IAU Colloquium 164: Radio Emission from Galactic and Extragalactic Compact Sources
ASP Conference Series, Vol. 144, 1998
J. A. Zensus, G. B. Taylor, & J. M. Wrobel (eds.)

The H_2O Supermaser Emission Region in Orion KL

L. I. Matveenko
Space Research Institute, Moscow 117810, Russia

P. J. Diamond
National Radio Astronomy Observatory, Socorro, NM, U.S.A.

D. A. Graham
Max-Planck-Institut für Radioastronomie, 53121 Bonn, Germany

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 $\delta\chi/\delta V = 13°/km/s$. 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

https://doi.org/10.1017/S0252921100045437 Published online by Cambridge University Press

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.

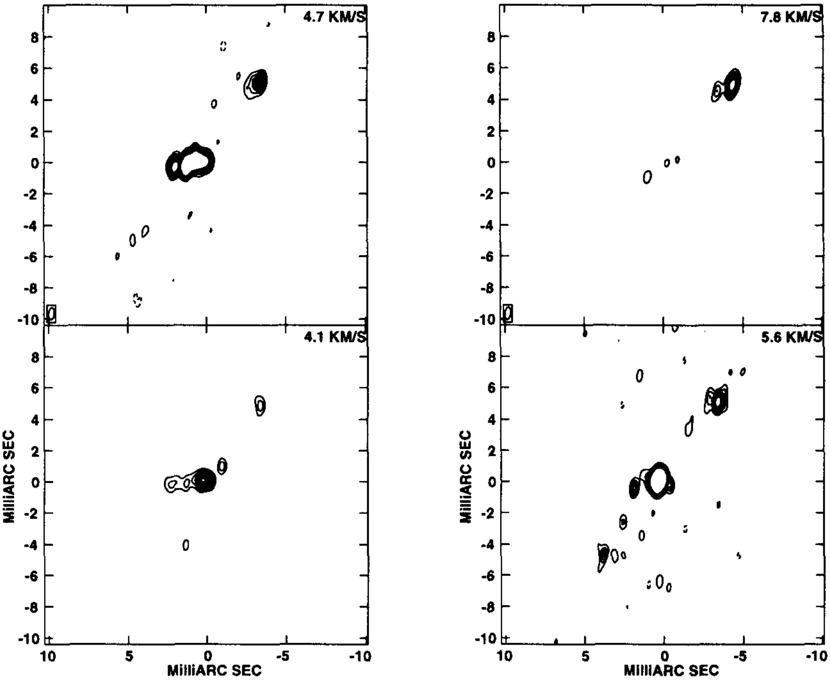

Figure 1. 1993 VLBA maps of central region.

Acknowledgments. LM is grateful to NRAO, IAU, and INTAS. The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under a cooperative agreement by Associated Universities, Inc.

References

Abraham, Z., et al. 1981. *A&A*, **100**, L10–13.

Garay, G., Moran, J. M., & Hashick, A. D. 1989, *ApJ*, **338**, 244–261.

Matveenko, L. I. 1981. *Soviet Ast. Lett.*, **7**, 54–57.

Matveenko, L. I., Graham, D. A., & Diamond P. J. 1988. *Soviet Ast. Lett.*, **14**, 468–476.

Matveenko, L. I., & Diamond, P. J. 1994. in *VLBI Technology, Progress, and Future Observational Possibilities*, eds. T. Sasao, S. Manabe, O. Kameya, & M. Inoue (Tokyo: Terra), 105–109.

https://doi.org/10.1017/S0252921100045437 Published online by Cambridge University Press