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The variability of 6.7 and 12.2 GHz methanol masers

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Abstract. Eight strong methanol masers were monitored using the 32-m Torun radio telescope at 6.7 and 12.2 GHz. The observations were taken in the period 2003 December to 2005 July at 1–2 week intervals. We have noted strong variability of single features but did not notice spectacular spectral shape changes. From our results we designated two groups of variability for corresponding features: Those where the 12.2 GHz flux density variations follow those at 6.7 GHz, and those where the 12.2 GHz flux density variations are opposite to 6.7 GHz.

Keywords. masers, radio lines: ISM, ISM: molecules, techniques: spectroscopic

1. Introduction

Methanol maser sources, associated with star foming regions (eg. Minier *et al.* 2003) often show emission structure which can be explained as rotating discs (Norris *et al.* 1998) or outflows (Minier *et al.* 2002). Changes in the dynamical environments can lead to changes in the maser regions which manifest as flux density changes. Methanol masers have previously been monitored by eg. Moscadelli *et al.* 1996, and Gaylard *et al.* 2004. Our monitoring programme follows the 12.2 GHz survey of Blaszkiewicz & Kus (2004a, 2004b). We have put particular stress on simultaneous observations of methanol masers at 6.7 and 12.2 GHz.

2. Observations

The selected sources were observed from December 2003 until August 2005 at intervals of 1–2 weeks for a period of 20 months with a gap between May and November 2004 due to work on the receivers. We monitored the sources: g25.71+0.04, g25.83-0.18, 18456-0129, 18470-0050, 18517+0437, 18556+0136, 18592+0108, CepA with W3(OH) as the calibrating source. Altogether there were more than 60 observing sessions.

The front-end was a modified 12.2 GHz TV Sat receiver (SMV XL 800A) maintained by X Line Comp. with LHC polarisation only. The T_{sys} was about 130K. For the 6.7 GHz observations we used a dual-channel (LHC and RHC) cooled receiving system with a T_{sys} of about 70K.

As the back-end we used a 2-level, 4 × 4096 channel digital autocorrelation spectrograph. The resolution for a bandwidth of 4 MHz was 22 m/s (12.2 GHz) and 44 m/s (6.7 GHz). Velocities were determined to about 0.2 km/s

3. Results

We have monitored many single features from the spectra obtained. In this paper we show three different sources (Fig. 1) where time series have been obtained for single features present at the same velocity for both frequencies. In general we find two types

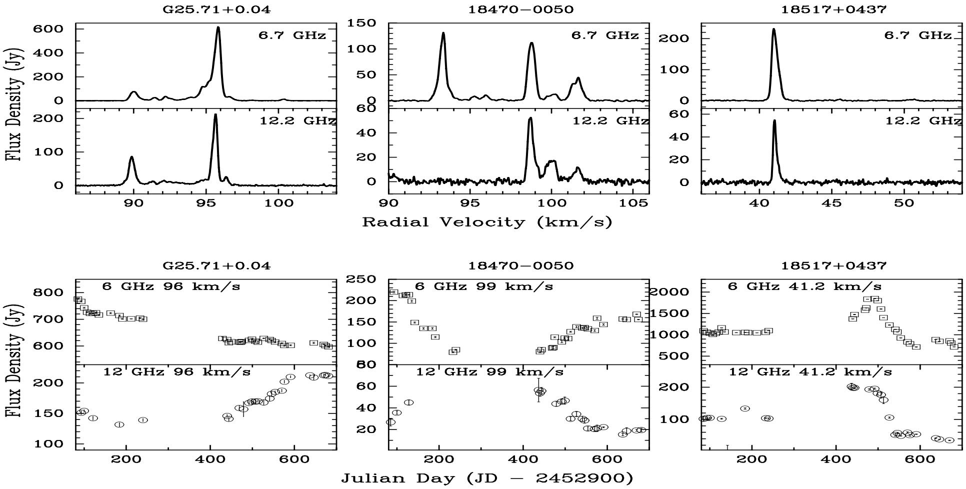

Figure 1. Three examples of variability of single features. The upper panels show spectral profiles at 6.7 GHz (top) and 12.2 GHz (bottom). The lower panels show time series of the flux density variations for selected features at the two frequencies.

of variability corresponding to whether the flux density changes are similar or opposite at the two frequencies.

4. Conclusions

We have observed eight strong methanol sources plus W3(OH) source at two methanol maser transitions: $2_0 \rightarrow 3_{-1}$E (12.178595 GHz) and $5_1 \rightarrow 6_0$ A$^+$ (6.668518 GHz). All sources were selected to be variable from a literature study.

The flux measurements were verified from observations of W3OH which is assumed to have very little variability at 6.7 and 12.2 GHz. We estimate that our flux densities are accurate to better than 10% at 6.7 GHz and 15% at 12.2 GHz.

The spectra of monitored sources (expect G25.83 0.18) were generally of reasonably high signal-to-noise with a one-sigma level below 4 Jy at 12.2 GHz and below 2 Jy at 6.7 GHz after 15 minutes of observations.

All of the observed sources revealed strong flux density variations. However, we did not observe a significant variability in the overall profile shapes for the monitored sources. In particular we did not detect new features or observe the disappearance of existing ones.

We have found two types of variability for corresponding pairs of spectral features. For one group the flux density variations increase and decrease in step, in the other group they are anti-correlated.

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