

# Time Variation of 6.7 GHz methanol maser features by VLBI

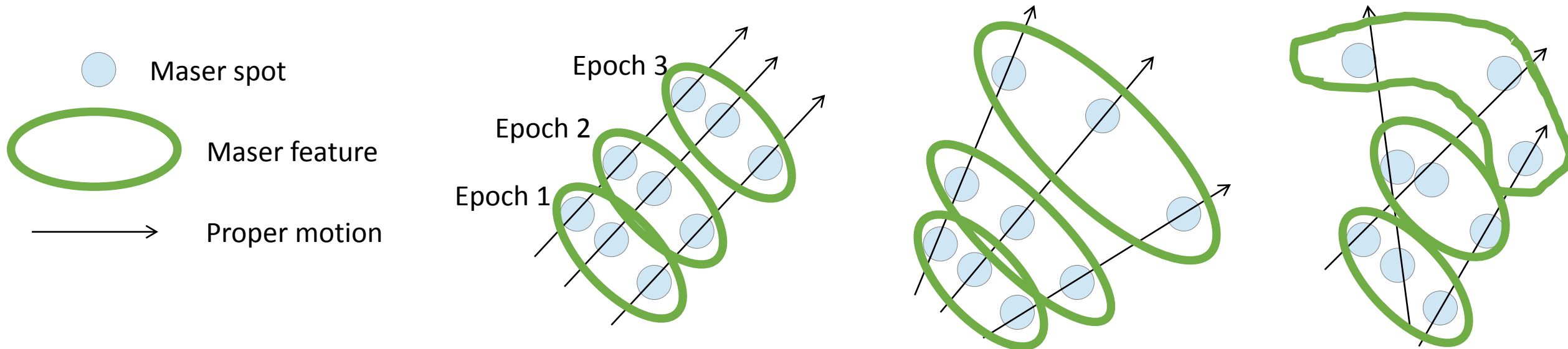
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We are performing the East Asian VLBI Network (EAVN) observations towards 6.7 GHz methanol maser sources which trace gases around massive protostar. The past VLBI observations (includes our EAVN observations) have detected internal proper motion of 6.7 GHz methanol maser, however it is hard to detect because it is too small to detect. Moreover the structure of maser (we called as maser feature) changes within few years, this change is also the reason for difficulty of detection. Here we report the time variation of maser features which observed by EAVN. This is very preliminary result.

