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# Unusual properties of the methanol maser emission in W48

Irina E. Val'tts

*Astro Space Center of the Lebedev Physical Institute, Russian Academy of Sciences, Profsoyuznaya str. 84/32, Moscow 117810, Russia*

Stella Yu. Lyubchenko

*Astro Space Center of the Lebedev Physical Institute, Russian Academy of Sciences, Profsoyuznaya str. 84/32, Moscow 117810, Russia*

**Abstract.** In the star forming region W48 the spectrum of methanol lines is studied. It is found that the intensity of the $2_0 - 3_{-1}E$ (12.2 GHz) line anti-correlates with the intensity of the $5_1 - 6_0A^+$(6.7 GHz). All other class II methanol lines in the spectrum of W48 ($2_1 - 3_0A^+$(157 GHz), $3_1 - 4_0A^+$ (107 GHz) (possibly) and $J_0 - J_{-1}E$ (157 GHz)) demonstrate the same behaviour as $2_0 - 3_{-1}E$ (12.2 GHz) line. This fact contradicts to the current models of the class II methanol maser emission. The effect is confirmed in the sample of 67 sources. For the explanation of this fact some possibilities are considered.

## 1. Pecularities of methanol lines

W48 is class II methanol maser. There are two groups of the maser components in this region: the first one is in the velocity interval near 41 km/s and the second one - near 45 km/s. The distribution of the line intensities at 41 km/s is described well in the model calculations existing at the moment (see, for example Sobolev et al. 1997). According the calculations, with the decreasing of the $5_1 - 6_0A^+$ (6.7 GHz) line intensity the intensity of the other class II lines such as $3_1 - 4_0A^+$ (107 GHz), $2_1 - 3_0A^+$ (157 GHz), $2_0 - 3_{-1}E$ (12.2 GHz) has to decrease. Nevertheless the intensity of the second detail (at 45 km/s) of the $5_1 - 6_0A^+$ (6.7 GHz) line is smaller, but the intensity of the other lines at this velocity is relatively larger. This is clearly seen in A-methanol, where the lines are formed in the similar type of transitions (Figure 1).

## 2. Discussion

To understand the fact we have analysed the most detailed data on $5_1 - 6_0A^+$ (6.7 GHz) and $2_0 - 3_{-1}E$ (12.2 GHz) lines - presented in the paper of Caswell et al. 1995a). There are 131 sources in this paper, 67 of them are presented with pairs of $5_1 - 6_0A^+$ (6.7 GHz) and $2_0 - 3_{-1}E$ (12.2 GHz) lines – as in W48. The relation is the same as in W48 in every of 67 sources, that is more weak detail of the $2_0 - 3_{-1}E$ (12 GHz) line corresponds to the more strong detail of



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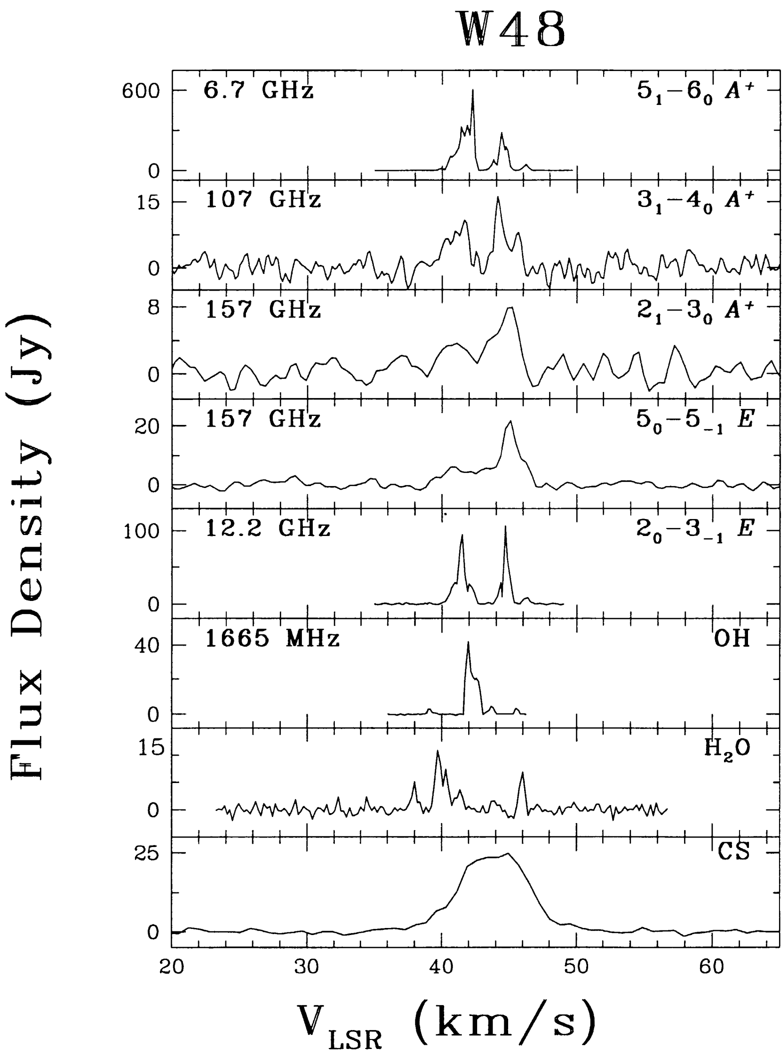


Figure 1. The spectra of maser lines in W48. These spectra were submitted in the following papers: 1) Caswell et al., 1995b, MN 272, 96; 2) Val'tts et al., 1999, MN 310, 1077; 3,4) Slysh et al., 1995, ApJ 442, 668; 5) Caswell et al., 1995a, MN 274, 1126; 6) Caswell and Haynes, 1983, Austr. J. Phys. 417, 36; 7) Migenes et al., 1999, ApJSS 123, 487; 8) Larionov et al., 1999, AASS, 257.

