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12.2 GHz survey towards 6.7 GHz methanol masers

A comparison of 12.2 GHz and 6.7 GHz spectra⋆

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Abstract. We present results of a 12.2 GHz methanol maser survey done with the Toruń 32 m radio telescope. We examined 261 star forming-sites, known as containing 6.7 GHz maser emission sources. The survey resulted in 49 sources with maser line detection, with 21 previously unknown emissions. All detected 12.2 GHz masers have been observed at the 6.7 GHz transition. Only one 12.2 GHz source had no 6.7 GHz counterpart. We compared basic spectral line properties at both transitions. In a few cases we observed absorption features and emitting counterparts in the other monitored frequency, at the same velocity.

Key words. masers – surveys – stars: formation – ISM: molecules – radio lines: ISM – ISM: HII regions

1. Introduction

The 12.178595 GHz maser emission of CH_3OH ($2_0 \rightarrow 3_{-1}$ E transition) was first observed by Batrla et al. (1987); the 6.668518 GHz methanol transition ($5_1 \rightarrow 6_0$ A^+) was discovered by Menten (1991) who designated two groups of 6.7 GHz methanol maser sources – class I and class II. The first group features a few narrow components in the velocity range less than 1 km s^{-1} and is related to outflow shocks (Plambeck et al. 1990). The class II which exhibits wide and complex spectral structures is usually observed towards Ultra Compact HII regions (UCHII). This class provides excellent information on the physics of the star forming sites. The 12.2 GHz emission is mainly bound with the class II sources.

In the past several searches for methanol masers were made.

• The 6.7 GHz methanol masers were observed towards selected IRAS sources with colour criteria of UCHII sites (Schutte et al. 1993; van der Walt et al. 1995; Walsh et al. 1997; Lyder & Galt 1997; MacLeod et al. 1993; Slysh et al. 1999; Szymczak et al. 2000); Caswell et al. (1993) examined methanol in the star-forming regions featuring OH maser emission. The 6.7 GHz blind survey of the galactic plane was done by Szymczak et al. (2002). All these studies show a strong dependence of detection rate on IRAS colour indices. Some 6.7 GHz surveys towards 12.2 GHz methanol maser sites (MacLeod & Gaylard 1992) and towards 1.6 GHz OH masers (Gaylard & MacLeod 1993) were also carried out.

• The 12.2 GHz methanol masers were observed towards OH maser sites (Kemball et al. 1988; Caswell et al. 1993) and H_2O masers (Koo et al. 1988); a few 12.2 GHz methanol maser survey experiments towards 6.7 GHz methanol maser sources also have been made (Catarzi et al. 1993; Gaylard et al. 1994; Caswell et al. 1995a). The detection rate (up to 60%) depends mainly on the sensitivity of the instruments used for observations.

In our survey we had a particular interest in Toruń surveys' detected sources (Szymczak et al. 2000, 2002). Presented results enable comparison of 6.7 GHz and 12.2 GHz spectral line properties. Known methanol maser pumping models (e.g. Sobolev et al. 1994, 1997) still need strong observational evidence and this survey could partially provide this.

Another idea behind our survey was to select the best candidates for future simultaneous VLBI observations of both the CH_3OH transitions to develop maser theory.

A secondary aim of this work is to demonstrate how unique results can be obtained with a simple TV 12.2 GHz receiving system, initially mounted on the 32 m Toruń radio telescope to perform holographic measurements.

2. Observations

The observations were carried out in 2002 between June 24th and August 15th with the 32 m Toruń radio telescope.

The front-end used for 12.2 GHz observations was a modified commercial TV Sat receiver installed for dish holography.

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⋆ Figure **??** is only available in electronic form at `http://www.edpsciences.org`
Tables 2 and 3 are only available in electronic form at the CDS via anonymous ftp to `cdsarc.u-strasbg.fr (130.79.128.5)` or via `http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/413/233`

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The local oscillator signal was fed from a computer-controlled HP synthesiser and an additional IF amplifier provided satisfactory gain. The overall performance receiving single LHC polarisation was surprisingly good and very stable; the system temperature was between $T_{\rm sys} \sim 130$–150 K.

For 6.7 GHz observations we used a dual channel (left and right circular polarisation) cooled HEMT receiving system with a system temperature of about 70 K.

The back-end was the 2^{14} channel, 2 level digital autocorrelation spectrograph. We used it split into four subbands, 4096 channels each. For both observed frequencies, 12.2 and 6.7 GHz, we adapted a 4 MHz bandwidth, which gives a spectral resolution of 24 and 44 m s^{-1}, respectively. The velocity span was 98.5 km s^{-1} for 12.2 GHz and 180 km s^{-1} for 6.7 GHz. The central value of the radial velocity for the first observation run was adapted from 6.7 GHz spectra as the mean value of emission features. The absolute accuracy of our velocity measurements was less then 0.2 km s^{-1}.