# Introduction:

## Time variation of maser feature and expected proper motion

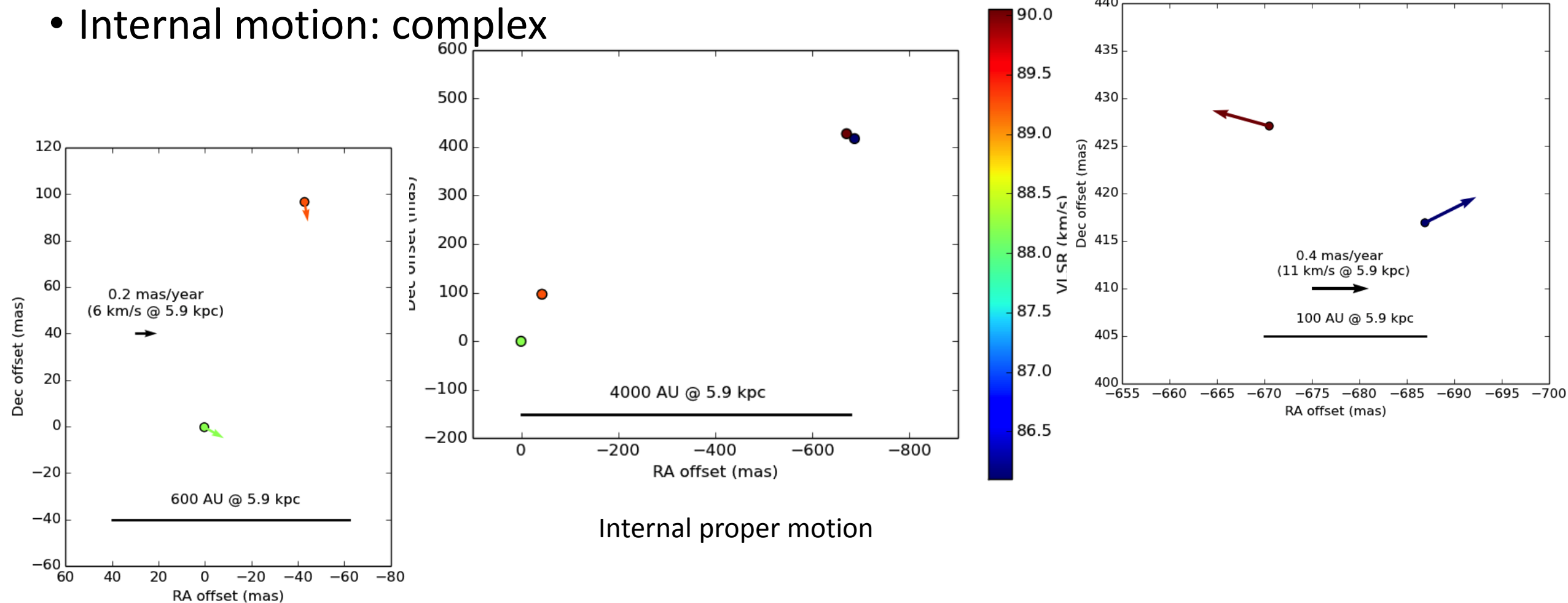
- Detected proper motion of maser features includes
  - Global motion (~100 to 1000 AU scale)
    - rotation around protostar, outflow from protostar
  - Local motion ( 1 to 10 AU scale)
    - turbulent motion of gas (probably change structure of maser feature)



Structure of maser feature during observations is	NOT changed	Expanded	Random motion
Detected proper motion should be	Same motion	Outward motion	Complex motion

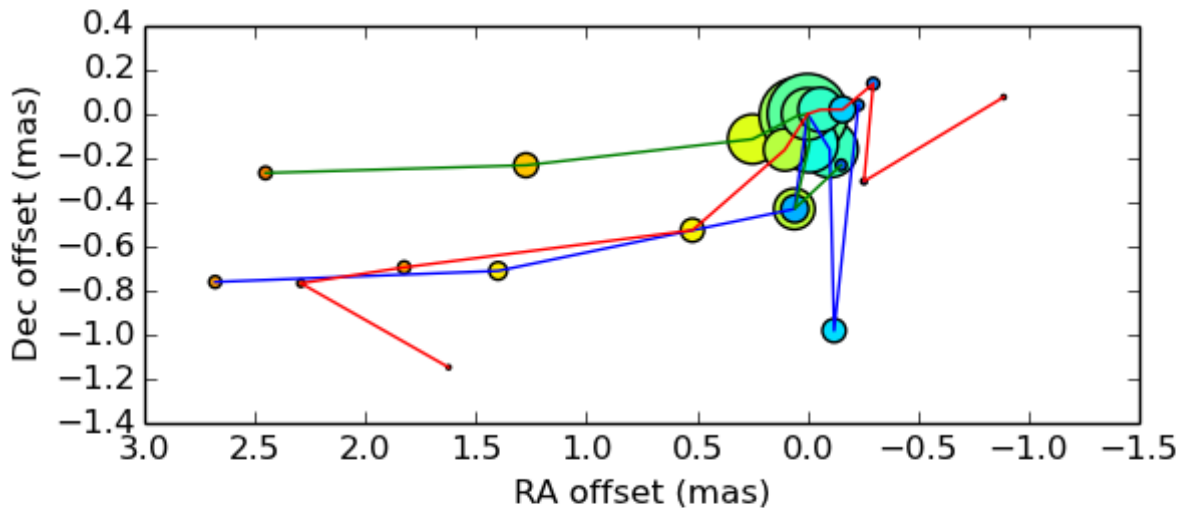
# Case 1. G30.70-0.06

- Distance: 5.9 kpc (annual parallax)
  - 1 milli-arcsecond = 5.9 AU, 1 mas/year = 28 km/s
- Morphology: “Paired” (Two maser groups exists).
- Internal motion: complex

