Cosmic Masers: Proper Motion toward the Next-Generation Large Projects
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Intensity monitor of water maser emission associated with massive YSOs

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Abstract. We are carrying out the intensity monitoring of the water maser emission associated with massive young stellar objects (YSOs) using the VLBI Exploration of Radio Astrometry (VERA) antennas. We are currently monitoring 108 sources. During our long monitoring period, we could find flares on several YSOs. As an example, we show the results from *IRAS* 16293−2422 and NGC2071 IRS1 here. We also show the results of monitoring of the water maser emission from G36.115+0.552, which the methanol maser flare was reported. We observed it as often as possible, usually once a day.

Keywords. masers, starts:massive

1. Introduction

We report our activities of the monitoring observations of the H_2O maser. Our aim of this study is to observe the variation and detect the maser flare. Various follow-up observations toward the flared objects will reveal the origin of flux variations and the circumstellar environment of YSOs.

2. Observations

We are monitoring the 108 sources, which are mainly massive YSOs. We observed the maser lines of H_2O ($6_{16} - 5_{23}$, 22.23508 GHz). We use three VERA stations: Mizusawa, Ogasawara, and Ishigakishima. The beam width (FWHM) and aperture efficiency of the telescope at the observation frequency were 145″ and 0.45, respectively. The pointing accuracy was better than 10”. For the backend, we use the spectrometers which have a frequency resolution of 31.25 kHz and a bandwidth of 32 MHz. This corresponds to a velocity resolution of 0.4 km s^{-1} and a velocity coverage of ±210 km s^{-1}. The on-source integration time is 6 minutes for each source. Our detection criteria is that the peak intensity exceeds the more than 4σ. The worst sensitivity of our observations is 16 Jy (4σ).

We are monitoring most of the sources since 2020. Some of the 108 sources have started the observations from 2015. Since 2020, we are observing at intervals of one month. Before 2020, we observed at intervals of two months.

When we detect maser flare from our target sources, we report it to Maser Monitoring Organisation (M2O). Both the flare sources which we detected and the flare sources which the other M2O members detected, we try to observe water maser emission and monitor it as often as possible, usually once a day.

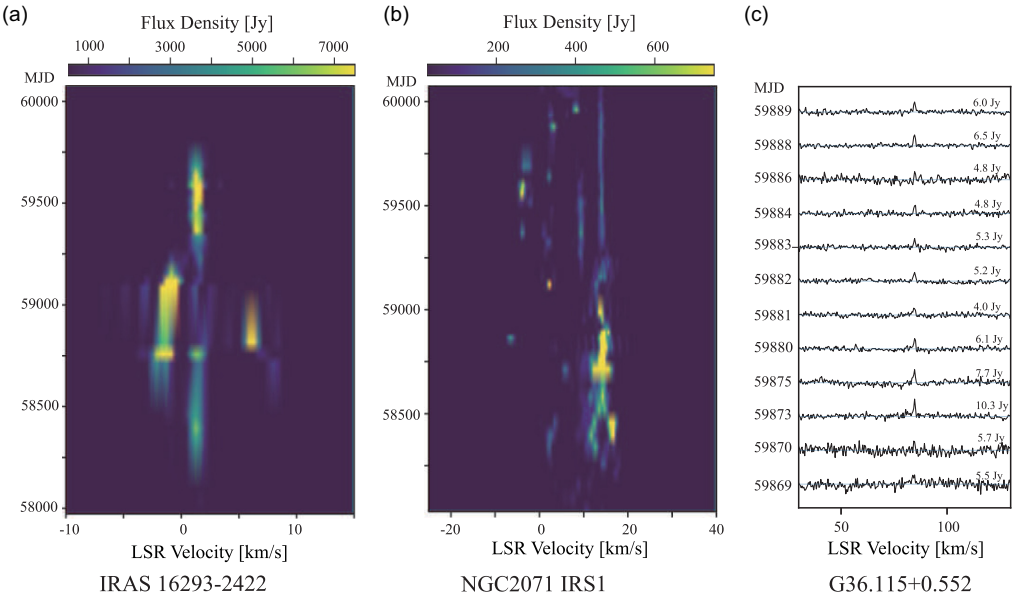

Figure 1. (a) Dynamic spectrum of H_2O masers in *IRAS* 16293−2422.(b) Same as but for NGC2071 IRS1. (c) H_2O maser spetra for G36.115+0.552. From bottom to top the spectra are shifted for each observation day.

3. Results

We present two examples, which we detected the maser flare, and one result which we carried out the follow-up observation of the methanol maser flare source.

3.1. *IRAS 16293−2422*

Figure 1(a) shows the results for *IRAS* 16293−2422 (RA(J2000) = 16h32m22.9s, Dec(J2000) = −24°28′36″). We have detected the increase in the flux of the 1.3 km s^{-1} component on MJD = 58277 (from 500 Jy to 5820 Jy). The flux density of this velocity component reached its maximum on MJD = 58762 and it gradually decreased. At the same time, the flux density of the −0.8 km s^{-1} component increased on MJD = 58587 and reached its maximum of 25700 Jy on MJD = 59088. Following this event, it is interesting to note that the flux density of the 1.3 km s^{-1} component increased again. It reached the maximum of 15990 Jy on MJD = 59517.

3.2. *NGC2071 IRS1*

Figure 1(b) shows the results for NGC2071 IRS1 (RA(J2000) = 5h47m04.8s, Dec(J2000) = +0°21′43″). The brightening of the flux density started on MJD = 58256 (109 to 226 Jy) and reached the maximum flux density of 2200 Jy on MJD = 58818. Ten months later, the flux density of the 2.6 km s^{-1} component showed the flare and reached its maximum flux density of 1260 Jy. Then, more 15 months later, the flux density of the −3.8 kms^{-1} component also flared the maximum flux density of 1000 Jy.

3.3. *G36.115+0.552*

We have also carried out the follow-up observations of flaring sources reported by other groups. The report showed that a flux increase of the 6.668 GHz Class II methanol

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maser of G36.115+0.552 (RA(J2000) = 18h55m16.8s, Dec(J2000) = +3°05′05″) started on MJD = 59790 (Tanabe and Yonekura 2002). We monitored the flux of the H_2O maser daily as far as possible. We show the result in Figure 1(c). The water maser peaked on MJD = 59873. This day corresponds about a week later than the date on which they observed the maximum flux of the methanol maser.

Reference

Tanabe, Y. and Yonekura, Y., 2022, *Atel, #15680*

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