The calibration of both receiving systems were made by using noise diodes and typical continuum sources (DR 21 for 12.2 GHz; 3C123 and Vir A for 6.7 GHz). The flux densities of calibrators were taken from Ott et al. (1994). The accuracy of the flux density scale is better than 10% for 6.7 GHz and about 15% for 12.2 GHz.

The half power beam widths of the Toruń 32 m antenna are 3 arcmin at 12.2 GHz and 5.5 arcmin at 6.7 GHz. The pointing accuracy found from regular checks of strong point sources is ≤30 arcsec for our observations.

The list of chosen targets includes all methanol masers detected in the Toruń observation programmes (Szymczak et al. 2000, 2002) and most of known 6.7 GHz northern hemisphere ($\delta > 0$ deg) maser sources taken from the literature. Our sole selection criterion for the targets was the 6.7 GHz detection reported in the papers cited above.

3. Results

In the present survey we have searched for 12.2 GHz maser lines towards 161 star-forming sites with previously detected 6.7 GHz masers. We detected 49 sources of which 21 12.2 GHz maser lines are new detections. We also found one extreme absorption source at this frequency. All 12.2 GHz detections have been monitored at 6.7 GHz. Only one source did not show features with flux above our 3σ level. We also found two additional absorption lines at 6.7 GHz and noted the presence of emitting 12.2 GHz counterparts at the same velocity.

The details of the newly detected 12.2 GHz maser lines are presented in Table 1. The spectra of the newly detected sources are shown in Fig. 1. Tables 2 and 3, available in electronic form at the CDS, present a summary of the 12.2 GHz and 6.7 GHz measurement, for all sources with positive detection. The layout of both tables is identical: Col. 1 lists the source (the IRAS name or name based on galactic longitude and latitude), Cols. 2 and 3 give coordinates for epoch 2000, Col. 4 presents integrated flux density, Col. 5 gives peak flux density, Cols. 6 shows the LSR velocity of the peak flux, Cols. 7 and 8 give the lower end the upper LSR velocity of emissions, Col. 9 shows 1σ (rms) level, Col. 10 lists the first detection references and Col. 11 gives other names of the sources.

Figure **??**, available in electronic form only, shows a comparison of spectra obtained by us at both observed frequencies.

3.1. Notes on individual sources

G173.59+02.44 First observed as a weak 6.7 GHz maser by Menten (1991). This survey did not reveal any 6.7 GHz features. We detected 12.2 GHz emission (12.5 Jy) at a different position (−32 km s^{-1}).

18128−1640 We discovered 12.2 GHz emission as two weak features at 11.2 and 15.4 km s^{-1} which are connected to 6.7 GHz emission components. We also noticed a decrease of the 6.7 GHz intensity of the main component in comparison with results presented by Slysh et al. (1999) and Szymczak et al. (2000).

18174−1612 The 12.2 GHz results are similar to those reported by Caswell et al. (1995a) but the flux density is weaker and the relative intensities of two observed components are reversed. The 6.7 GHz flux density of the main feature compared with previous observations (Menten 1991; Caswell et al. 1995a; Walsh et al. 1997; Szymczak et al. 2000) shows clear continuous decrease in intensity.

18217−1252 We detected strong 12.2 GHz absorption which could be connected to 6.7 GHz emission. Caswell et al. (1995a) did not observe spectral features at 12.2 GHz but reported 2.9 Jy OH emission towards this source. The comparison of our 6.7 GHz detection with previous observations (Menten 1991; Caswell et al. 1995a; Walsh et al. 1997 and Szymczak et al. 2000) suggests weak variability.

18232−1154 We found strong 12.2 GHz emission at 3.9 km s^{-1} but we did not observe features exceeding the 3σ level at the position previously reported (Caswell et al. 1995a). Our observations of the 6.7 GHz maser showed decreasing flux intensity.

G23.01−0.41 Our results compared with previously obtained data suggest variability of the 6.7 GHz maser emission and an absence of variations at 12.2 GHz.

G23.19−0.38 We discovered 12.2 GHz maser emission as a single feature with a flux density of 6.9 Jy at 81.9 km s^{-1}. Our 6.7 GHz measurements in comparison to results obtained by Szymczak et al. (2000, 2002) suggest strong variability of line components.

18324−0737 Our 6.7 GHz observations showed dramatic changes in the spectrum shape and relative intensity of components. The Szymczak et al. (2000) suggestion of variability of 6.7 GHz maser emission is substantiated.