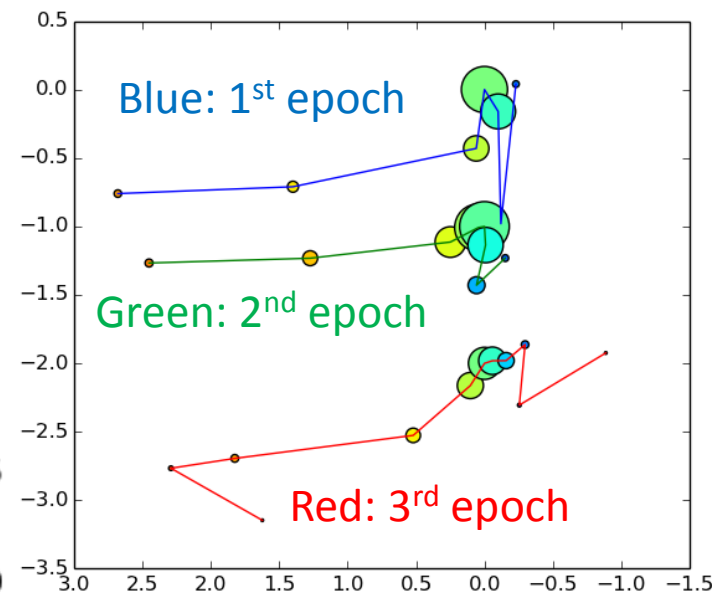


# G30\_feature01: positional reference feature

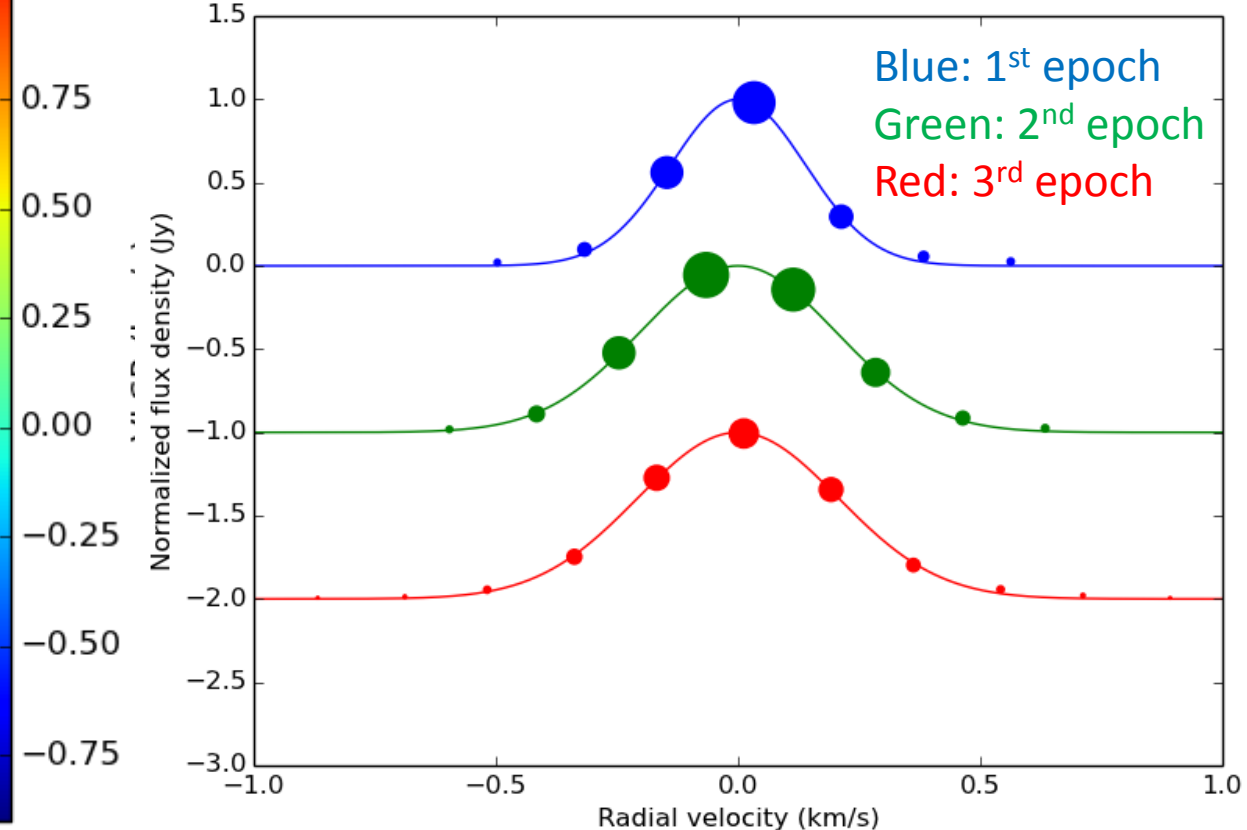
- This maser feature contains the strongest maser spot.
- The position of the strongest maser spots set to  $(x,y)=(0,0)$  at all epochs as the positional reference.



