Astrophysical Masers:
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Long term 6.7 GHz methanol maser monitoring program

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Abstract. The first long-term maser (mainly methanol) monitoring program is under way with the radio telescopes of Ventspils International Radio Astronomy Center. The first activity of this program was to develop an observations methodology and data registration and reduction software for the Ventspils telescopes. The developed routines are to be used for maser variability monitoring, investigating short bursts of intensity and a search for new, previously unknown, maser sources. Currently the program consists of 41 methanol masers observed at 6.7 GHz, while new ones are periodically added. The maser sources are observed at 3 – 5 day intervals. It was found that most the sources display a significant level of variability with time, ranging from a few days, up to several months and, perhaps, years. In addition to non-varying masers, several types of maser variability behavior were observed, including: monotonic increases or decreases, un-periodical, quasi-periodic and periodic variations.

Keywords. masers, methanol, radio astronomy, circumstellar matter.

1. INSTRUMENTATION

After a modernization program, the capabilities of Ventspils International Radio Astronomy Center (VIRAC) 32-m and 16-m telescopes have been greatly improved. A methanol maser monitoring program has been started, employing the two radio telescopes. Digital backend consisting from DBBC-2 (*Digital Base Band Convector* developed by HAT-LAB, Italy) and *Flexbuff* (data storage system based on commercially available server system) is used for data digitalization and registration. The spectra were obtained by autocorrelation using program package *mark5access* (tool *m5spec*). We attempted to ensure 3–5 day observation intervals for all selected sources. For bright masers (Flux >200 Jy), the recording time was taken to be 3 min, while for weaker ones – 7 min.

More details about instrumentation and data reduction are given by Shmeld *et al.* (2018).

2. SOURCE SELECTION

The Torun methanol source catalogue (Szymczak *et al.* 2012) was used as the initial list of the monitored methanol masers. The first task after the recent telescope renovation was telescope testing and calibration. The main initial criteria for sources to be included in our list were: (i) visibility from Northern hemisphere, (ii) Flux >3 Jy, (iii) easy to observe and well-known masers. Initially, 13 brightest and well-studied 6.7 GHz methanol masers were selected. However, the main task of our maser monitoring program is researching the properties of their variability and now our list is expanded by adding of 29 sources, mostly known as being variable.

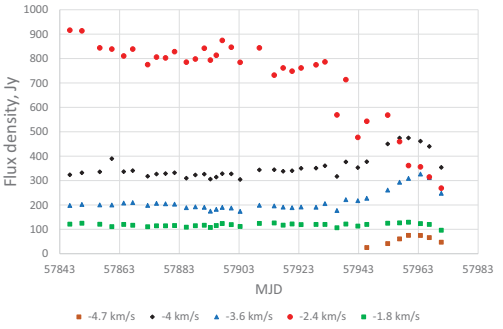

Figure 1. Cepheus A: intensity changes of spectral features.

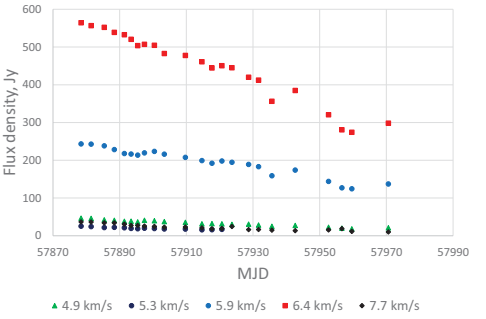

Figure 2. S255: dimming of 6.4 and 5.3 km s^{-1} spectral features.

3. FIRST RESULTS AND RECENT HEADLINES

Currently we have accumulated up to 9 months of intensity variability data for 41 maser sources. This is not sufficient for a thorough analysis, so the program is to be continued. However, more or less clear results can be seen towards constantly dimming or rapidly bursting sources Berzins *et al.* (2017). The 3–5 day interval seems to be sufficient for noticing a short-time maser bursts or other rapid brightness changes with high probability. Also, it is possible to increase the rate of observations during the period of rapid intensity changes even up to multiple times per day.

Despite of the relatively short duration of the monitoring, some notable intensity changes for our program sources can be already noticed. The most notable maser spectrum changes were observed towards Cepheus A and S255. For Cepheus A, the previously relative stable -2.4 km s^{-1} spectral feature has lost 2/3 of its amplitude in about 40 days and has been overtaken by two other features, which have witnessed 30% gains in the same period. For S255, monotone dimming in two strongest spectral features has continued for the last 5 months.

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