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VERA Single Dish Observations

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Abstract. We will report the activities of the VERA single-dish observations. We are carrying out single-dish observations with two purposes. The first purpose is the monitoring of known H_2O maser sources. At present, we are carrying out monitoring observations for 312 H_2O maser sources at intervals of two months. The second purpose is the search for new water maser sources. We selected 901 target sources from the AKARI FIS Bright Source Catalogue. We found 61 new H_2O maser sources.

Keywords. masers, surveys

1. Monitoring Obsrvations

Because water maser emission shows time variability, it's important to monitor its intensity to progress with the high resolution observations by the VLBI Exploration of Radio Astrometry (VERA) effectively. Periodicity and a flare of the maser emission can be detected only through long-term monitoring observations.

Monitoring observations have been started since December 2015 at intervals of two months. We observed the maser line of H_2O ($6_{16} \rightarrow 5_{23}$, 22.23508 GHz). We used three stations of the VERA, the 20 m telescopes Mizusawa, Ogasawara, and Ishigaki-jima. The beam width (HPBW) and the aperture efficiency of the telescopes at the observation frequency were 145" and 0.45, respectively. The pointing accuracy was better than 10". The spectra were obtained using the digital spectrometer. This provided a bandwidth of 32 MHz and a frequency resolution of 31.25 kHz. This corresponds to a velocity coverage of $\pm$ 215 km s^{-1} and a velocity resolution of 0.4 km s^{-1} at 22.2 GHz. To get the same velocity resolution, data obtained at Mizusawa was smoothed to the same frequency resolution of the data obtained at the other telescopes. The integration time of each observation was 6 minutes. All the data were analyzed by the automatic pipeline. We considered the H_2O maser emission detected when the peak intensity was higher than the 4σ noise level.

We update the monitoring list at August every year. More than 300 sources were replaced because their H_2O maser emission was not detected for more than one year. The present monitoring list consists of 312 H_2O maser sources and includes sources already observed with VERA and sources waiting for VERA observations. We show an example of our monitoring results in Figure 1. This example clearly indicates the intensity variability, the velocity shift of the maser emission, and also the emergence of new velocity components.

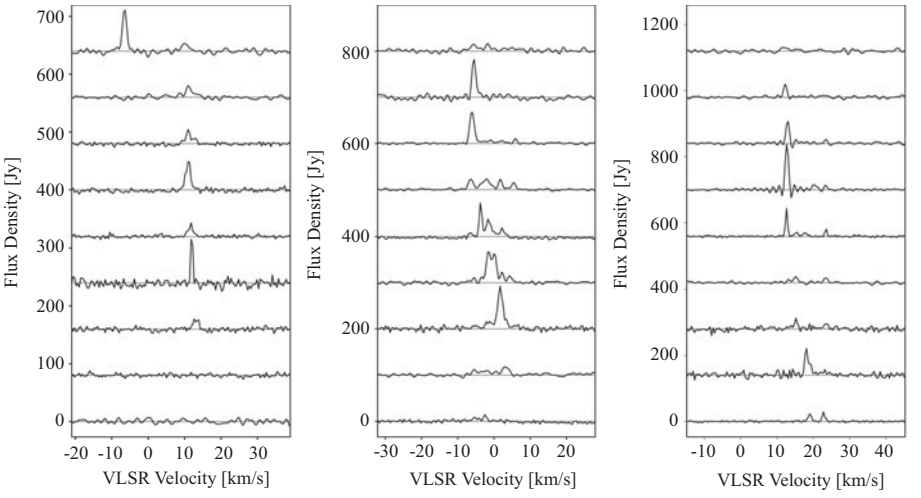

Figure 1. Examples of the results of our monitoring observations for three sources.

2. Survey Observations

Since there were many H_2O maser sources which we could not detect for a long time, survey observations to search for new maser sources are necessary to increase VERA observation candidates.

Various wide-area surveys have been carried out. For example, the far infrared satellite, AKARI, carried out a far infrared survey of all the sky (Murakami *et al.* 2007). The bolometer array camera, Bolocam, carried out the 1.1 mm continuum survey of the galactic plane (Aguirre *et al.* 2011). Such surveys supplied the comprehensive catalogs of young stellar objects (YSOs) and/or dense clumps, such as the AKARI FIS Bright Source Catalogue (AKARI FIS BSC) (Yamamura *et al.* 2010). YSOs and dense clumps in these catalogs are good target sources for searching maser emission.

We selected 901 sources from AKARI FIS BSC. We started the survey observations in August 2009. We are carrying out the survey observations in the intervals between VLBI observations. The specifications of the survey observations were the same of the monitoring observations except for the integration time. Depending on the system noise temperature, we set the integration time of each observation to obtain a 4σ noise level of less than 4 Jy. If the obtained noise level was higher than 4 Jy, we observed the source again. Some of the sources, therefore, were observed more than two times.

We detected the H_2O maser emission from 120 sources. The sources having larger FIS 140 μm flux showed higher detection rates. 61 of the 120 detected sources were new detections. For these new detected sources, we carried out VLBI observations and measured accurate maser positions. These new sources were also added to the monitoring list and we are continuing the monitoring observations.

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