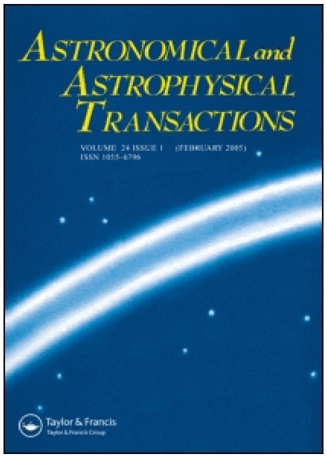

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UNIFIED CATALOGUE OF CLASS II METHANOL MASERS AT 6 GHz

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UNIFIED CATALOGUE OF CLASS II METHANOL MASERS AT 6 GHz

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In this paper we present a unified catalogue which contains published data about class II methanol masers at 6 GHz. Our catalogue contains information about 495 maser sources. The data on some parameters of emission in "quasi-thermal" molecular lines CS(2-1) and SiO(2-1) is also included in our catalogue.

Using the unified catalogue we studied correlations between some parameters of the sources. Analysis of the data shows the following: physical conditions within the usual maser source vary considerably; maser brightness is determined by parameters of some distinguished part of the object – maser formation region; class II methanol masers are formed not in the shocks but in the regions affected by their propagation.

Keywords: ISM; Star formation; Methanol masers

1 GENERAL DESCRIPTION

The class II methanol masers (MMII) are present in the regions of formation of massive stars and are frequently close in position to OH, H_2O masers and IR sources. The MMII at 6.7 GHz are among the strongest and most widespread in the interstellar medium. Information on 495 sources is reported in the literature. We collected all published data about these objects in a unified catalogue of the strongest class II methanol masers.

The 6.7 GHz methanol maser emission was first detected by Menten (1991) toward massive star forming regions, most of which contain OH masers. Since then, many new searches were carried out. Our catalogue includes the data from thirteen papers. The bulk of the sources was detected in surveys toward positions of the IRAS sources and OH masers. Surveys by Szymczak *et al.* (2000), Slysh *et al.* (1999), MacLeod *et al.* (1998), Walsh *et al.* (1997), van der Walt *et al.* (1995), and Schutte *et al.* (1993) were done toward positions of the IRAS sources. Surveys by Caswell *et al.* (1995), Gaylard and MacLeod (1993), MacLeod and Gaylard (1992), and MacLeod *et al.* (1992) were done toward OH maser positions. Blind surveys by Caswell (1996) and Ellingsen *et al.* (1996) brought several new detections and have shown that many 6.7 GHz methanol masers are not associated with IRAS

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sources and OH masers. The blind surveys were done in a rather limited volume of space. So, the unified catalogue is subject to selection effects.

At present, our catalogue is the most complete and contains the following data about 495 maser sources: the peak fluxes in the methanol lines at 6 GHz, 12 GHz, and 107 GHz, the galactic coordinates, the equatorial coordinates for the epochs B1950.0 and J2000.0, the range of velocities of the 6 GHz maser features, the velocities of the strongest peaks at 6 GHz, 12 GHz, and 107 GHz, the notations of associated IRAS sources, and other names of the 6 GHz sources, when they exist: The data on some parameters of emission in "quasi-thermal" molecular lines CS(2-1) and SiO(2-1) is also included in our catalogue. This information is taken from surveys of Juvela (1996) and Bronfman *et al.* (1996) in CS lines and survey of Harju *et al.* (1998) in SiO lines.

Our catalogue is available at http://astrophysic.chat.ru/cat.htm

2 CORRELATIONS BETWEEN PARAMETERS OF MASER LINES

Using the unified catalogue, we studied correlations between several selected parameters of sources. Figure 1 shows the values of the peak flux at 6.7 GHz versus those at 12 GHz. It is seen that the 6 GHz fluxes are usually greater than the 12 GHz fluxes and no correlation between the values exists. The 12 GHz fluxes are higher than the 6 GHz fluxes only in two sources. The data on one of them, NGC6334I(N), is controversial because of the presence of the very bright nearby source, NGC6334I. The second source, G24.33-0.14, has the 6 GHz/12 GHz peak flux ratio of about 2. Anyhow, all sources of the catalogue are brighter at 6 GHz in terms of the brightness temperature derived from the peak fluxes, under assumption that the spots have equal sizes at 6 GHz and 12 GHz.

The fact that the difference between velocities of the strongest maser peaks at 6 GHz and 12 GHz is quite common was noted by Val'tts and Lyubchenko (private communication). Consideration of the data of our catalogue shows that the velocities of the strongest maser peak are usually different for all of three considered transitions (Fig. 2). These differences are often greater than both the characteristic breadth of maser feature and the error of velocity determination. At the same time, the differences are always less than the spread of velocities at 6 GHz, and the peaks at 12 GHz and 107 GHz never appear out of the range of velocities of the 6 GHz maser features.

