



The Proper Motions of Water Masers at 22 GHz in W49N star-forming region measured with KaVA

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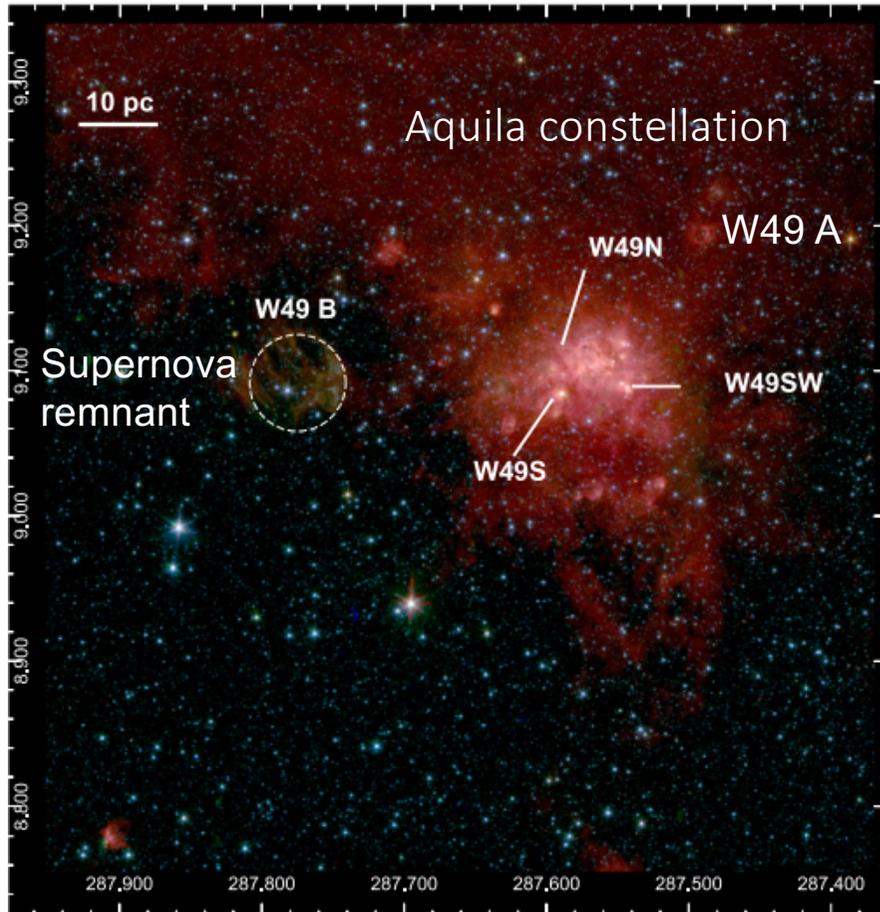
OUTLINE OF TALK

- 1) Introduction and the objective of the study
- 2) Methodology
- 3) Result and discussion
- 4) Conclusion & Future works

What is W49 A?

Star-forming region W49 A

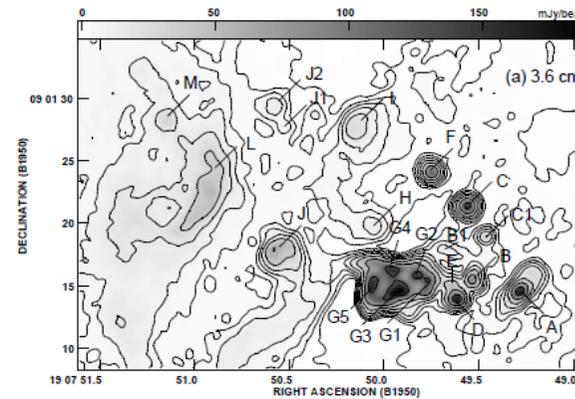
11.1 kpc [Zhang+2013]



(Saral+2015; Spitzer IRAC band)

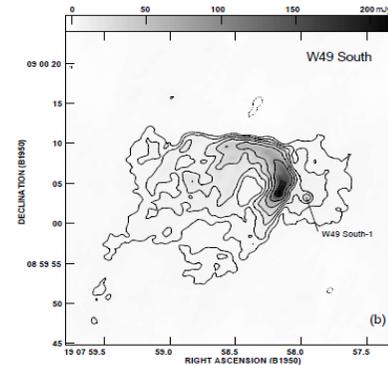
[De Pree+1997]

W49 N: Welch ring (3.6 cm)

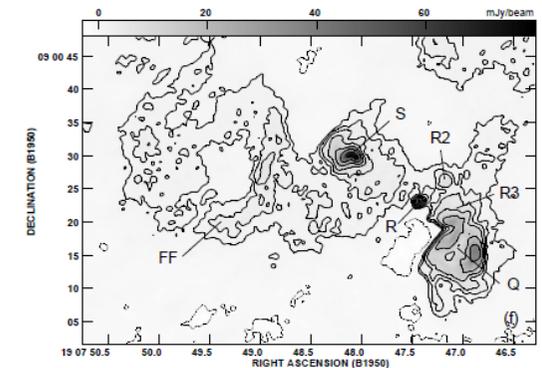


- Complex and luminous
- Strong signal in water maser

Cometary shape: W49 S (3.6 cm)



