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The H_2O Supermaser Emission Region in Orion KL

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Abstract. We compare spatial structure of the H_20 maser during an active period with that during a later quiescent period, received with VLBA in 1993.

We have studied the fine structure of the H_2O super maser emission region during a period of high activity (1979–1986) using global VLBI and using the NRAO VLBA in 1993 during a comparatively quiescent period. In the active period flux density levels reached $(0.5-7)\cdot 10^6 Jy$, (Abraham et al. 1981; Matveenko 1981; Garay, Moran, & Hashick 1989) and the quiescent period $F \leq 2.2 \cdot 10^3 Jy$.

In this period maser emission is dominated by a chain of four groups of compact components, P.A. $\sim 90^o$ with a total extent of $\sim 8.3AU$, (Matveenko, Graham, & Diamond 1988; Matveenko & Diamond 1993). The velocities of these groups range from 6.1 ('C'- group) to 8.5 km/s ('D'- group). The mean velocity gradient across the chain is 0.14 km/s/mas or 0.29 km/s /AU. The main group, 'A' at V=7.5 km/s, consists of 7 components. The velocity gradient is 0.32 km/s/mas. The component sizes are 0.1–0.15 AU. The brightness temperatures of the components are $T_b = 10^{16-17}$ K. The compact components of the main group are linearly polarized with $P \geq 85\%$. The position angle of polarization was measured for each component and correlated with the component location, yielding a gradient of polarization angle $\delta\chi/\delta V = 25^o/km/s$ or $\delta\chi/\delta L = 13.5^o/AU$.

The NRAO VLBA measurements of the super maser structure during the quiescent period of 1993 had high dynamic range. The maser emission was $F \leq 2200Jy$ in the 'super-maser' velocity range . The compact structure can be summarized as 6 compact components lying along a line $PA = -43^o$ within $\sim 6AU$. The component velocities are V_{LSR}= 5.5 - 8.9 km/s. The velocity of the central component is 6.2 km/s corresponding to the velocity of the 'C' group seen during the active period. The component emission is F=1200 Jy and is linearly polarized. The position angle of polarization changes with velocity with a gradient equal to $\delta\chi/\delta V = 13^\circ/km/s$. We assume the systemic velocity is that of the component at 6.1 km/s. The jet-like structure near this component is visible at V = (4.3 - 5) km/s, where emission of the main component is weak. The jet size is 1 AU and orientation $PA = 90^o$, F = 27 Jy/beam, Fig.1.

Our results can be described by a proto-planetary disc-ring model. The compact maser components lie in a thin, edge-on, rotating and expanding disc-ring, we suggest that the velocity center of the system is that of the strong component at $V_{LSR} := 6.1km/s$. The velocities of the component groups are $V_b = 0.3$, $V_a = 1.4$ and $V_d = 2.4$ km/s. The super maser components lie along the edge of the disc - ring, where the longest path lengths are available. The groups have radius of 3 to 8.3 AU. The mass of the star is $M \sim 2 \cdot M_o$, a rotational velocity of $V_\tau = 48 \cdot R^{-0.5} km/s$ and an expansion velocity of $V_n = 0.28 \cdot R^{0.28} km/s$. The total value V and direction Q of the velocity vector for each group is $V_b = 46.6$ ($Q_b = 36.5^o$), $V_a = 48.5$ (25.4), and $V_d = 52.4$ (18.6). The components lying along a line $PA = -43^o$ and $PA = 137^o$ relative to the central component are perhaps injected from a star located in the central region.

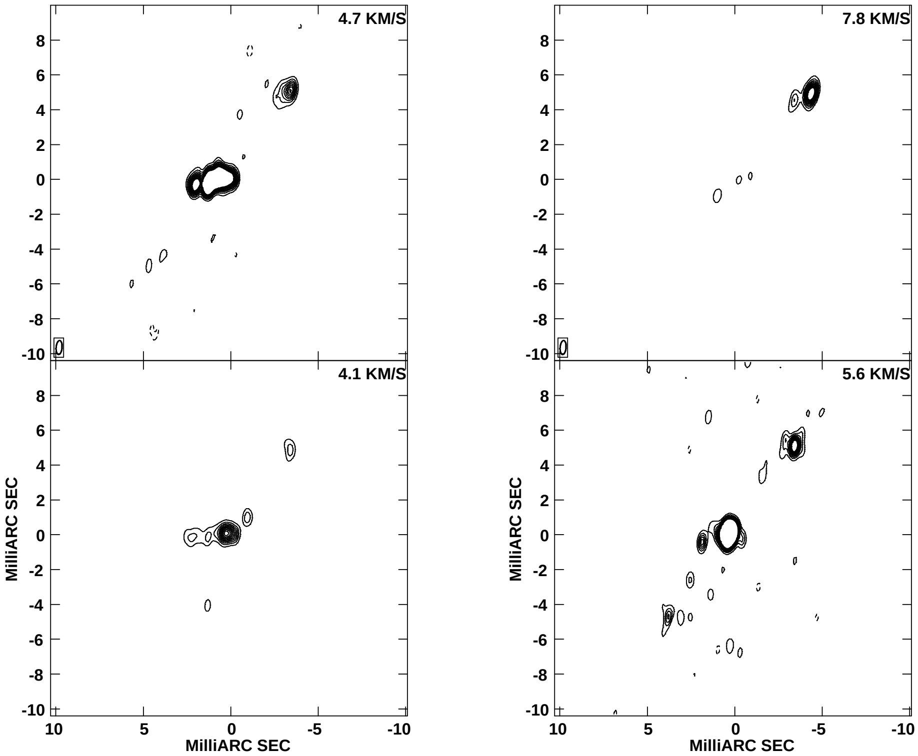

Figure 1. 1993 VLBA maps of central region.

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