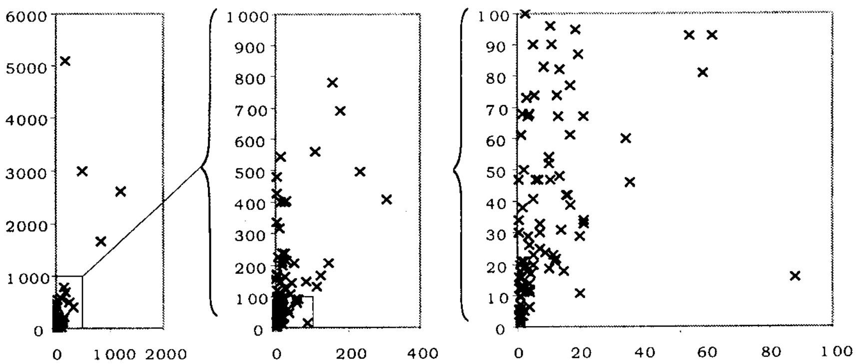

FIGURE 1 Methanol maser flux at 6 GHz versus that at 12 GHz.

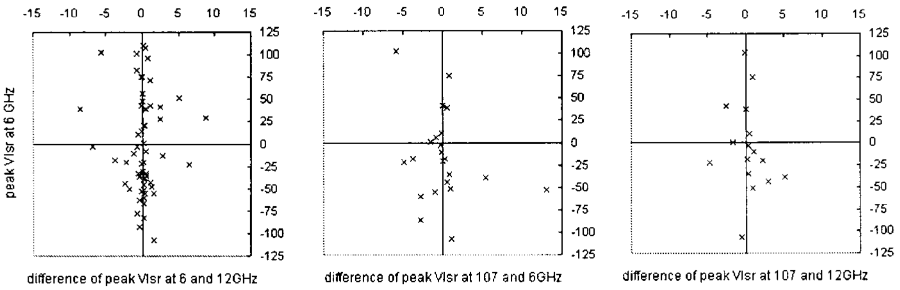

FIGURE 2 Differences of the strongest peak velocities versus velocity of the strongest 6 GHz peak are shown for three pairs of class II methanol maser lines: 6 GHz and 12 GHz, 107 GHz and 6 GHz, 107 GHz and 12 GHz.

3 RELATIONS BETWEEN PARAMETERS OF MASER AND "QUASI-THERMAL" LINES

As it was mentioned above, the catalogue contains some parameters of the lines of CS and SiO molecules observed toward class II methanol maser sites. It was assumed that the source of CS or SiO emission coincides in position with the methanol maser, if the separation between observed points is less than the half-power beam width of the telescope, which was 50 "for CS(2-1) line and 60" for SiO(2-1) surveys.

CS is a probe of the dense parts of interstellar clouds. Observations of the CS(2-1) line provide information about the regions where the matter is compressed by the passage of shock waves and the inner parts of molecular core, which are close to the young stellar object. The brightness of CS line provides information about the amount of dense gas in the source. Analysis of the catalogue data shows that there is no obvious correlation between the CS line brightness and the peak flux value of the methanol maser (Fig. 3).

The width of the CS(2-1) line reflects the average kinetic energy of the dense gas. In the majority of sources the range of velocities of maser features considerably exceeds the width of the CS(2-1) line (Fig. 4).

The SiO abundance is greatly enhanced in the shocked gas and, hence, the range of velocities of SiO emission reflects the spread of the shock velocities. In the majority of sources the range of maser velocities is much less than the range of velocities of emission in SiO(2-1) line (Fig. 5).

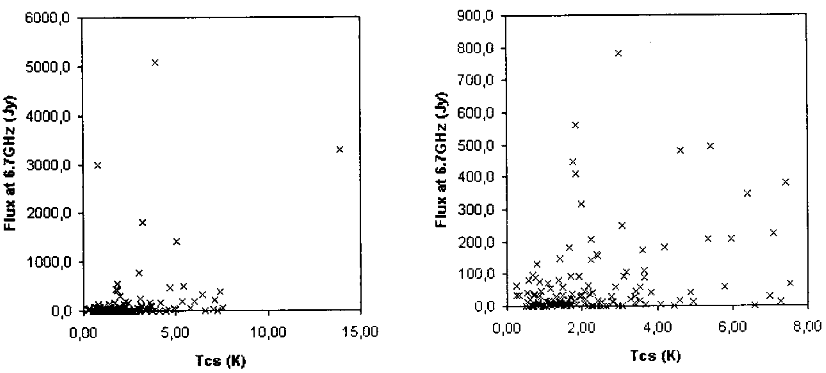

FIGURE 3 The 6 GHz maser flux versus brightness of the CS(2-1) emission line.