W49 SW (3.6 cm) W49



The possible causes & Literature reviews

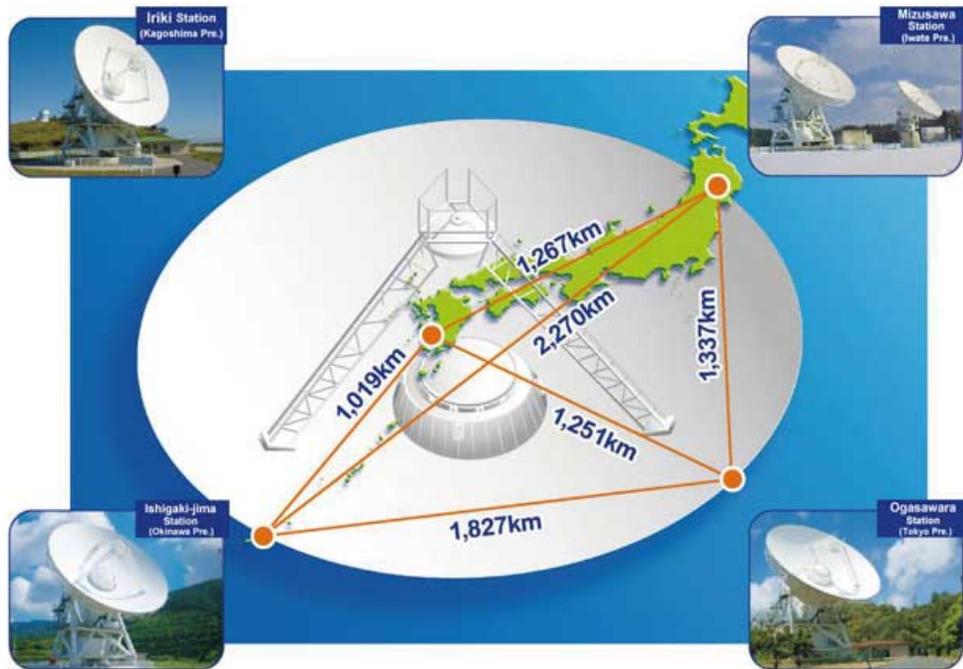
- 1) Water maser emission from star-forming regions is known to show a **strong time variation** and the most variations are 'outbursts' by changing dramatic flux for a few tens of days until to a few months.
- 2) The outburst mechanism is still puzzling!
- 3) The recent strong outburst of the W49N H₂O maser was observed in 2003 with VERA (Honma+ 2004) and found to be located on the **arc-like structure** in the central maser concentration, implying its connection to shock phenomena powered by the YSOs.
- 4) The burst events will be occurred again ~2017, therefore, the good chance to **re-observe** by using the **Effelsberg telescope** (Kramer, B.H.) and KaVA (this work).

The objective of the study

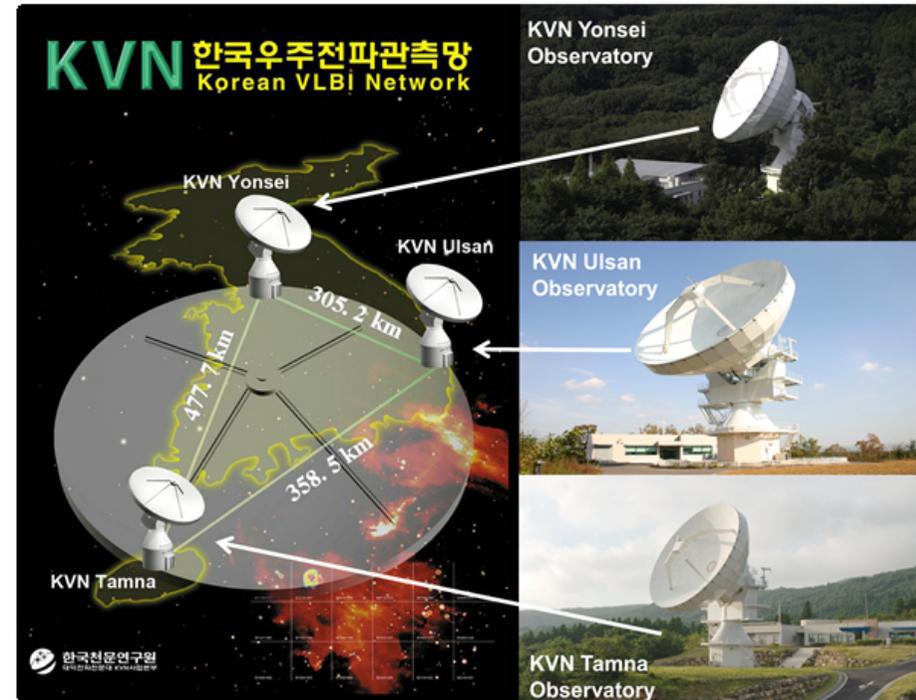
- To study the physical properties of water masers such as the position offset, the radial and transverse velocities toward W49N star-forming region
- To study the proper motion of water masers by using KaVA data
- To study the flux variability by comparing the positions of water masers with previous work (i.e. **Effelsberg telescope** => Kramer, B.H. in preparation)
- To understand the environment of W49N region; morphology, flare

Methodology

Resolution at 22 GHz → 0.001-0.005 arcsec



<https://www.nao.ac.jp/en/news/science/2012/20121003-vera.html>



<https://www.kasi.re.kr/eng/pageView/89>

Total time requested: 40 hrs;

