Long-term flux variation of 6.7 GHz methanol maser in High-mass star forming region

H.Nakamura , K.Fujisawa , K.Ninuma , K.motogi , K.Hachisuka (Yamaguchi university)

ABSTRACT

It is known that 6.7 GHz methanol maser in high-mass star-forming region shows the flux variation. The methanol maser is excited by IR radiation, and the variation of the maser is caused by the variability of the central source. However, the maser of the Mon R2 can not be simply explained by IR excitation of the circumstellar gas. Mon R2 shows significant flux variation (∼180Jy) as well as the variation of its line shape. The maser spot distribution is perpendicularly to the radial direction from the central star. The variability and distribution suggest that the maser trace the shock region caused by outflows from the central star. Therefore the excitation mechanism of the 6.7 GHz methanol maser in Mon R2 is still unclear. We plan to find sources like Mon R2 and to reveal the excitation mechanism by comparing such as nature of the flux variation and spatial distribution in many sources. Currently, we are looking for candidate sources that show the behavior of the flux variation similar to Mon R2 based on the data of monitoring of the long-term flux variation over 100 sources by Yamaguchi 32m radio telescope (2004∼2007,2010) and Torun survey in 1999 (Szymczak et al.2000).

INTRODUCTION

High-mass stars have mass of M>8M_{sun} .

The formation process of high-mass stars is important. However, its formation process (Mass accretion stage of gas in particular) is still unclear. 6.7GHz methanol maser has been used in the study of motion of gas around the stars under standing motion of this gas. Features of the 6.7 GHz maser are as follows.

- Associated only with high-mass star forming region
- Long life (more than 4 years [2])
- Flux variation
- Very compact and bright (VLBI observation)
- 3D kinematics (Doppler shift +Proper motion) would be available

→ Useful tool !!

Unsolved problems

- What is associated with ? (Disk ? Outflow?)
- Mechanism of excitation ? (IR excitation from warm dust (100~200K) [3])
- Mechanism of flux variation ? (variation of the central source [1])

Mon R2

High-mass star forming region Mon R2 (Table 1.) has peculiar features.

- The 6.7 GHz methanol maser in Mon R2 away ∼0.1pc from near UC H Ⅱ region.
- The maser spot distribution is perpendicularly to the radial direction from the central star.
- Shape of the spectrum shows large change (Figure 1)
- Radial velocity drift is detected.(~$7.3\times10^{-2}[km\cdot s^{-1}\cdot yr^{-1}]$) [5]

This maser may be associated with an outflow ? And what is the excitation sources ?
Flux variation and proper motion study is needed !!

→ There may be sources like Mon R2.
It will help to understand the excitation mechanism if we find such sources !!!

Table. 1. Source information of Mon R2

Distance	0.83kpc(from the solar system)
	the third-closest sources from the solar system among the high-mass star forming region.
Center mass	∼$15M_{\odot}$
Luminosity	∼$1.4\times10^{4}L_{\odot}$

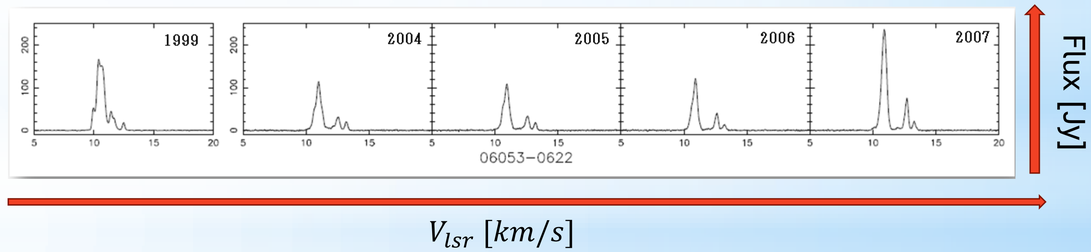

Figure. 1. Spectrum of MonR2 observed in 1999, 2004 , 2005, 2006 and 2007. [4:

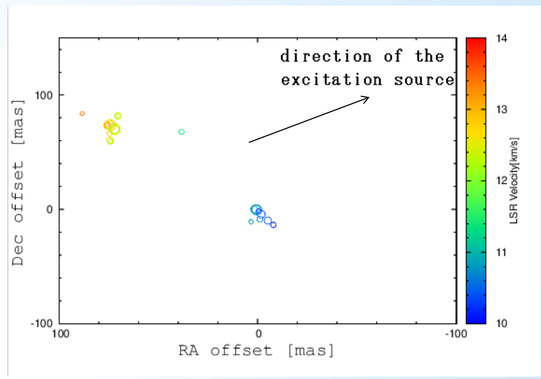

Figure 2. spatial distribution of the 6.7GHz methanol maser in Mon R2

PURPOSE

Our aim of this study is to observe the long-term flux variation over 100 sources and find the flux variation sources similar to Mon R2.

Increase the sample sources

If we can find flux variation sources such as Mon R2, it may be a clue to reveal the excitation mechanism of 6.7 GHz methanol maser.

SOURCE SELECTION

The election of candidate sources in our study is as follows.(after Szymczak et al. 2000)

- $S_{60} \geq 100$Jy (Storng)
- $S_{60} \geq S_{25}$ (low temperature)
- $\delta \geq -20°$ (Observable in the Northern Hemisphere)

→ 1411 candidate sources

S_{60}: Flux density of 60 μm in IRAS observation wavelength
S_{25}: Flux density of 25 μm in IRAS observation wavelength
σ :The declination in 1950 equinox

2. Source with 6.7 GHz methanol maser detected at least once in Torun 1999, Yamaguchi 2004～2007

213 sources

OBSERVATION

We will observe the 213 sources by Yamaguchi in 2014. We plan the observation of approximately one and a half months from November, 2014. Table 1 shows observation parameter of Yamaguchi in 2014. The expected rms noise level 1σ of～0.7Jy. The observation time of one source takes 420 seconds if we assume detection limit of 3σ.

Table.1. Observation parameters in Yamaguchi in2014

	Yamaguchi (2014)
Radio telescope	Yamaguchi32m
Beam size [arcmin]	～5
Aparture efficiency [%]	70
System noise level temperature [K]	40～80
Bandwidth [MHz]	4
Sampling bit [bit]	2
Intergration time [s]	420

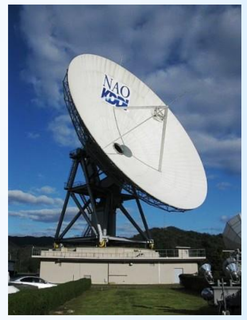

Figure.2 Yamaguchi 32m radio telescope

FUTURE

We will observe 213 flux methanol maser sources and their variation from November of this year.
It is possible to increase the sample of sources such as Mon R2 by this observation. If we can find the flux variation sources as Mon R2, we will conduct the short-term flux variation monitoring and VLBI observation.
We can know the detailed flux variations by these observations and it might lead to the clarification of excitation mechanism of the 6.7 GHz methanol maser . Because the relationship of shock area of outflow from the central star and IR excitation is still clarified, we try to reveal it.

REFERENCE

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