18324−0820 We discovered 12.2 GHz methanol maser emission. The velocity range and main feature position is the same as previously observed at 6.7 GHz (e.g. Schutte et al. 1993).

G25.71+0.04 We observed 12.2 GHz maser emission. The position and shape of the spectrum is very similar to 6.7 GHz ones. We also noted an increase in 6.7 GHz intensity since its

Table 1. Details of the newly detected 12 GHz maser lines.

Source	α (2000)	δ (2000)	S_i12.2 (Jy km s^{-1})	S_p12.2 (Jy)	P vel. (km s^{-1})	Δ vel. (km s^{-1})
G173.59+02.44	05 39 27.8	+35 40 58	6.8	12.5	−31.6	−33.0; −31.0
18128−1640	18 15 45.5	−16 38 58	3.5	7.3	11.2	9.8; 15.5
18232−1154	18 26 03.0	−11 52 34	39.4	81.6	3.9	3.0; 5.7
G23.19−0.38	18 34 54.5	−08 50 04	3.0	6.9	81.8	81.2; 82.8
18324−0820	18 35 10.7	−08 17 56	10.5	10.5	79.0	76.0; 80.0
G24.15−0.01	18 35 20.8	−07 48 48	3.4	8.7	17.7	17.0; 18.2
G25.71+0.04	18 38 03.1	−06 24 32	192.2	213.7	95.6	88.9; 97.2
G25.83−0.18	18 39 04.7	−06 24 17	17.1	31.2	90.7	90.0; 92.0
G27.21+0.26	18 40 03.8	−04 58 09	6.9	17.5	14.1	13.5; 14.8
G28.85+0.50	18 42 12.8	−03 24 26	1.8	4.7	87.3	86.9; 87.8
18448−0146	18 47 25.5	−01 43 21	5.9	6.2	100.2	99.0; 103.0
G33.64−0.21	18 53 28.7	+00 31 58	21.7	89.4	58.6	58.2; 60.4
18577+0358	19 00 14.4	+04 02 35	5.6	9.8	61.8	61.4; 63.0
G43.15+0.02	19 10 10.6	+09 05 27	4.5	14.3	−4.1	−3.6; −4.6
G43.17+0.01	19 10 13.5	+09 06 14	2.5	9.3	−19.4	−20.5; −19.2
G43.17−0.00	19 10 16.2	+09 06 02	4.5	13.6	−44.4	−43.8; −45.0
19120+0917	19 14 26.1	+09 22 34	4.6	5.2	51.8	45.8; 52.5
19186+1440	19 20 57.0	+14 46 40	4.4	13.5	−10.1	−9.3; −10.2
			19.0	27.8	−1.9	−3.5; −0.3
19303+1651	19 32 35.3	+16 57 34	1.5	4.3	65.4	65.0; 66.1
20290+4052	20 30 50.8	+41 02 25	3.2	6.5	−5.7	−5; −6.4
21381+5000	21 39 58.0	+50 14 24	3.7	12.3	−37.8	−38.2; −37.2

first detection (Walsh et al. 1997) and subsequent observations made by Szymczak et al. (2000, 2002).

G25.83−0.18 We discovered 12.2 GHz emission and we noted increasing 6.7 GHz flux density by a factor of about two. The source is probably strongly variable.

G27.21+0.26 This weak source was first observed at 6.7 GHz by Szymczak et al. (2002). We noted the increase of this transition intensity. We also discovered a strong 12.2 GHz feature near the 6.7 GHz line position.

18448−0146 We found the 12.2 GHz emission of 6.2 Jy, towards this source. Szymczak et al. (2000) suggest that this source and 18446−0150 previously observed by Schutte et al. (1993) are the same emitting region, but we did not detect greater then 3σ signal towards 18446−0150.

18456−0129 Koo et al. (1988) discovered a 12.2 GHz maser emission towards this source. In the present survey we noted the decreasing of intensity by a factor of about six.

18470−0050 van der Walt et al. (1995) detected a 6.7 GHz emission towards this source and Gaylard et al. (1994) first observed 12.2 GHz maser emission towards 18470−0049. Our observations showed that both targets are the same emitting region with differences of flux density of separate components only.

G33.64−0.21 We did not see differences between our spectral profile shape at 6.7 GHz and that published by Szymczak et al. (2000, 2002) but we noted weak variation of single components. We also discovered 12.2 GHz strong maser emission connected to the most blueshifted feature of the 6.7 GHz profile.

18517+0437 Our measurements of flux density, compared with those previously obtained, suggest the growth of 12.2 GHz intensity, unlike the 6.7 GHz behaviour, where we noted slight decreasing of flux density.