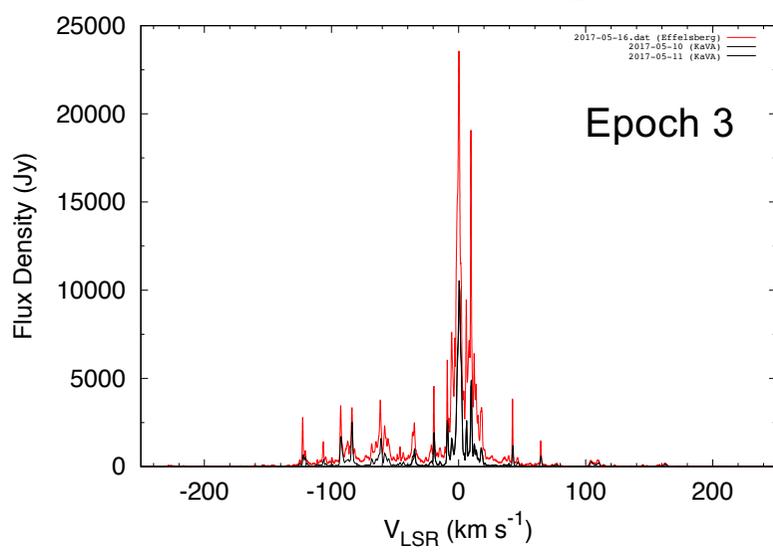
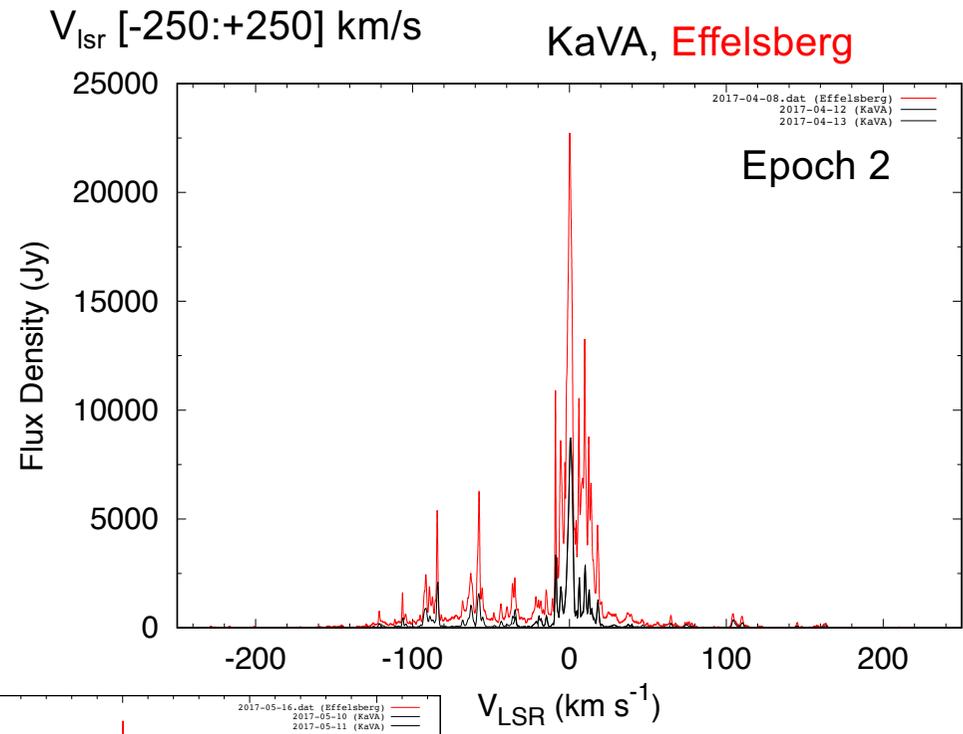
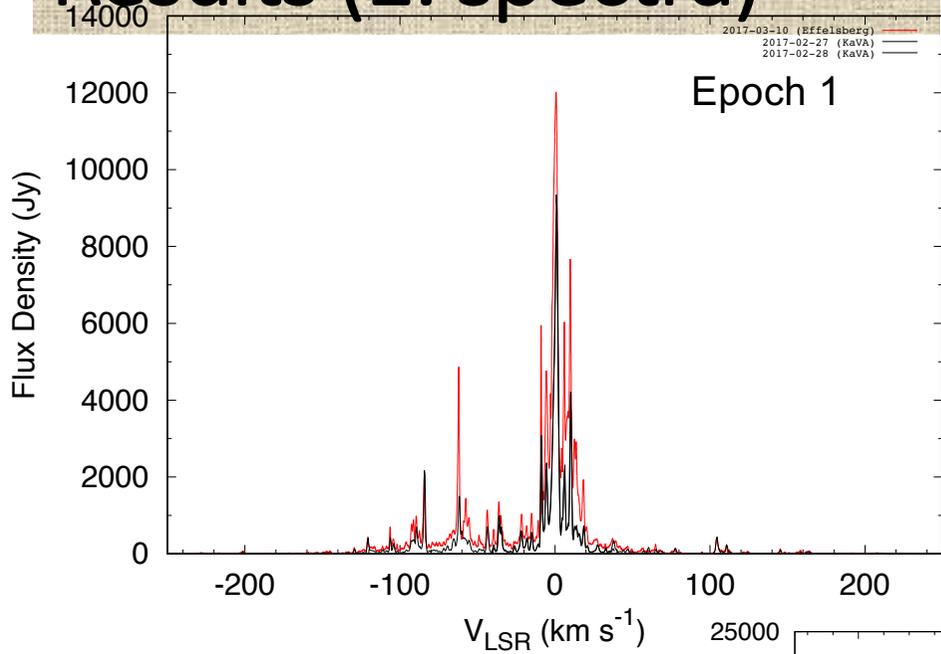
Number of hour each: 5 hrs ; Min/Max Separation: 1-3(calibrators)/20-40 days(target sources)

Epoch 1 (58.5D): Feb. 27-28, 2017 (1&2 session)

Epoch 2 (102.5D): Aprl. 12-13, 2017 (1&2 session)

Epoch 3 (130.5D): May 10-11, 2017 (1&2 session)

