VLBI OBSERVATIONS OF THE H_2O MASER OUTBURST IN ORION KL

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We present preliminary results from a seven year VLBI study of the H_2O maser outburst in Orion-KL. Our results reveal changes in the profile, in the spatial structure and in the polarization characteristics of the H_2O masers. We interpret our data in terms of edge-on rings rotating about a protostellar object.

In August 1979 Abraham *et al.*(1981) observed an enormous outburst of the H_2O maser emission in Orion-KL. The peak flux density at a velocity of ~ 8 km s^{-1}rose from a $\sim 10^4$ Jy to $\sim 10^6$ Jy. The outburst emission was observed to have strong linear polarization ($P \sim 60\%$) and was concentrated inside a linewidth $\Delta f \approx 30$ kHz. The profile shape and flux density is changing with time. See Fig.1 for a representative spectrum and its linear polarization structure.

We have performed multi-epoch VLBI observations of the H_2O maser outburst in order to study the spatial structure as a function of time. Our results (so far obtained only by model-fitting) demonstrate that the structure is changing and complex, but in general consists of a few compact maser components distributed along a position angle $\phi \sim -80°$.

We briefly descibe a subset of our results.
25 September 1979. Observations with the Crimea-Puschino baseline revealed a simple core-halo structure, the core has $4-5$ compact components and a total size ~ 0.6 AU and a halo size ~ 1.2 AU. The brightness temperature T_B was observed to be $\geq 2 \times 10^{16}$ K. The compact emission region had a total linewidth ≤ 10 kHz implying $T_K \sim 100-200$ K if the maser is not saturated, this suggests an IR pumping mechanism. Observations with Crimea-Effelsberg and Greenbank-Haystack in Nov. 1979 showed a very similar structure.
1 December 1982. Observations with Crimea-Onsala-Effelsberg revealed 4 compact components each of size ≤ 0.2 AU implying $T_B \geq 10^{17}$ K. The masers were located along $\phi \sim -80°$ (see Fig.2a), a distinct velocity gradient was visible implying $\Delta V/\Delta L \approx 0.44$ km s^{-1}/AU. We suggest that this gradient implies the masers lie in a disc which is rotating around

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a protostar. The masers have a velocity ~ 11 km s^{-1}relative to the protostar (deduced from the velocity of the ambient molecular gas) and lies at a distance of 12 AU to the west of the masers.

10 October 1983. Observations with Crimea-Effelsberg revealed a structure similar to that seen in Dec 1982. Other observations from the Crimea-Puschino baseline combined with single dish data showed that the compact regions have $P \geq 85\%$ and that the polarization position angle was changing across the profile (see Fig.1).

26 May 1985. We were able to obtain a global observation of the outburst using Crimea-Effelsberg-Onsala-Greenbank-Haystack-VLA-OVRO. Our initial model-fitting showed that a new feature was now visible in the source (see Fig.2b) at a ~ 6.5 AU from the centroid of the previous structure.

Our observations have revealed the presence of maser components with $T_B \sim 10^{16-18}$ K. These are the highest T_B yet recorded and are probably caused by a high degree of beaming ($\Omega < 10^{-4}$). The beaming may be due to a) coherent emission, which we do not regard as physically likely; or b) the masers being filaments of gas which lie in edge-on rings rotating around the protostar. We suggest that the large degree of linear polarization is caused by an anisotropic pump engine due to IR radiation from an unidentified source (possibly the protostar). From the velocities and distances observed the motion could be supported if the protostar had a mass $\sim 1.8 M_\odot$. The observed change in polarization position angle across the maser profile and emission region could be explained if the proposed rotating rings also had an expansional velocity component and were permeated by a magnetic field.

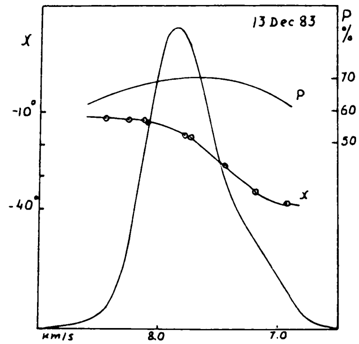
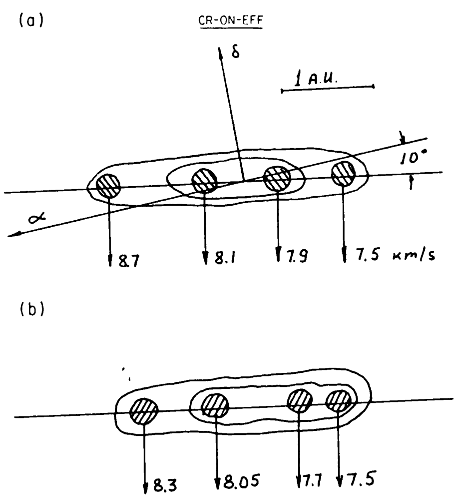


Figure 1. A single dish profile of the H_2O maser in Orion-KL, the solid line (P) is the percentage linear polarization, the line (χ) is the polarization position angle. Figure 2 shows maps of the maser distribution at different epochs.



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