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$0''.4$ BIMA Array Mapping of the 107 GHz Methanol Maser in W3(OH)

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Abstract. Using A-configuration of the BIMA-array with $0''.4$ angular resolution maps were obtained of the 107 GHz methanol line in W3(OH). The 107 GHz masers have their counterparts in another methanol transition at 6.7 GHz. The strongest maser spots are unresolved with the BIMA-array and are less than $0''.15$, which corresponds to the lower limit of the brightness temperature 5×10^5 K. A model of Class II methanol masers emitted in the extended atmosphere of icy planets orbiting around the O-star which excites H II region is proposed.

Introduction. Methanol masers of Class II are found around compact H II regions excited by massive young O-stars (Menten 1991a). The maser spots are often aligned along straight lines or arcs, and it was suggested that they originate in protoplanetary disks (Norris et al. 1993). The most widespread are Class II methanol masers in the transition $5_1 - 6_0\mathrm{A}^+$ 6.7 GHz (Menten 1991b). Menten et al. (1992) made VLBI maps of 6.7 GHz maser in ultracompact H II region W3(OH). The masers are distributed in regions adjacent to the H II region, mainly in two clusters M1 (South) and M6 (North). Here we report results of the mapping of Class II methanol masers in the transition $3_1 - 4_0\mathrm{A}^+$ in the millimeter wavelength band at 107 GHz in W3(OH).

Results and Discussion. Both continuum and 107 GHz methanol line were mapped. Fig.1 shows a grey scale plot of the continuum and contour plot of methanol line emission. The line map is integrated over the whole velocity range of methanol emission of about 5 km sec^{-1}. The individual spectral channel maps have been fitted by Gaussian components.

At least 9 components have been detected, most of them unresolved or barely resolved by $0''.4$ beam. Component 5 is extended, but with a higher resolution it may break in smaller components. The brightest component 4 is less than $0''.15$, and has brightness temperature more than 5×10^5 K. It corresponds to the component M6 on the 6.7 GHz map of Menten et al. (1992). The second major component is 3 corresponding to the 6.7 GHz component M1. Components 5, 7, 9 also have their counterparts at 6.7 GHz. In general there is a good correspondence between maser distributions at 6.7 and 107 GHz, taking into account difference in angular resolution. As 6.7 GHz methanol and 1.6 GHz OH masers, 107 GHz methanol masers seem to be distributed in a ring around the ultracompact H II region W3(OH), with the inner part of the ring very close to the boundary of the H II region. We suggest that the maser spot radiation is emitted in the atmosphere of planetary size icy solid bodies orbiting around the exciting star of the H II region. The methanol and OH molecules are produced by evaporation from the surface of these icy planets, much the same as it occurs in comets. The size of the planets is much larger than the size of comets—several thousand kilometers. The 50 $M_\odot$ O-star exciting the W3(OH) H II region can gravitationally bind the planets even at the distance 2200 AU,

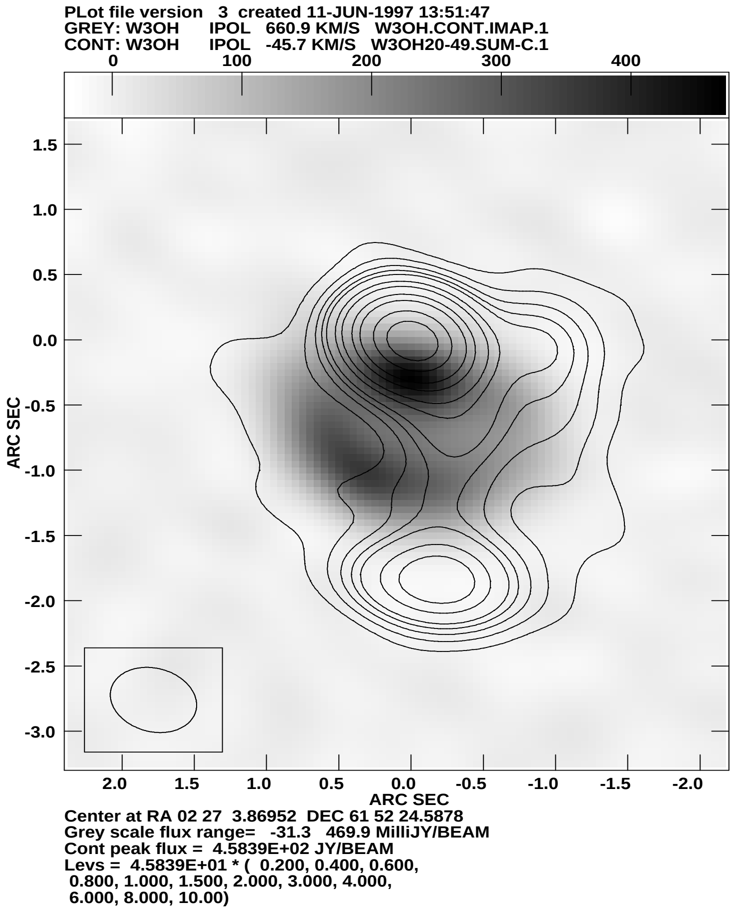

Figure 1. 107 GHz methanol line and 107 GHz continuum map of W3(OH). Grey scale: continuum, maximum 470 mJy/beam, contours: velocity integrated methanol line, maximum 458 Jy/beam. The beam is shown in the lower left corner.

and provide enough heat to evaporate ice. We suppose that the ice is a mixture of water and methanol in the same proportion as in the interstellar grain mantles and in comets: several per cent of methanol. In the maser emission zone of planetary atmosphere at the distance of several million kilometers from the surface $n_{H_2O}=10^7$ cm^{-3} and $n_{CH_3OH}=10^5$ cm^{-3}. The maser excitation is provided by the submillimeter radiation from the H II region.

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