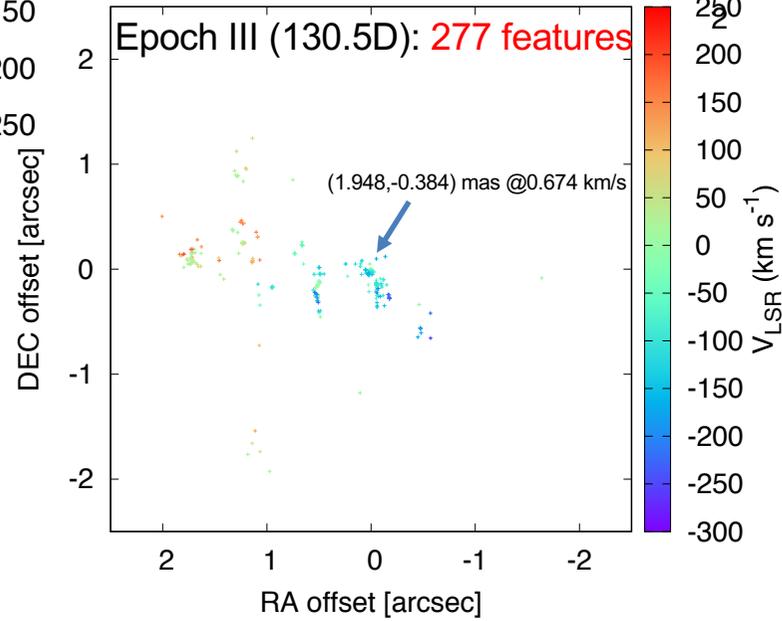
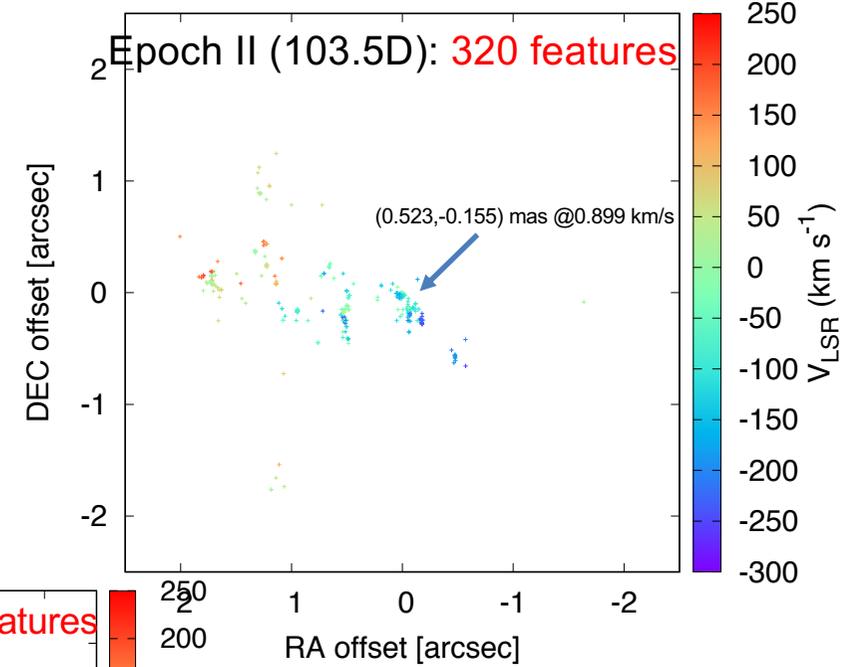
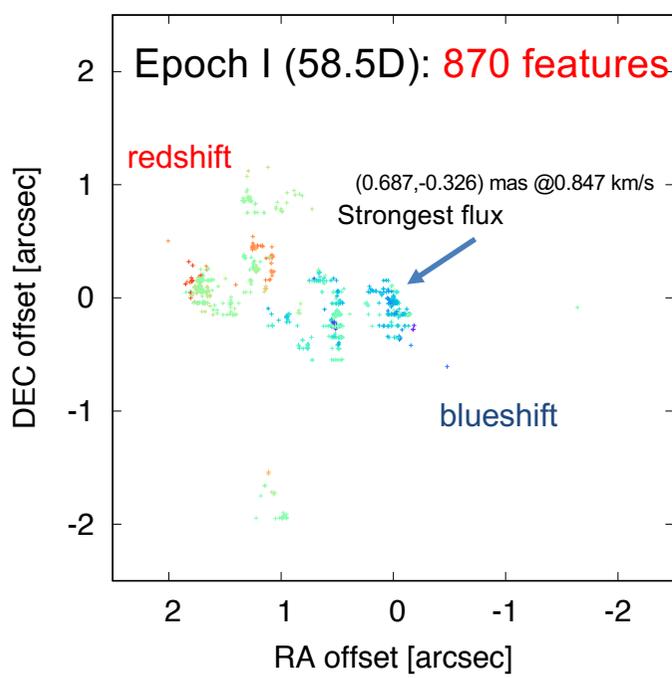
Results (1: spectra)