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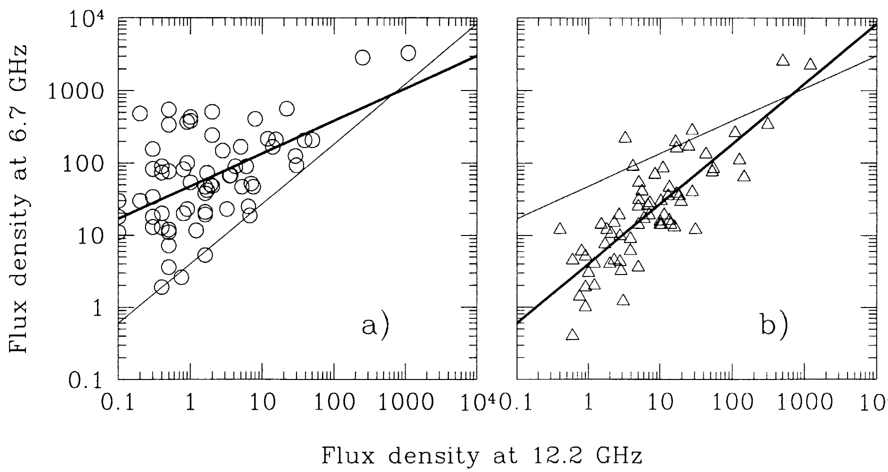


Figure 2. The relation between the flux densities in the pairs with the stronger a) and the weaker b) $5_1 - 6_0A^+$ (6.7 GHz) line. Solid line is the approximation y=Ax+B in non-lg scale. Thin line at Fig. 2a is from Fig. 2b and vice versa.

the $5_1 - 6_0A^+$ (6.7 GHz) line. There are some possibilities of the explanation of this fact.

1) $5_1 - 6_0A^+$(6.7 GHz) line and $2_0 - 3_{-1}E$ (12 GHz) line are formed in different condensations. However, there is a contradiction with the fact that the detected effect is observed in a large sample of sources – 67. Different physical conditions in the maser condensations should give a spectrum of the relations between the intensities of the lines - not the same relation in many sources. That is, different physical conditions in the condensations should smeared any effect in the large sample of the sources.

2) It could be a factor inside some condensations which provocates the preference of the $5_1 - 6_0A^+$ (6.7 GHz) transition. Such a factor should be as an addition to the pumping and one could name it, for example, "trans-pumping mechanism". This mechanism acts only for the $5_1 - 6_0A^+$ (6.7 GHz) transition, therefore the condensations with the more strong $5_1 - 6_0A^+$ (6.7 GHz) line in the table of Caswell et al. (1995) we could name as class IIa, and with more weak detail - as class IIb. We suggest, that this mechanism could begin to act only after the execution of some conditions in the maser condensation (this is the difference from physical conditions, which change continuously from one condensation to another), therefore we could see or not see the result in the spectrum.

Fig. 2 shows that the behaviour of the "strong" and "weak' pairs is described with the "threshold": this is an evidence in the trans-pumping mechanism favour.

The relation between the intensity of the $5_1 - 6_0A^+$ (6.7 GHz) line and corresponding $2_0 - 3_{-1}E$ (12 GHz) line for 64 sources from the table of Caswell et al. (1995a) with a single detail of these lines in the spectrum is the same as for the pairs with a weak line $5_1 - 6_0A^+$ (6.7 GHz), that is the most part of class II masers are class IIb masers with usual mechanism of the pumping.

The problem is that in the frames of this model of the maser with the trans-pumping mechanism we also could not understand, why this effect is observed in every of 67 sources! To explain this fact, it is interesting to notice, that may be not only the relative increasing of the $2_0 - 3_{-1}E$ (12 GHz) line intensity is important, but the tendency of changing the intensity of this line in every source. We mean that in every source one can see not only the "strong" and the "weak" $5_1 - 6_0A^+$ (6.7 GHz) line, but the weak $5_1 - 6_0A^+$ (6.7 GHz) line under other pumping conditions, according the intensity ot the $2_0 - 3_{-1}E$ (12 GHz) line. In the previous point we suggested that the pumping source is the same for all lines and also that this source is at the same distance from two condensations in the molecular cloud. It is very easy to explain the difference in the pumping conditions if the distances of the two condensations are different – in this case we could see "strong" and "weak" $5_1 - 6_0A^+$ (6.7 GHz) lines. The situation that there is one "strong" and the other - "weak" line is possible if the condensations are, for example, at different orbits around the pumping source. If class II masers are planets around young massive stars (Slysh et al. 1999), one could to imagine, that one condensation is in the own orbit, more close to the pumping source, and another one is on its own more distant orbit. Our results show that if this hypothesis is correct, all class II methanol masers could be planet systems.

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