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Methanol maser monitoring at 6.7 and 12.2 GHz

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Abstract.

Methanol masers occuring in thirteen star-forming regions at both 6.7 and 12.2 GHz were monitored for a year at one to two week intervals using the 26-m Hartebeesthoek telescope. Correlated variations occurred in the masers in six of the ten sources that provided useful data.

1. Introduction

Methanol masers at 6.7 and 12.2 GHz in star-forming regions are both of class II excitation, and the maser spots often occur at the same location in the two transitions (Menten et al. 1992, Minier, Booth & Conway 1998). However comparison of the spectra from a given object at the two transitions shows that their excitation differs.

Variability of very compact radio sources may be intrinsic or arise from extrinsic causes such as refractive interstellar scintillations (RISS) (Rickett 1990, Cordes 1992, Qian 1995). In understanding maser variations in starforming regions, the advantage of the 6.7 and 12.2 GHz methanol masers compared to, e.g., 1.6 GHz hydroxyl and 22 GHz water masers (Simonetti et al. 1992), is that the methanol masers are evidently largely co-spatial.

The dual frequency methanol maser monitoring provides new information on the relative responses of the two maser types to perturbations, and hence on the degree of saturation of each. Tying in the single dish monitoring results with the interferometric spot maps allows one to assess the spatial relationship between maser spots in which correlated variations occur, and so permits models of the maser distribution, excitation and perturbation to be tested.

2. Observations

Thirteen maser sources were monitored from 2000 January, using the 26-m Hartebeesthoek telescope. Observations were generally made at one to two week intervals. The zenith system temperatures were 50 and 135 K at 6.7 and 12.2 GHz respectively, and the beamwidths at half maximum were $7'$and $4'$. Observations at the cardinal halfpower points of the beam were made on the stronger sources in the sample in order to measure pointing offsets. The same spectral resolution of 0.06 km s^{-1} was used at 6.7 and 12.2 GHz. This is sufficient to resolve the narrowest unblended maser feature.

3. Results

The higher noise temperature, lower maser flux, and lower relative pointing accuracy at 12.2 GHz meant that the observational uncertainties were largest at that frequency. Three sources proved to be too weak at 12.2 GHz to provide useful data. Two sources showed no significant variation, one showed a monotonic decay at both transitions, two showed small, slow variations, and several showed moderate variations at both frequencies, generally with larger amplitude at 12.2 GHz. Variation timescales ranged from weeks upwards.

Typical monitoring spectra for G351.42+0.64 at 12.2 and 6.7 GHz are shown in Fig. 1. The time series of the peaks at −10.48/9 km/s are shown in Fig. 2. The time series from two channels at 12.2 GHz away from the masers are shown on the same scale for comparison. This peak did not vary significantly at either frequency and thus provides an internal confidence check on the other masers.

By contrast, G323.77–0.21 showed large amplitude variations simultaneously at 12.2 and 6.7 GHz. Typical maser profiles and the time series at −50.8 km s^{-1} are shown in Figs. 3 and 4. In both cases, the whole maser profile changed at approximately the same rate as the peak illustrated.

4. Discussion

The variations were correlated in the two transitions and either similar in amplitude or larger at 12.2 GHz. This suggests that the variations are not due to refractive scattering, but are intrinsic. If so, then the 12.2 GHz masers are the more sensitive to perturbations and hence are likely to be less saturated. The large range of timescales of variation observed indicate that different intrinsic mechanisms may well be causing the variations in different sources.

References

Cordes, J. M. 1992 in Astrophysical Masers, ed. A. W. Clegg & G. E. Nedoluha (Berlin: Springer), 251

Menten, K. M. Reid, M. J., Pratap, P. & Moran, J. M. 1992 ApJ, 401, L39

Minier, V., Booth, R. S. & Conway, J. E. 1998 A&A, 336, L5

Qian, S. J., Britzen, S., Witzel, A., Krichbaum, T. P., Wegner, R. & Waltman, E. 1995 A&A, 295, 47

Rickett, B. J. 1990 ARA&A, 28, 561

Simonetti, J. H., Diamond, P. J., Uphoff, J. A., Boboltz, D. & Dennison, B. 1992 in Astrophysical Masers, ed. A. W. Clegg & G. E. Nedoluha (Berlin: Springer), 311

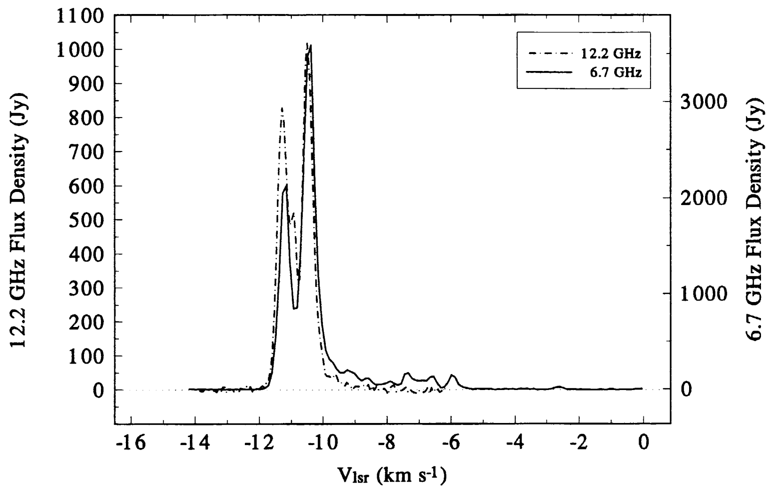

Figure 1. G351.42+0.64 typical monitoring spectra.