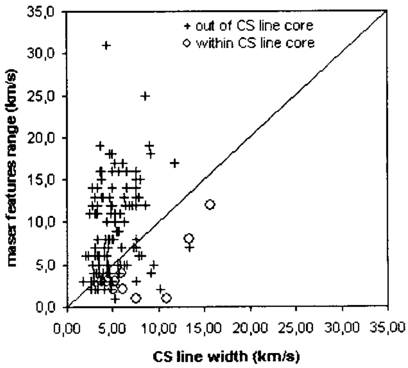

FIGURE 4 Range of velocities of the 6 GHz maser features versus CS(2-1) line width. The circles designate cases when all the maser features are within the core of CS(2-1) line, crosses designate cases when the maser features appear outside CS line core.

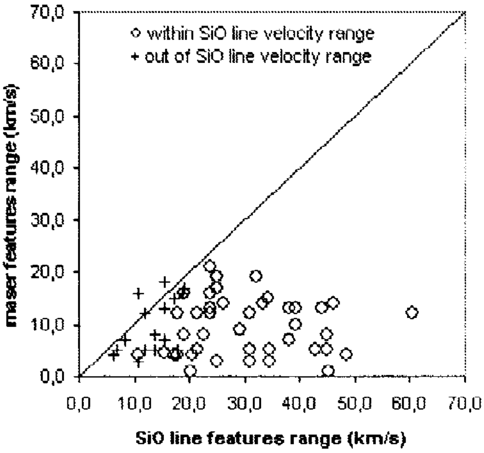

FIGURE 5 Range of velocities of the 6 GHz maser features versus that of the SiO(2-1) emission line.

4 CONCLUSIONS

A unified catalogue of class II methanol maser sources is compiled. The catalogue is complete for the data published before 2001.

Analysis of the data shows that:

1. Surveys in the 6 GHz line provide complete information on positions and range of velocities for the overwhelming majority of class II methanol masers sources. Surveys in other methanol maser lines do not add much in that sense.
2. It is quite common for the class II methanol maser sources that the velocity of the peak differs for different maser lines. That means that physical conditions within a usual maser source vary considerably.
3. Class II methanol maser brightness does not depend on the total amount of dense gas in the associated molecular core. Spread of maser velocities usually exceeds velocity dispersion of the bulk of dense gas. Hence, maser brightness is determined by parameters of some distinguished part of the object – maser formation region.

4. Comparison of spread of velocities of SiO line emission and that of maser features leads to conclusion that class II methanol masers are formed not in the shocks but in the regions affected by their propagation.

Acknowledgements

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References

Bronfman, L., Nyman, L.-A. and May, J. (1996). *Astron. Astrophys. Suppl. Ser.*, **115**, 81.
Caswell, J. L. (1996). *Mon. Not. R. Astron. Soc.*, **279**, 79.
Caswell, J. L., Vaile, R. A., Ellingsen, S. P., Whiteoak, J. B. and Norris, R. P. (1995). *Mon. Not. R. Astron. Soc.*, **272**, 96.
Ellingsen, S. P., von Bibra, M. L., McCulloch, P. M., Norris, R. P., Deshpande, A. A. and Phillips, C. J. (1996). *Mon. Not. R. Astron. Soc.*, **280**, 378.
Gaylard, M. J. and MacLeod, G. C. (1993). *Mon. Not. R. Astron. Soc.*, **262**, 43.
Harju, J., Lehtinen, K., Booth, R. S. and Zinchenko, I. (1998). *Astron. Astrophys. Suppl. Ser.*, **132**, 211.
Juvela, M. (1996). *Astron. Astrophys. Suppl. Ser.*, **118**, 191.
MacLeod, G. C. and Gaylard, M. J. (1992). *Mon. Not. R. Astron. Soc.*, **256**, 519.
MacLeod, G. C., Gaylard, M. J. and Nicolson, G. D. (1992). *Mon. Not. R. Astron. Soc.*, **254**, P1.
MacLeod, G. C., van der Walt, D. J., North, A., Gaylard, M. J., Galt, J. A. and Moriarty-Schieven, G. H. (1998). *Astron. J.*, **116**, 2936.
Menten, K. M. (1991). *Astrophys. J.*, **380**, L75.
Schutte, A. J., van der Walt, D. J., Gaylard, M. J. and MacLeod, G. C. (1993). *Mon. Not. R. Astron. Soc.*, **261**, 783.
Slysh, V. I., Val'tts, I. E., Kalenskii, S. V., Voronkov, M. A., Palagi, F., Tofani, G. and Catarzi, M. (1999). *Astron. Astrophys. Suppl. Ser.*, **134**, 115.
Szymczak, M., Hrynek, G. and Kus, A. J. (2000). *Astron. Astrophys. Suppl. Ser.*, **143**, 269.
van der Walt, D. J., Gaylard, M. J. and MacLeod, G. C. (1995). *Astron. Astrophys. Suppl. Ser.*, **110**, 81.
Walsh, A. J., Hyland, A. R., Robinson, G. and Burton, M. G. (1997). *Mon. Not. R. Astron. Soc.*, **291**, 261.