KaVA, Effelsberg

Effelsberg:
Ep1 Mar. 10, 2017
Ep2 Apr 8, 2017
Ep3 May 16, 2017

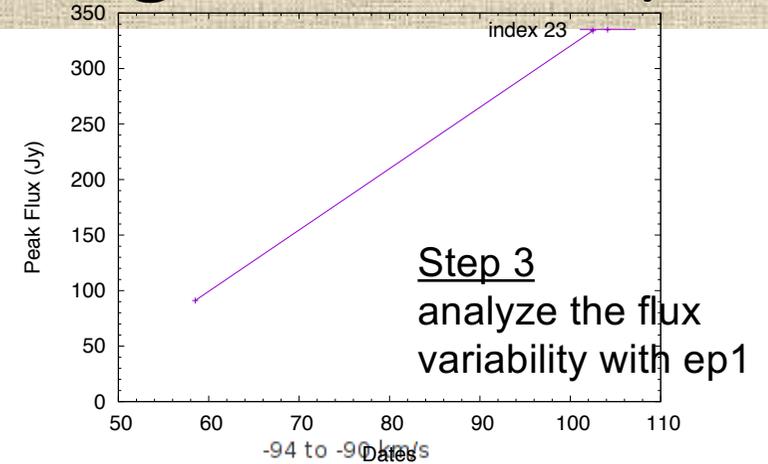
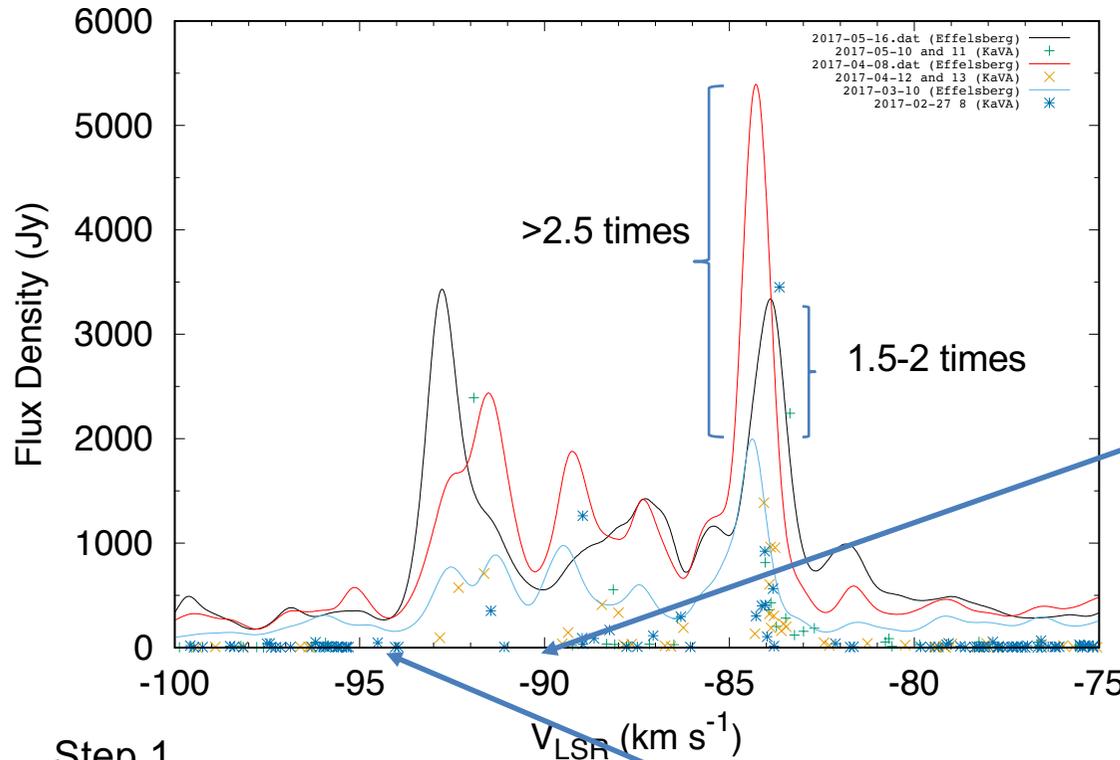
Results (2: distribution)



Gone! disappear

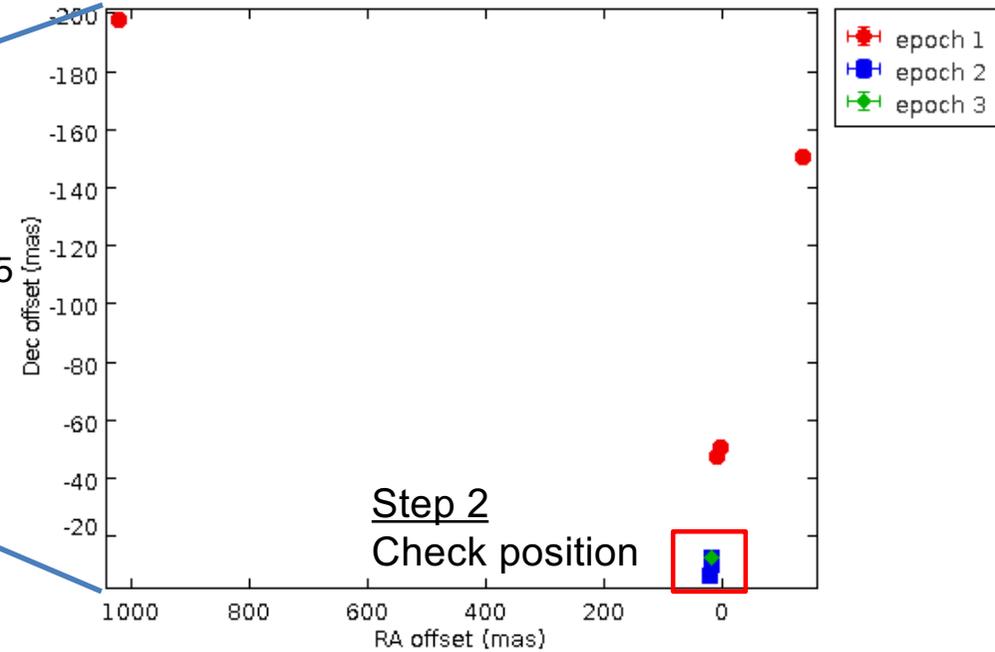
Found in other channels
(0.433, 0.087) @ 1.314 km/s

Results (3.1: Comparison with Effelsberg observation)