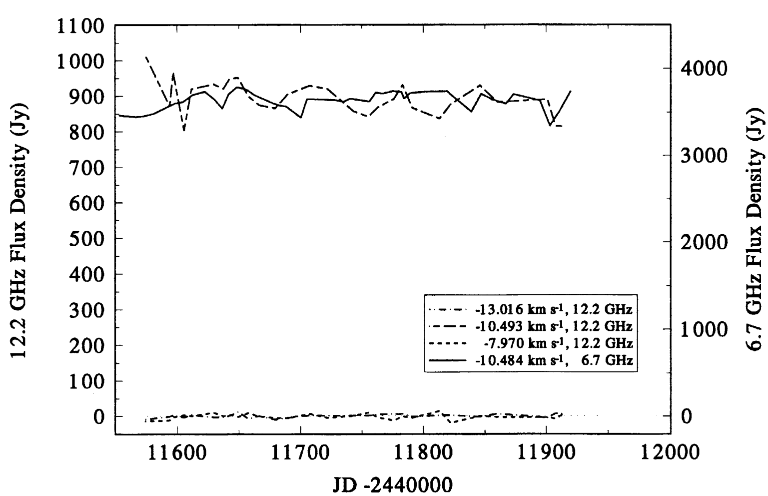

Figure 2. G351.42+0.64 time series of the strongest 12.2 and 6.7 GHz maser peaks and for two channels with no emission at 12.2 GHz.

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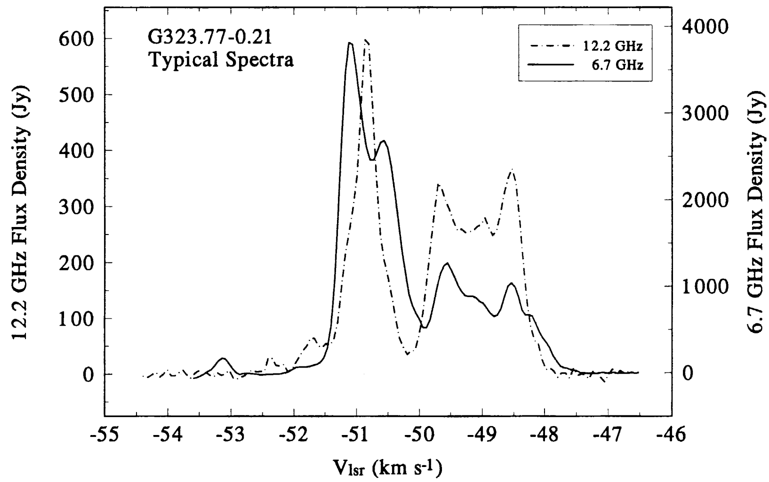

Figure 3. G323.77–0.21 typical monitoring spectra.

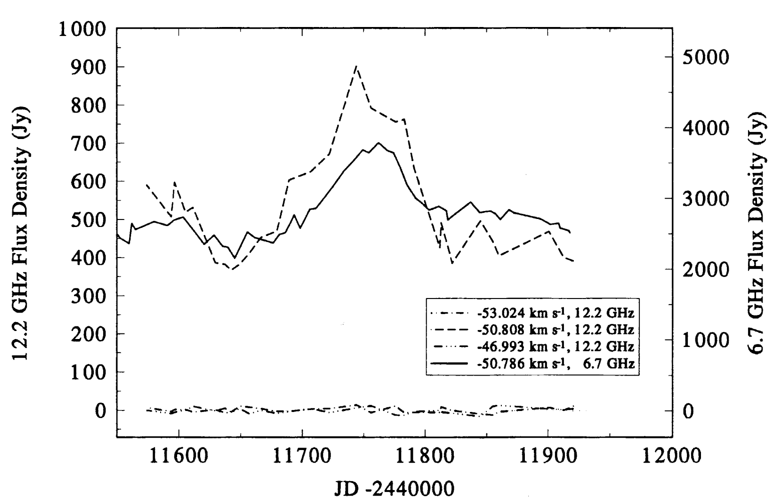

Figure 4. G323.77–0.21 time series of the strongest 12.2 and 6.7 GHz maser peaks and for two channels with no emission at 12.2 GHz.

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