18592+0108 Moscadelli & Catarzi (1996) described huge variation of the 12.2 GHz intensity of this source (first observed by Norris et al. 1987). Our measurements and comparison with results previously obtained did not support that suggestion, but a weak variability is possible.

G43.15+0.02, G43.17−0.00 and G43.17+0.01 are probably parts of the great W49N complex that contains many HII regions. We observed two groups of 12.2 GHz emission towards G43.15+0.02. The first, at the velocity range from −3.6 to −4.6, is without a 6.7 GHz counterpart. The second emission group

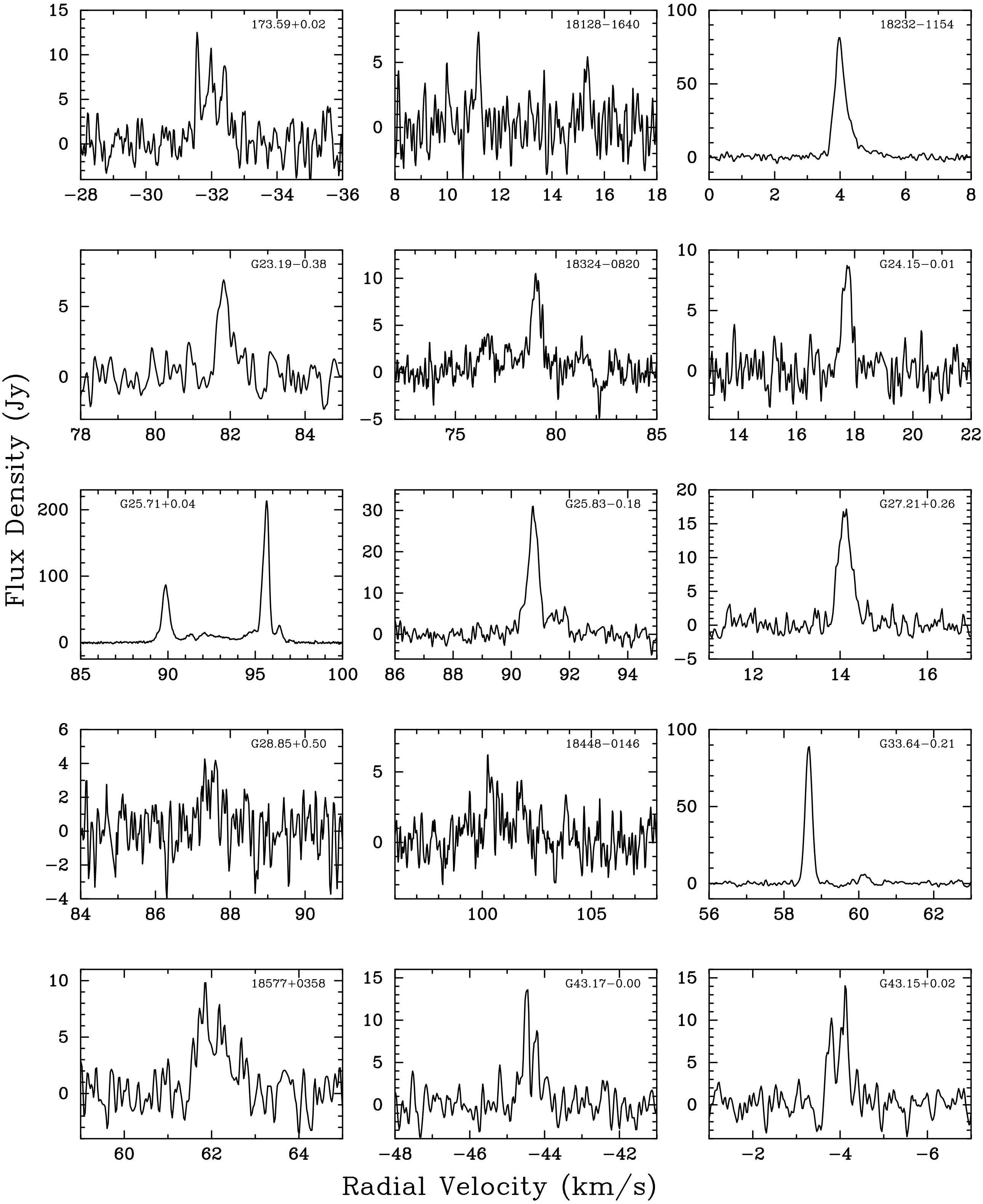

Fig. 1. 12.2 GHz spectra of the newly detected methanol sources. For this presentation they have been smoothed with the Hanning function.

at 13.6 km s^{-1} has a 6.7 GHz counterpart at the velocity range of 6.6–22.2 km s^{-1}.

