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Early stage of star formation in Orion KL

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Abstract. Super H_2O outbursts accompany star formation. We have been studying this phenomenon in Orion KL starting in 1971.8.

Super H_2O outbursts accompany star formation. We have been studying this phenomenon in Orion KL starting in 1971.8. Over the first period (1971-1988) the flux density of the outbursts was 8 MJy, the line velocity was 8 km/s and the line width 0.4 km/s. The duration of the outbursts are ~1 month. The emission is strongly linearly polarized (80%), and has extraordinary rotation of 25°/km/s. A highly collimated bipolar outflow is visible, too. The ejecta brightness temperature is $T_b = 10^{17}$ K. The helix structure of the bipolar outflow is the result of a precession instability, with a period of 10 yrs. The highly collimated fragments of the outflows are visible at distances out to 80 AU. Velocities of the maser sources at the disk boundary can be Keplerian, in this case the equivalent mass of the central body is $M < 0.01 M_\odot$. A silent period around 1995 showed a maser flux density of 1 kJy at 7.65 $\mathrm{km\,s^{-1}}$. A bipolar outflow was visible as well as the ejecta, the brightness temperature of which was $T_b = 10^{12}$ K with a polarization of 50%. The same structure was observed during a silent period in 2003.

Our studies show that the polarization angles of the nozzle fragment outflows are different by 45°, and that the line of sight velocities are around 0.3 km/s. This accounts for the extraordinary rotation of polarization. The orientation of the polarization is perpendicular or parallel to the outflow velocity. Linear polarization is the result of the spin alignment of H_2O molecules with anisotropic pumping. Ejection velocities of the streams are 5 $\mathrm{km\,s^{-1}}$ and increase up to 40 $\mathrm{km\,s^{-1}}$ at a distance of 1.5 AU. Kinematics of the active region of star formation corresponds to an anti-centrifuge cosmic whirlwind. Surrounding matter is accreting onto a disk, follows along the arms and the ejected bipolar outflow. Conditions in the central part of the disk stimulated the formation of a massive body, the gravity field of which accelerates and stabilizes the system. Interaction of the rotated outflows with surrounding matter accelerated and collimated the system. The period of the outflow rotation is $T_{rot} = 0.5$ yr. Surrounding matter amplifies the emission by 2–3 orders at 7.65 $\mathrm{km\,s^{-1}}$ at a width of 0.4 $\mathrm{km\,s^{-1}}$. The visible fragments of the bipolar outflow at far distances are the results of an interaction with the surrounding media.

References

Matveenko L. I. 1981, *Astron. Letters*, 7, 100
Matveenko L. I., Zaharin K. M., Diamond P. J., & Graham D. A. 2003, *Astron. Letters*, 9, 641
Matveenko L. I., Zaharin K. M., Diamond P. J., & Graham D. A. 2004, *Astron. Reports*, 2, 100
Demichev V. A. & Matveenko L. I. 2004, *Astron. Reports*, 12, 979
Matveenko L. I. & Sivakon S. S. 2008, *Astron. Letters*, 12, 820
Matveenko L. I. & Demichev V. A. 2010, *Astron. Letters*, 11, 986