Non-thermal *emission*: masers
 - *Absorption* with thermal sources with compact backgrounds
CH, OH, CH₃OH, H₂CO, HC₅N, C₄H, CCS, (H₂O, NH₃), ..., HI, radio recombination lines (RRLs)
- Techniques: **free from dilution effects**
 - 3D velocity fields (with l.o.s vel.), velocity drifts (acceleration)
 - Polarimetry: **Zeeman splitting** (Robishaw et al. AASKA15_110)

sub-mas annual parallax of OH masers

1612 MHz
OH masers
Towards
OH138.0+7.2

Orosz et al.
(2015 in prep.)



❖ Dynamics (astrometry)

- Milky Way **spiral arm tomography** (see Mark Thompson's talk)
sequence of stars in different stages and locations in spiral arms, $\sigma_D \sim 10 \text{ pc@1kpc}$
- Bulge: testing coevolution with the central massive black hole
- Local Group dynamics (orbital determination of the satellite gals.)

❖ Magnetism (polarimetry)

- Macroscopic: Galactic scale (e.g. along disks)
- Microscopic: Individual sources:

mass accretion and jets around young and dying stars

❖ Interstellar turbulence (astrometry and source mapping)

- Macroscopic (irregular motions): **super bubbles, cloud collisions**, etc.
- Microscopic:
 - **seeds (tiny structures)**: as building blocks of molecular gas clumps/cores
 - **<100 AU**, seen in absorption or scintillation
 - **shocks, vortices**: points of turbulence dissipation
 - **<1 AU**, seen in maser regions

Galactic and extragalactic targets

—External galaxies at nearby and cosmological distances—5

See Mark Sargent's talk

❖ Starbursts and galactic evolution

- **OH masers** tracing sites of *present-day* massive-star formation
- **CH₃OH masers** as new probes of SFRs in external (nearby) galaxies (?)
(c.f. Chen et al. 2013)

❖ AGN diagnostics

- Process of mass supply from disks/tori down to super massive black holes (SMBHs) (<1 pc)
- Diagnostics of AGN systems (e.g. absorption systems)

❖ Cosmology

- Masers used for determining cosmological parameters (e.g. H_0)
though geometrical parallax distances
- Mega-masers in the Hubble flow ($D > 30$ Mpc)
 - Mega-maser Cosmology Project (Braatz et al.)
 - H₂O masers at **z=0.66** (Barvainis et al. 2005)
- Mega-masers in gravitational lens systems
 - H₂O masers at **z=2.64** (Impellizzeri et al. 2008)

❖ Spectral resolution

- 0.5 GHz BW/130k channels → 0.72 km/s @1.6GHz OK
- Narrower channel width for **Zeeman splitting** measurement

❖ Commensality: widely expected, but depending on

- station beam size and beam numbers
- common targets and fields:
continuum VLBI, pulsars, Milky Way survey, AGN surveys, etc.

❖ Synergy

- Between sciences in high and moderate angular resolutions (HI, molecular lines, etc.)
- Between different populations in common fields (objects in the Milky Way, AGNs)

❖ Locations of VLBI antennas

- **100—3000 km from SKA1 core** (for Galactic sources)

- ❖ **Spectral line VLBI also well follows the strategy for continuum VLBI with the SKA.**
- ❖ **Tight association with other KSPs should be explored**
- ❖ **Specific features to spectral line SKA-VLBI are**
 - Spectral resolution
(for Zeeman splitting and analyses for ISM turbulence)
 - Array configuration (100—3000 km for Galactic sources)
 - Monitoring for astrometry and interstellar scintillation
 - VLBI correlation (with phase-up signals from the SKA core)
 - Off-line procedures of data reduction and analyses

Thank you!