Step 1

Span and check in each
velocity set



Results (3.2: Flux variability)

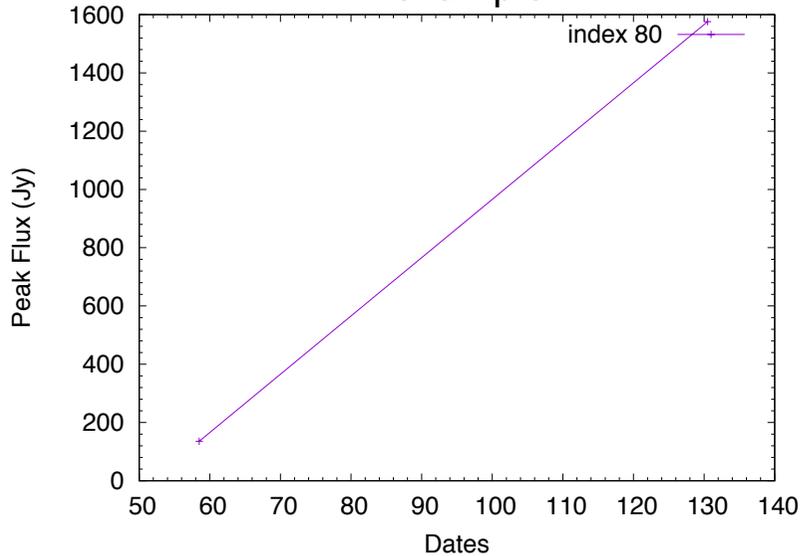
Compare with the single dish spectra which obtained from Effelsberg telescope

99 features of water masers are counted as follow the Effelsberg telescope detection.

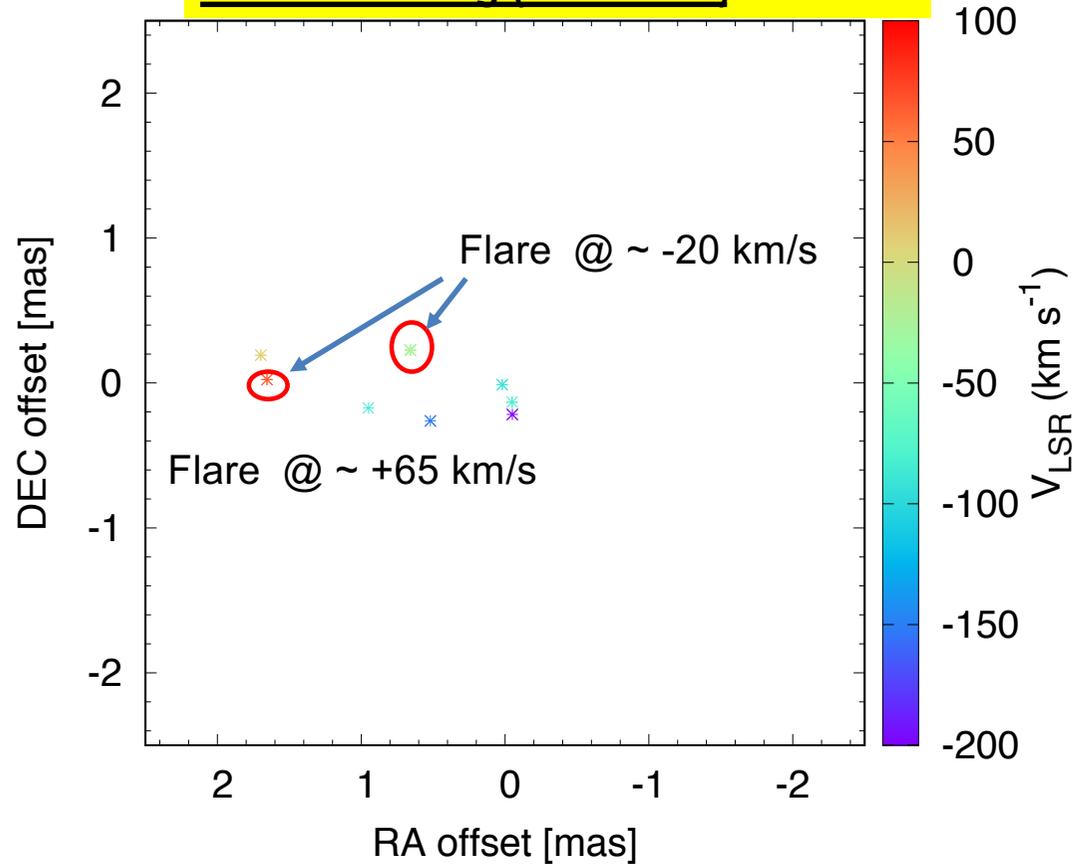
Only 37 features are classified as the flux variability in this observation.

Flare ~ flux \geq 10 times of flux_{ep1}

An example



Flux Increasing (9 features)