G43.17−0.00 We discovered 12.2 GHz emission towards this source, at −44 km s^{-1}. At both observed frequencies we also detected maser features at about 15 km s^{-1} (probably connected to emission observed towards G43.15+0.02).

G43.17+0.01 Caswell et al. (1995a) detected the 6.7 GHz maser near 20 km s^{-1} and found a 12.2 GHz weak counterpart

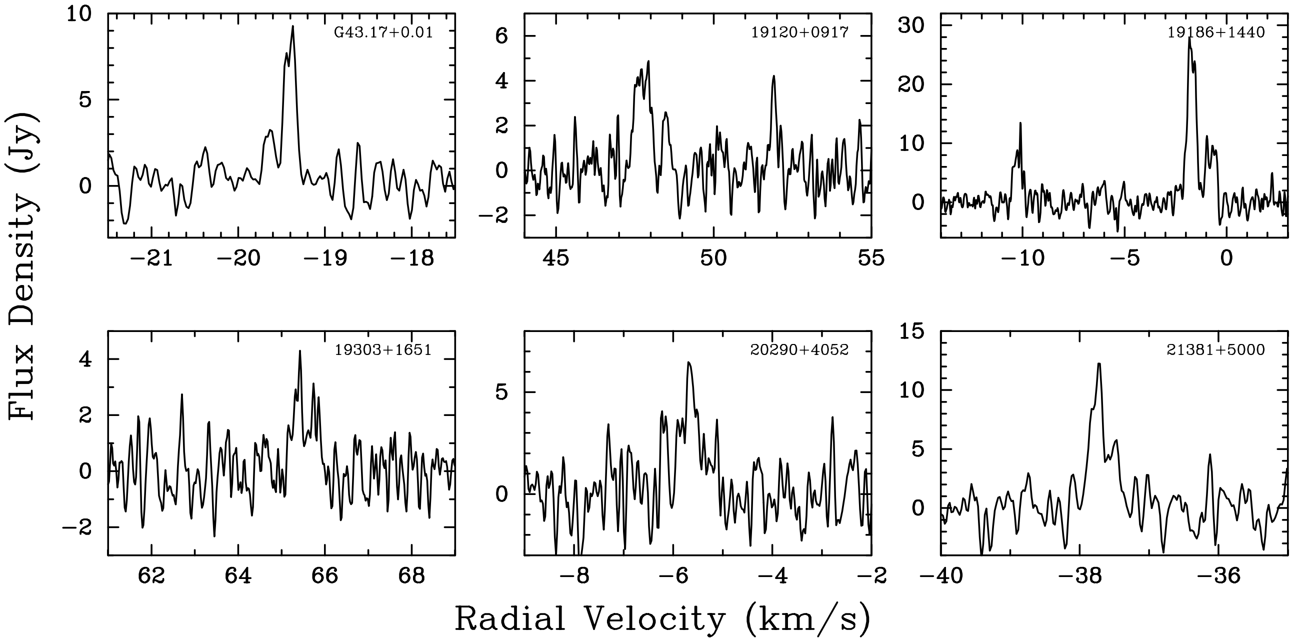

Fig. 1. continued.

(Caswell et al. 1995b). We did not see emission at this velocity but we detected the 6.7 GHz line at different positions (probably connected to the G43.15+0.02 and G43.17−0.00 emission) and the 12.2 GHz feature, which is a newly detected maser line.

19120+0917 The 6.7 GHz emission was first observed by Schutte et al. (1993). The differences between our spectrum and that previously published result from the higher sensitivity and spectral resolution obtined by us. We also discovered 12.2 GHz emission towards this source.

19186+1440 We found the 12.2 GHz emission with the main component position very similar to the 6.7 GHz absorption recorded during our survey.

19211+1432 Szymczak et al. (2000) found 6.7 GHz maser emission. We obtained a similar spectral profile at this frequency and we noted variations of the relative intensity of components. We also identified the 12.2 GHz emission towards this source.

19303+1651 We found the 12.2 GHz maser emission towards this source. The comparison of our measurements at 6.7 GHz and those previously obtained by van der Walt et al. (1995, 1996) suggests the possibility of weak variability.

19410+2336 The 12.2 GHz differences in our observations and previously reported results (MacLeod et al. 1993; Caswell et al. 1993) may indicate possible variability. The comparison of our 6.7 GHz result with previously published work (Menten 1991; MacLeod et al. 1993; Szymczak et al. 2000) convinced us of strong variability at this transition.