The size of circle show the magnitude of flux density of maser spot.  
(Larger circle show stronger flux maser spot)

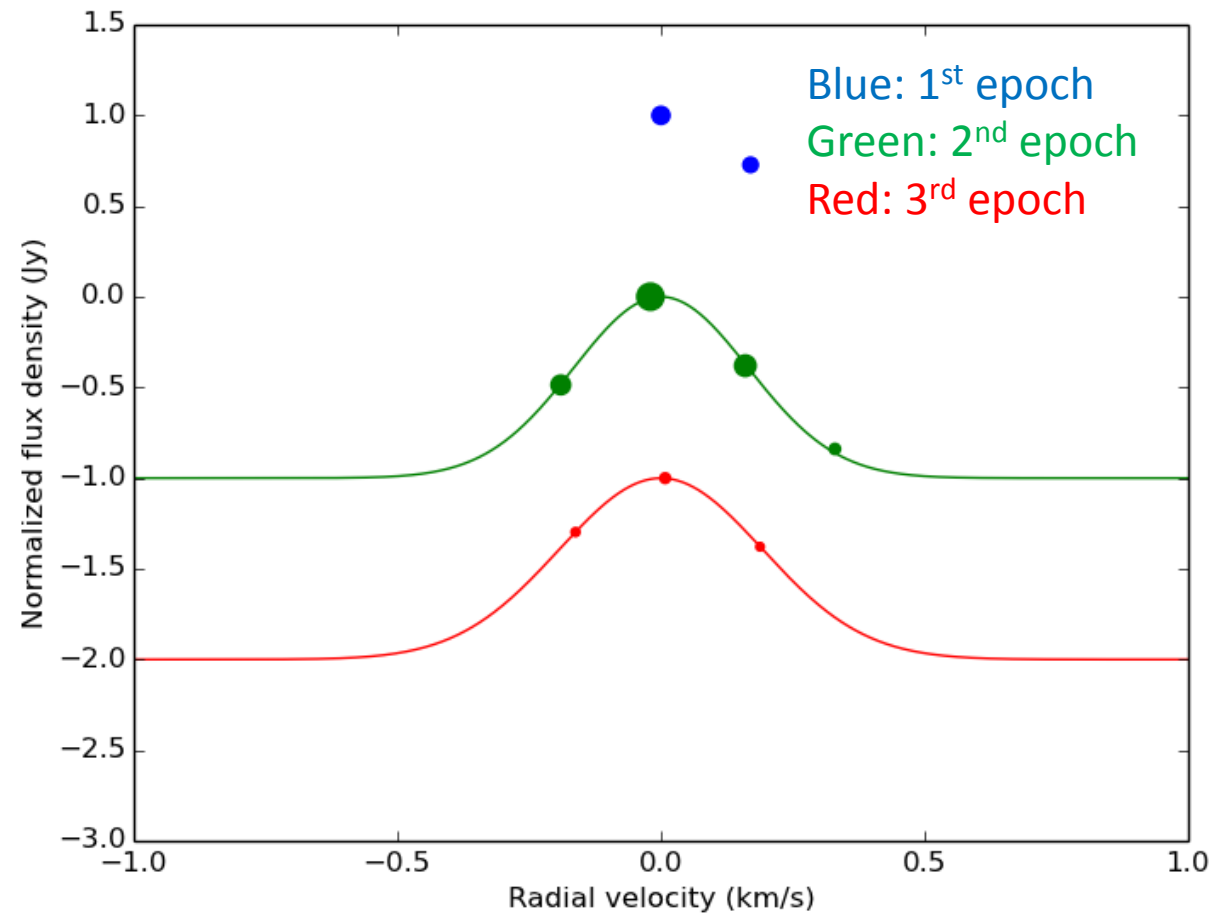
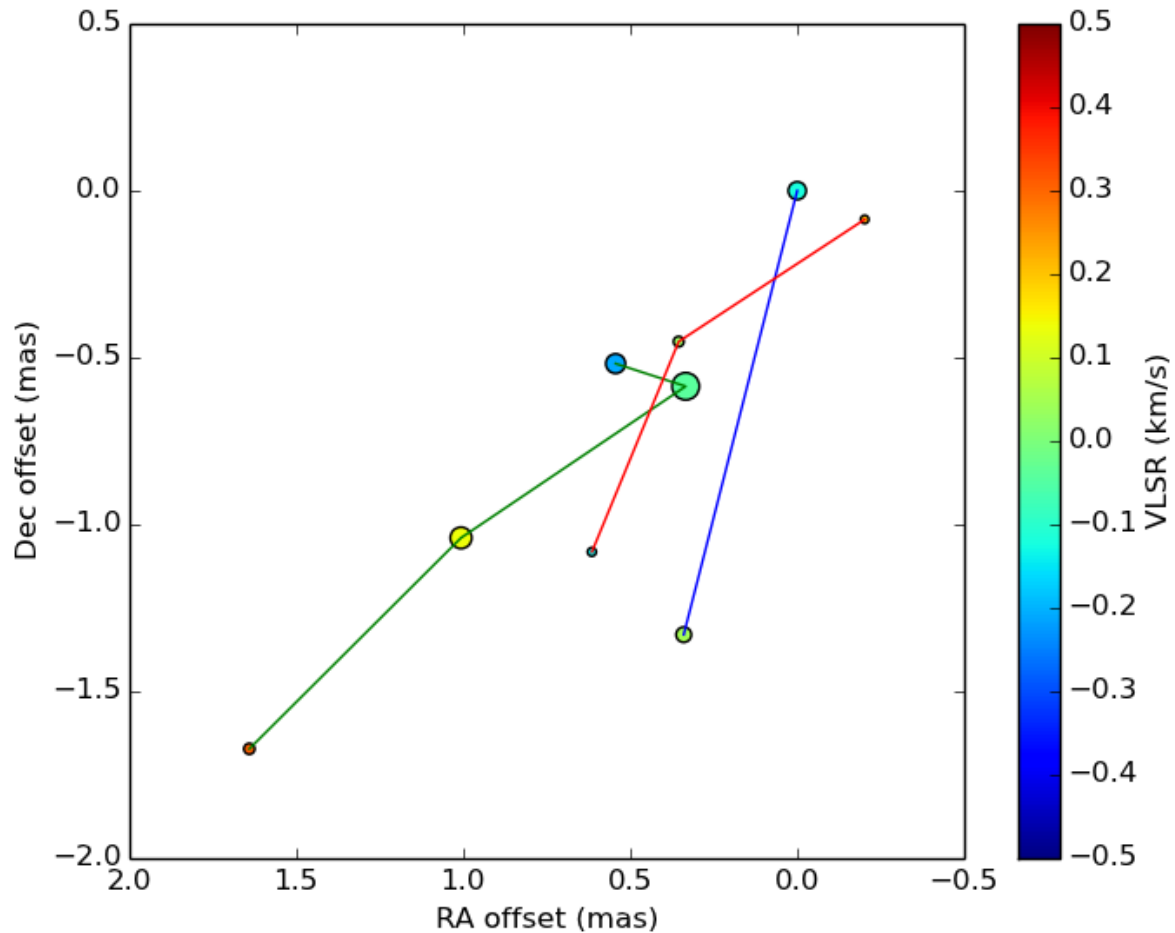