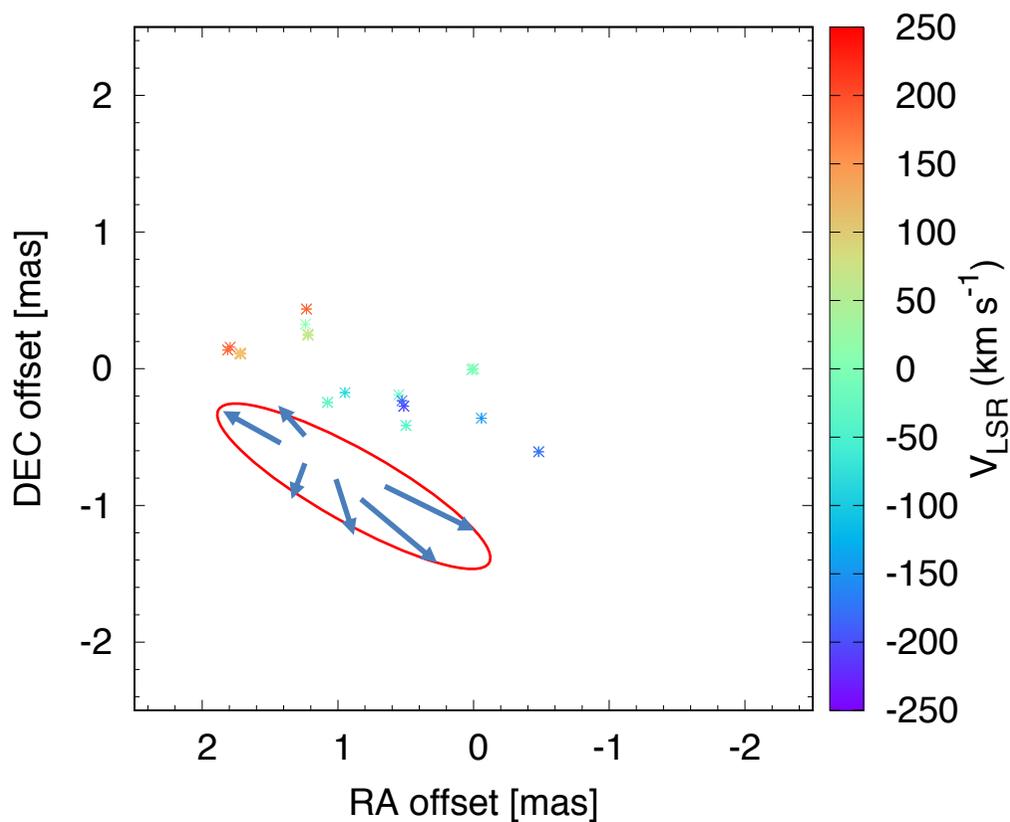


Honma+2004 found ~30 km/s ...burst!

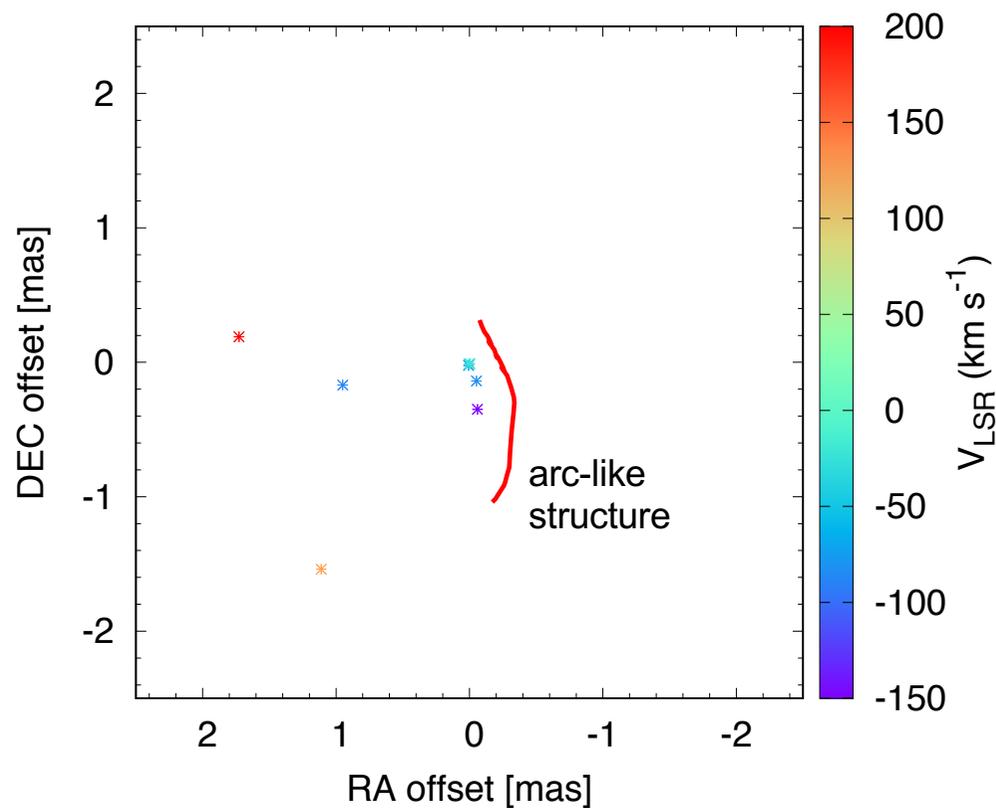
Results (3.2 cont. : Flux variability)

Flux Decreasing (28 features)

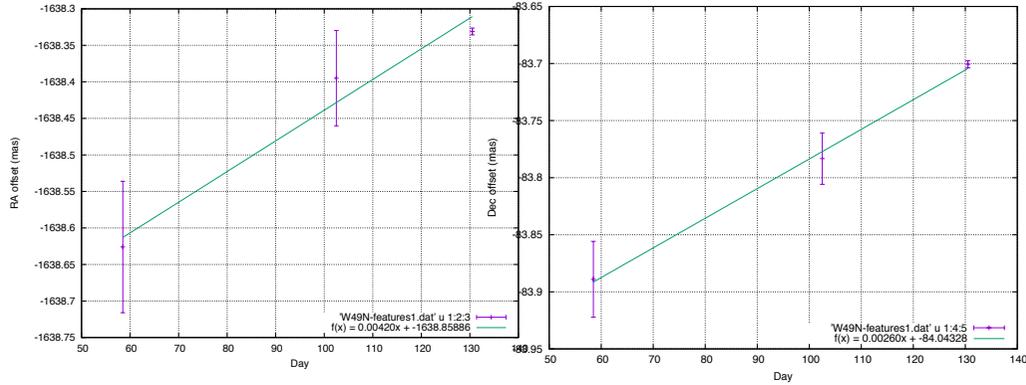
Type A (linear)