21381+5000 Slysh et al. (1999) discovered 6.7 GHz maser emission during observations towards GL 2789. Szymczak et al. (2000) provided a different spectral shape. The profile presently obtained is similar to the one recorded by Szymczak in general, but we noted significant differences in separate components which suggest their variability. We also found a 6.7 GHz absorption at the position of the 12.2 GHz emission line discovered by us. This case is similar to 19186+1440, where we have observed the 6.7 GHz absorption associated with the 12.2 GHz emission.

22543+6139 Cep A was firstly observed at 12.2 GHz by Koo et al. (1988). Moscadelli & Catarzi (1996) showed the huge variability of this source. The present value of flux obtained by us confirms that conclusion.

4. Discussion

4.1. General

This 12.2 GHz methanol maser survey has been done in the following manner. Firstly, we searched selected regions containing known 6.7 GHz masers. Secondly, we determined the sky position of the 12.2 GHz emission maximum by observing five points around given detection coordinates. Thirdly, we measured the 6.7 GHz maser emission. However, there is a possibility that some sources could have been missed, but this observation strategy was chosen due to limited antenna availability. Therefore, this survey did not provide any useful information on source distribution.

Most authors gave a flux determination accuracy of about 5–15% for 6.7 GHz (Caswell et al. 1995a; Slysh et al. 1999) and 5–20% for 12.2 GHz maser detection (Caswell et al. 1995b; Gaylard et al. 1994; Catarzi et al. 1993). Although we noted significant discrepancy between the flux determination in our survey and previously published values, we made comments on the variability for distinctive cases only. We have put particular attention on the comparison of basic properties of maser line transitions at both observed frequencies.

4.2. Comparison of 12.2 GHz and 6.7 GHz spectra

For 48 of 49 detected 12.2 GHz sources (including one absorption) we found 6.7 GHz counterparts. In this section we comment the general shape of lines at both the observed frequencies, fluxes and radial velocities. However, we are careful about drawing conclusions due to the relatively high 12.2 GHz rms level. Thus in the following we limit ourselves to a few remarks only.

4.2.1. Morphology

Caswell et al. (1995a) showed strong connections between 12.2 GHz and 6.7 GHz spectra in general, but it is noted that the 12.2 GHz masers are slightly weaker. In most of the observed sources only a fraction of the features seen at 6.7 GHz have 12.2 GHz counterparts. We designated three groups of 6.7 and 12.2 GHz pairs. In the first group the general shape of profiles are similar and velocity ranges of emission are the same. The best examples are the strongest sources: W3 (OH), 06058+2138, 07299−1651, 18529+0108 or NGC 7538. To the second group belong objects with a 12.2 GHz counterpart observed for only a few 6.7 GHz features (usually one). This set of sources is the largest one. The third designated group has sources with 12.2 GHz emissions without a clear 6.7 GHz feature correspondence or these with 6.7 GHz absorption as a counterpart. The members for this set could be G28.85+0.50, G43.17−0.00 at −44.5 km s^{-1} and at 11.5 km s^{-1} where a 12.2 GHz feature is in the gap between two strong 6.7 GHz components. In this group we also included two 6.7 GHz absorption sources, 19186+1440 and 21381+5000.

For several sources we recorded a characteristic double structure (e.g. 18089−1732, 18174−1612 or G25.71−0.04) which could be a hint of a rotating disc (e.g. Norris et al. 1993, 1998; Sobolev et al. 1997; Minier et al. 2000). Some other profile shapes could also be described in disc structure terms. As Ye Xu (2001) showed, some examples of methanol sources could be explained by a multidisc system. However, this problem is not yet unresolved and other models (e.g. shock fronts) could possibly explain the observed profiles.

4.2.2. Fluxes

Figure 2 shows a comparison of the flux rate histograms. As we can see, in the range from 0 to 50 Jy the distribution is flat for 6.7 GHz sources and has a peak of about 10 Jy at 12.2 GHz. Previous 12.2 GHz results provided by Caswell et al. (1995b) are in good agreement with our observations. The comparison of this survey 6.7 GHz flux distribution with data presented by Szymczak et al. (2000) gives different results. The distribution of the flux rate shows a maximum of about 6 Jy and the source number decreases with higher peak flux densities. That discrepancy of distribution of fluxes in our results and those presented by Szymczak et al. (2000) can be easily explained. The 12.2 GHz masers are at least a few times weaker than 6.7 GHz emission from the same region (see below). Therefore we detected 12.2 GHz emission for strong 6.7 GHz sources only.