Structure change of this maser feature.  
(To check the changes, add position offsets)



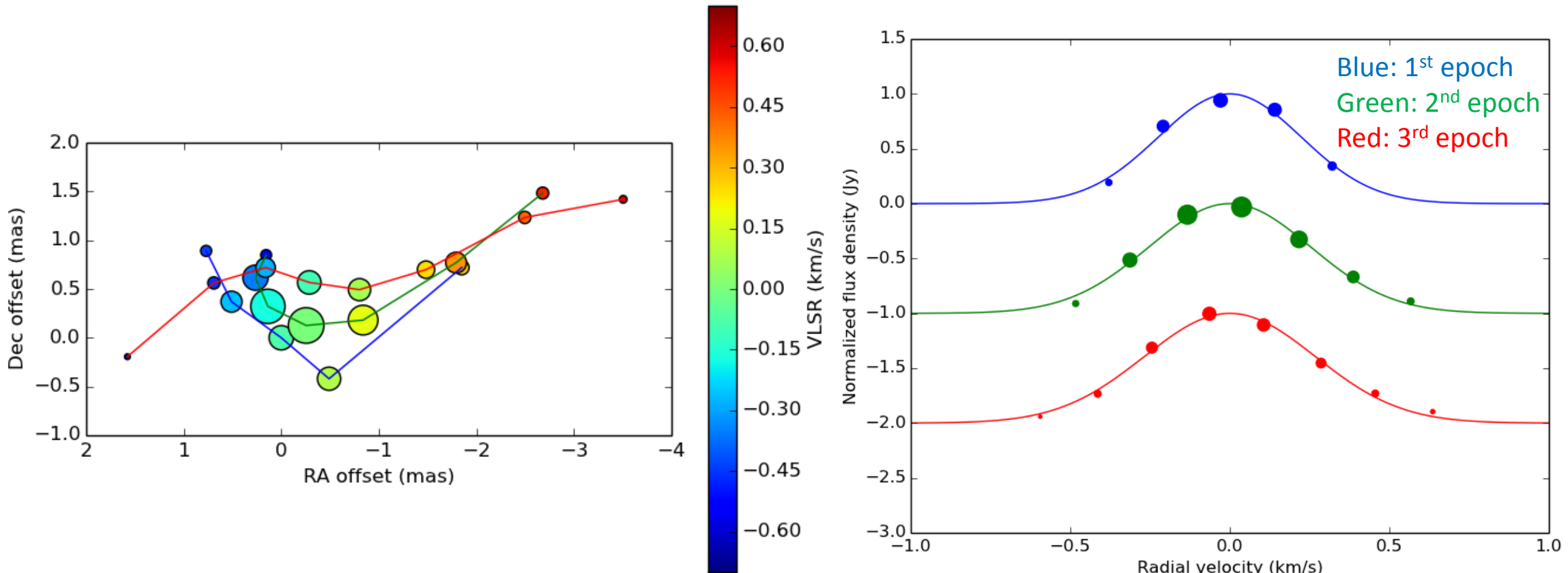
# G30\_feature02: complex motion

- This is not linear motion.
- New maser was appeared?



# G30\_feature03: Structure changed slowly

- The structure was stable during the observation



# Summary: Structure change of maser feature

- The most of maser features changes the structures within 0.2 mas/year, which corresponds 5 km/s at 5 kpc.
  - Local (turbulent) motion?
  - New maser was appeared? (not real motion)
- The most of maser features show complex motion, especially weaker maser features.
  - Q: Is it real? , A: I don't know.
- Perhaps, these maser varied rapidly more than we expected.
  - I thought the methanol maser is stable within a few years at least.
- Of course, there is a possibility that my data reduction is failed.
  - Check the data again.