Type B (random: decrease+increase)

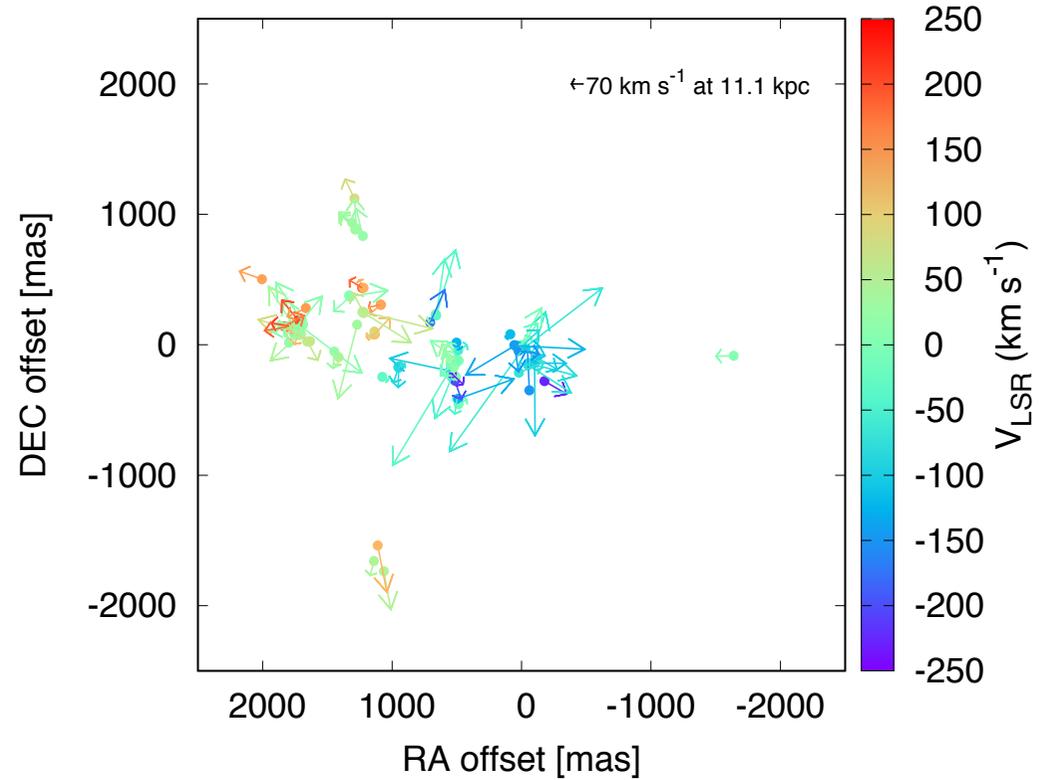
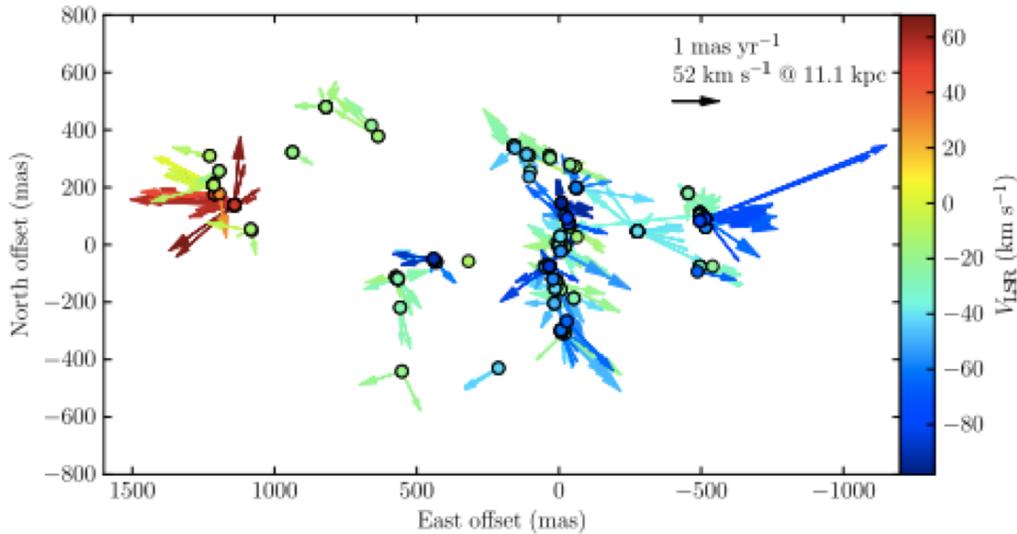


Results (4: proper motion)



Linear fitting => proper motion/year
(ref. the strongest spot and the same V_{LSR})

Proper motions of water maser emission were measured and analysed by Zhang+2013 (BeSSeL survey).



Conclusion and Future works

- The KaVA spectra have the flux density in the same trend with Effelsberg telescope.
- Found many new spots which have flux variability in each epoch
- The strongest flux for our results are found $\sim 10,000$ Jy and at the centre.
- The proper motion of water masers are agreed well when compared to previous work.
- The maser feature at the region (0.657, 0.226) arcsec is found to be “flare” event and located inside the arc-like structure but different position&velocity.

Future work: Need to do the velocity modelling >> outflow, shell expansion etc.

ขอบคุณค่ะ

ありがとうございました

Thank you for your attention