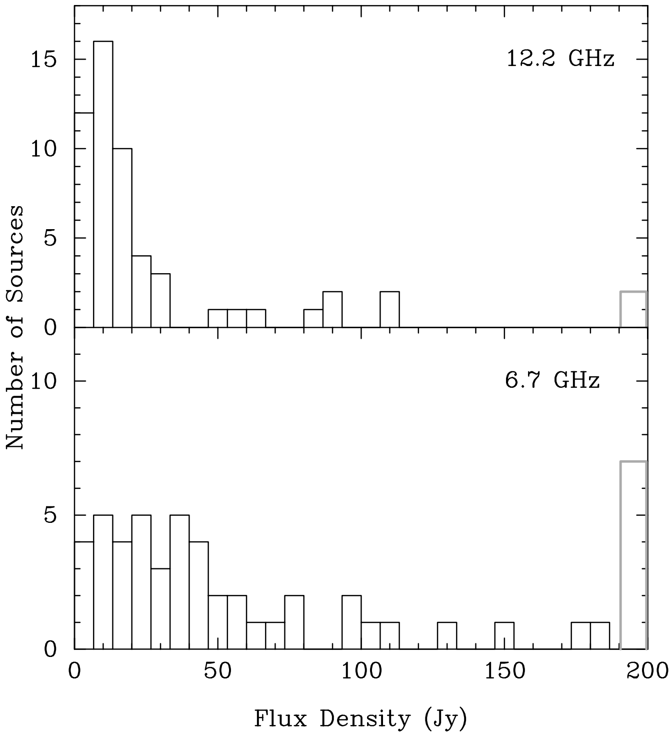

Fig. 2. Comparison of fluxes in the detected 12.2 and 6.7 GHz emissions. Gray bins at the right side show all sources with fluxes exceeding the level of 200 Jy km s^{-1}.

We also counted the mean value of the 6.7/12.2 rate for the obtained results and we got the value of 5.4. To compare this value with the results of other surveys we have taken all 12.2 GHz flux measurements of Caswell et al. (1995b) exceeding our 3σ limit (>~4 Jy) and we compared them with 6.7 GHz fluxes (Caswell et al. 1995a). The mean value of the 6.7/12.2 flux rate was about 11.5 while the similar mean rate value for MacLeod et al. (1993) was over 46. These results suggest that the selection of sources alone influences the 6.7/12.2 rate.

4.2.3. Velocities

In our methanol maser line analysis we compared velocity ranges of emission. Figure 3 presents the comparison of emission velocity spans for all 12 GHz sources with 6.7 GHz counterparts at similar positions. As we can see there are two groups of 6.7 GHz sources on the plot: the first between 2 and 6 km s^{-1} and the second from 10 to 15 km s^{-1}. There are no 12.2 GHz profiles with a velocity range over 10 km s^{-1}. Most of the profiles have a velocity span smaller than 4 km s^{-1} at our sensitivity level. Szymczak & Kus (2000) showed a similar distribution and linked their result with the halfwidth of single spectral components, assuming the limit of about 0.14 km s^{-1}. Lower values of halfwidth are related to $\Delta V < 6$ Jy. Similar results have been obtained previously by Caswell et al. (1995a). In the present paper we did not show Gaussian parameters of single components but other measurements, not discussed here, assure us that our results do not contradict those presented by Szymczak & Kus (2000).

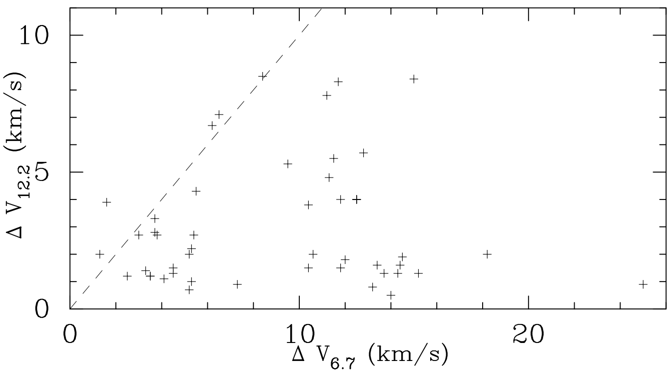

Fig. 3. The velocity dispersion of spectral features for 12.2 and 6.7 GHz. Dashed line marks equality region of the plot. Only a few 12.2 GHz sources have wider line's groups then the same lines at 6.7 GHz.

4.3. Absorptions

In a few spectra we have observed absorption lines. An absorption at 12.2 GHz was observed in many sources in maser emission surveys (Caswell et al. 1995b) and in a dedicated absorption survey (Peng & Whiteoak 1992). A 6.7 GHz methanol absorption was also detected (Caswell et al. 1995b). In our data analysis we have put particular stress on 12.2 and 6.7 GHz spectral feature comparison. We found three examples of absorption at observed frequencies which have other frequency-emitting counterparts (Fig. 4). Previous observations of 12.2 GHz CH_3OH absorption (e.g. Whiteoak et al. 1988; Peng & Whiteoak 1992) were compared with H_2CO lines and the authors presented the dependence of emission of both molecules. Caswell et al. (1995a,b) observed methanol absorption at both the frequencies in their surveys. Theoretical considerations of Cragg et al. (1992) suggest a connection between different frequency methanol masers. They expressed the opinion that the pump schemes of different methanol transitions are probably linked to each other. Our observations of examples of the coincidence between CH_3OH masers and absorption lines at both frequencies support their theoretical assumptions.

