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Disk Structure of the H_2O Maser IC 1396N

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Abstract. The VLBA map of the H_2O maser IC 1396N, which was obtained during the VSOP pre-launch survey, shows an ordered position of maser spots. The maser spots are located along an almost straight line with the separation between extreme maser spots of 20 mas. The radial velocity varies along the line from by 3 km s^{-1}. In total 9 maser features have been located on the line, all of them unresolved by the VLBA beam. This geometry is consistent with the disk model of masers. The mass of the disk is estimated between 10^{-7} and 10^{-4} M$_\odot$, depending on the thickness and density. The disk must be supported by a central star with the mass of about 0.07 M$_\odot$. The H_2O maser in IC 1396N may be a proto-planetary disk around a low mass protostar in the process of accretion.

Introduction. IC 1396N (north) is a bright-rimmed globule in H II region IC 1396 at the distance 750 pc, associated with bipolar molecular outflow. The IRAS source 21391+5802 is in the middle of the globule and has a luminosity 500 L$_\odot$ (Sugitani et al. 1989). In this paper we report the results of high angular resolution observations of the H_2O maser which may be associated with one of the young stellar objects.

Results and Discussion. We obtained maps of the maser in all spectral channels. The summed map of the central group obtained with the convolving beam $(200\times200)\mu$as is shown at Fig.1. A remarkable feature of the map at Fig.1 is almost perfect alignment of the maser spots along a straight line with the position angle 86°. The radial velocity varies monotonously along the line from -1.8 km s^{-1} on the right to 1.3 km s^{-1} on the left. It is reasonable to assume that the maser source in IC 1396N has a disk structure. The mass of the disk IC1396N can be estimated assuming a density 10^9–10^{10} cm^{-3} as required for H_2O masers (Elitzur 1992), disk diameter 15 A.U. (20 mas at the distance 750 pc (Matthews 1979)) and disk thickness 0.01 to 0.1 of the diameter, to be in the interval between 10^{-7} and 10^{-4} M$_\odot$. With the velocity difference of 3 km s^{-1} over the range of 15 A.U. the disk can not be self supported gravitationally; but a central star of the mass of 0.07 M$_\odot$ or more can support the disk. The inferred mass of the star 0.07 M$_\odot$ probably is related to a low mass protostar in the process of formation. The disk with H_2O masers is probably a circumstellar disk, which arises as a by-product of star formation, and which accumulates the excess angular momentum of the collapsing molecular cloud core. The building of the final stellar mass occurs by accretion through this centrifugally supported disk (Shu et al. 1988). Genzel et al. (1978) proposed a disk model for H_2O masers in W51M and NGC7538S. Disk model of H_2O masers was proposed by Elmegreen & Morris (1979) and by Cesaroni (1990). Lekht et al. (1993) from the analysis of time variation of H_2O maser in S140 also proposed a maser model

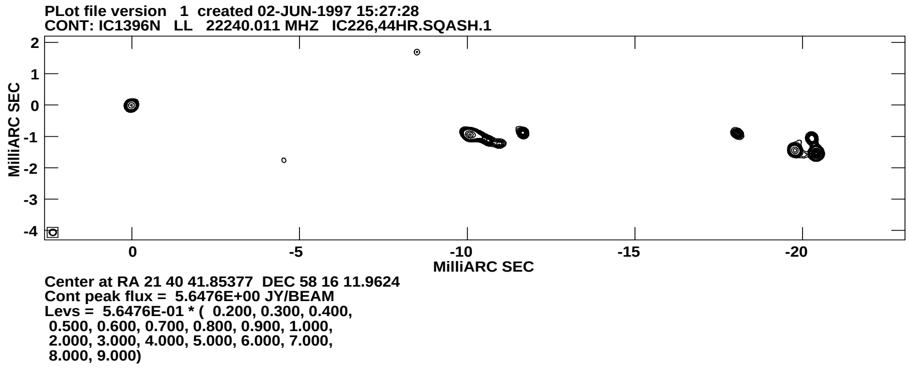

Figure 1. The summed map of the maser IC 1396N in the velocity interval -1.5 to 1.6 km s^{-1}. Restoring beam is 0.2 mas.

with the Keplerian disk of the radius 30 A.U. and a central star of the mass 5 $M_\odot$. The protoplanetary disk in Ori KL observed by Matveyenko et al. (1988) during the large outburst had the radius of 5 A.U. The disk model was also proposed for Class II methanol masers by Norris et al. (1993). It seems that the observed structure of H_2O maser in IC 1396N is an additional evidence in support of the theoretical scenario of low mass star formation.

Summary. The VLBA map of the H_2O maser IC 1396N, which was obtained during the VSOP pre-launch survey shows an ordered position of maser spots. The maser spots are located along an almost straight line with the separation between extreme maser spots of 20 mas (15 A.U.). The radial velocity varies along the line from -1.5 km s^{-1} to 1.6 km s^{-1}. In total 9 maser features can be located on the line, all of them unresolved by the VLBA. This geometry is consistent with the disk model of masers. The mass of the disk is estimated between 10^{-7} and 10^{-4} $M_\odot$, depending on the thickness and density. The disk must be supported by a central star with the mass of about 0.07 $M_\odot$. The H_2O maser in IC 1396N may be a proto-planetary disk around a low mass protostar.

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