H_2O MEGAMASER IN ORION KL

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ABSTRACT. The region of the H_2O megamaser emission in Orion KL had been studied by VLBI method. The structure is a chain of the compact components oriented under the angle X ≅ -80°. The size of the components is $\lesssim 0.1$ A.U., the brightness temperature $T_b \cong 10^{17}$ K, the linewidth of each component is $\Delta f \leq 7$ kHz. The emission has linear polarization $P \geq 80$ % and position angle is changed by 9.2 degree / A.U. The velocity of the components has a gradient 0.41 km/sec A.U. The masers are unsaturated, the kinetic temperature $T_k \leq 120$ K. The structure corresponds to an expanding protoplanet rings, radius of which is equal R = 6 A.U. The rotation and the expanding velocities are equal 5 and 3.8 km/s accordingly. Mass of a protostar is $\sim 0.7\ M_\odot$.

INTRODUCTION. In a number gas-dust complexes of our Galaxy it has been processed a star formation, which accompanied by a hydrocsil and a water vapor maser emission. A H_2O megamaser outbursts observed in a two cases : in a object W 49 and Orion KL,(Matveyenko, (1981)). The active period of the megamaser emission had been observed in Orion KL nebula at 25.09.1979 to end 1987. The maximum flux density was equal to $F = 8 \times 10^6$ Jy and linewidth $\Delta f \cong 40$ kHz (Abraham et al.,(1986), Matveyenko et al., (1988), Garay et al.,(1989)).

OBSERVATIONS AND RESULTS. To study this fenomena one needs measuring a structure of the emission region. But the maser sources are very compact and can be measured by VLBI method only. The H_2O maser outburst in Orion KL observed from a moment, when emission began to grow (Matveyenko , (1981), Matveyenko et al.,(1982)), and continued each year at different interferometers. The Fig 1 shows results of this observations. The megamaser region has a complex st-

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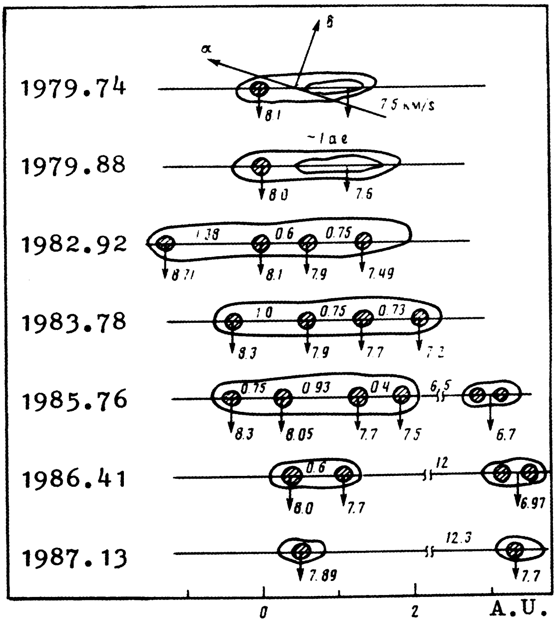

Fig. 1. Relative position of the compact components and velocity.

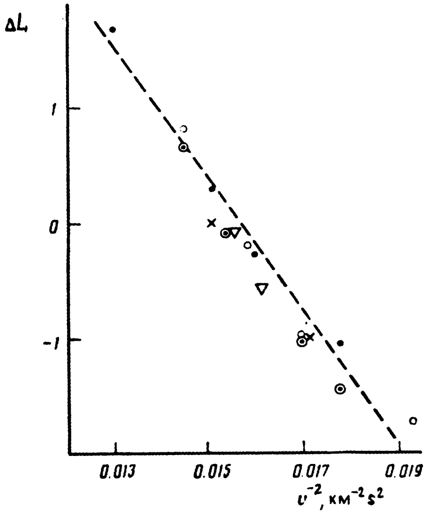

Fig. 2. Reletive position (ΔL,A.U.) plotted against velocity (V^{-2}, km^{-2} s^2).

ructure, which consists of a few compact components distributed along a direction $X = - 79^{o}$. The size of the components is equal to $\leqslant 0.1$ A.U. A distance between them is equal to 0.4 - 1.4 A.U. One can observe 3 - 4 compact brightness components inside ~ 2.5 A.U.. The velocity of the components are $V = 7.2 - 8.7$ km/s and correlated with their location. The gradient velocity is equal to $dV/dL = 0.41 \pm 0.05$ km/s A.U. . The linewidth of each component is equal to $\Delta f = 10$ kHz, or $\Delta V = 0.135$ km/s. The linewidth corrected by the differential velocity inside the emission region would be $\Delta f = 7$ kHz. A brightness temperature of the compact components is $T_b = 10^{16-17}$ K and changes gradually. Correlation of the T_b with time of the components is not observed. Such a high brightness temperature is defined by a high directivity of emission $\Omega < 10^{-4}$, which is determined by a geometry of the maser source. The shape of source looks like a cylinder by length -l and diameter -d. In this case $\Omega = (d/l)^2$. For $d = 0.1$ A.U. $l \geqslant 10$ A.U. . A chain of the components corresponds to the parallel cylinders, which are observed along its axis, or a protoplanet rings, a plane of which is parallel to a beam of view. A radius of the rings are equal to $R = 6$ A.U.

MODEL OF THE MEGAMASER. The masers are unsaturated or saturated only partialy. Thus, the variability of the flux density would be $I/I_o = e^{-\Delta\tau}$. The optical depth is $\tau = \ln T_b / (T_g + T_s)$, where T_g and T_s correspond to the background and spontaneous emission. $T_g + T_s \cong 100$ K for Orion KL and $\tau = 35$. A few percent variation of τ changes the maser emission strongly.
The dependence of velocity of the components from the location (Fig 2) corresponds to Kepler,s low $\Delta L \sim V^{-2}$. In this case $R_K = V\Delta R/2\Delta V$. The velocity of region, where the maser is located is $V = 5.5$ km/s and $R = 3.5$ A.U. A discrepancy R and R_K can be explained by rings expansion and rotation $V_{exp} = 3.8$ km/s and $V_{rot} = 5$ km/s.
The slope of line Fig 2 corresponds to $\alpha \equiv MG = 570$ and $M = 0.7 M_\odot$, ($G = 6.67 \times 10^{-8}$ $Din \cdot cm^2 \cdot g^{-2}$).
The temperature of the rings from the linewidth is equal to $T_k = \Delta f^2 \tau / 2 = 120$ K. The low kinetic temperature proposes IR pumping. The IR source can be a protostar. The IR emission relative to the protoplanet rings would be isotropic and a polarization of the maser emission would be strong linear (Western and Watson (1983)). The emission of the compact components is linear polarized $P > 80$ % (Matveyenko and Romanov (1983)). Position angle of the polarization is changed in dependence with its location. The gradient is equal to $dX/dL = 9.2$ deg./A.U. and corresponds to the expanding rings with a magnetic field, (Matveyenko et al., (1988)).

A non-homogenious destribution of H_2O molecules in the rings would change optical depth in the tangential directions of rings and a maser emission would be variable with rotation. For the change of the emission on the order τ would be change by 2.3 or 6% of τ. This model explaned why correlation of the variability emission of the components is absent. The number of H_2O molecules in colomn is equal to $\sim 10^{18}$ cm^{-2} and the density is $\sim 10^4$ cm^3 .

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