5. Conclusions

Our 12.2 GHz maser emission survey towards 261 previously known 6.7 GHz masers from Szymczak et al. (2000, 2002) supplemented by all other previously observed emissions from the northern hemisphere yielded 49 detections, including 21 new emissions. We also examined 6.7 GHz emissions. Only one of the observed 12.2 GHz sources, G173.59+02.44, has no 6.7 GHz counterpart.

New absorption features have been found of which two 6.7 GHz absorptions have a 12.2 GHz emission counterpart. We also found an extreme 12.2 GHz absorption with a 6.7 GHz counterpart. The radial velocities of the absorptions and the emitting counterparts are the same. This suggests a physical connection of processes in regions generating the lines.

Comparing both the observed spectra of the methanol transition gives a picture of the 12.2 GHz emission being weaker and less complex. In most of the examined cases only a fraction of the observed 6.7 GHz-emitting complexes have a 12.2 GHz counterpart.

Some of sources have very interesting structures at both frequencies. Morphological similarity suggests their physical connection. Our results provide a good base for future interferometric simultaneous monitoring.

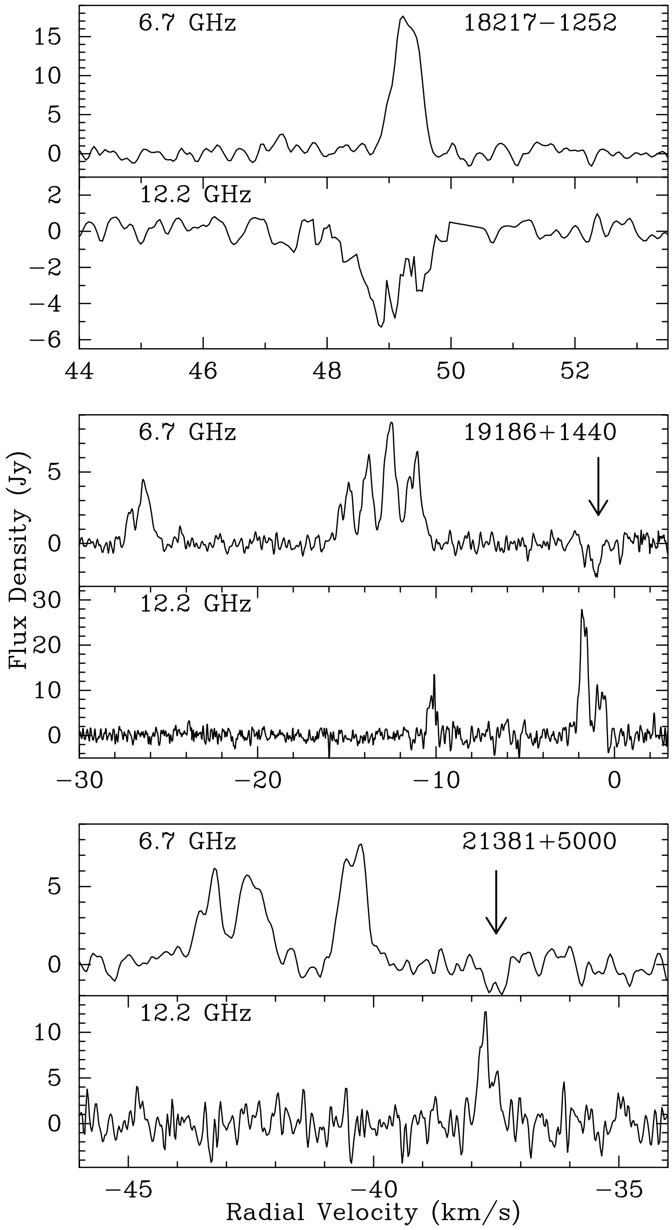

Fig. 4. A comparison of spectra of three sources. Top panels of each box show 6.7 GHz spectra, and the bottom ones contain 12.2 GHz spectra at similar radial velocity. The top box presents the 6.7 GHz emission and observed huge absorption at 12.2 GHz in 18217−1252. Middle and bottom pairs of spectra show 6.7 GHz absorptions at the radial velocity of 12.2 GHz emission features for 19186−1440 and 21381+5000.

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