

The first mas-resolution map of 6 GHz OH maser for PN K3-35

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Abstract

Planetary Nebulae (PNe) are born during the final stage of the life of low or intermediate mass stars. K3-35 is a prominent young PN, which is the brighter one of two PNe detected 6 GHz OH masers up to now. We proposed a relative motion measurement for the 6 GHz OH masers toward K3-35 with the EVN in full polarization spectral line mode, to understand the morphology and kinematics of central core where the OH masers reside, and the role of the magnetic field in shaping the circumstellar envelope of the PN. Here we will present the preliminary results of the first epoch observations carried out on 16 June, 2014.

1. PN K3-35 and 6035 MHz OH maser

K3-35 (IRAS 19255+2123) is a prominent young PN, harboring both 18 cm OH emission (main and satellite lines) and the first excited state of OH maser emission at 6035 MHz (Desmurs et al., 2010). It is also the first PN where 22 GHz H₂O maser was discovered (Miranda et al., 2001). K3-35 exhibit bipolar morphology at radio wavelengths (Aaquist, 1993), and the H₂O maser emission are arising not only from the central core of the PN in a torus-like structure, but also from the tips of the bipolar lobes (Miranda et al., 2001). Uscanga et al. (2008) studied the kinematics of the H₂O masers near the central core of K3-35, by analysing the spatial distribution and line-of-sight velocities of the maser spots from the VLA observations. They identified an expanding and rotating ring, and suggested that the presence of a disc or torus may relate to the collimation of the outflow.

The first 6035 MHz OH maser map for K3-35 was obtained from the MERLIN observation by Desmurs et al. (2010), which shows that the OH maser spots are very compact. Much higher angular resolution observation with the EVN toward the 6035 MHz OH masers would be promising for providing morphologic and kinematic information, combined with the distance of the PN (~3.9 kpc, Tafuya et al., 2011), allowing us to obtain the full 3-dimensional motions, which is essential to understand the original of the asymmetry observed in K3-35.

2. The EVN observations

To measure the morphology and kinematics of PN K3-35, and understand the role of the magnetic field in shaping the envelope of this stellar system, We propose to observe the 6035 MHz OH masers toward K3-35, with full polarization spectral line mode using EVN at three epochs spanning ~1 yr. The first exploratory epoch (EVN code: EC044) was carried out on 16 June, 2014, with a recording rate of 256 Mbps and two correlator passes, one pass generates 16 channels for all data and a second pass generates 1024 channels for line sources. The observations were continuing in total of 9 hours, and J1925+2106 was observed as phase-reference calibrator, 3C286 and 3C48 were observed for polarization calibration. the EVN antennae involved were Effelsberg, Yebes, Torun, Noto, Westerbork, Jodrell Bank, Onsala and Tianma65. Unfortunately, Yebes and Noto didn't get useful data because of LO wrong setting, however, the good data getting from the rest six antennae is enough to look into some general properties of the 6 GHz OH maser reside in K3-35.

3. Preliminary Results

Here we just present the preliminary results of the EVN observations. The uv-coverage is given in panel left of figure 1 and the cross-power spectrum between Effelsberg (EF) and Tianma65 (T6), the longest baseline with the length of ~ 8000 km, is given in panel right, which shows that the 6 GHz OH maser is detected distinctly with the SNR of ~20. In figure 2, the 6035 MHz OH maser channel map of K3-35 is presented, with the resolution of milliarcsecond, which is the highest angular resolution for this kind of maser in PNe.

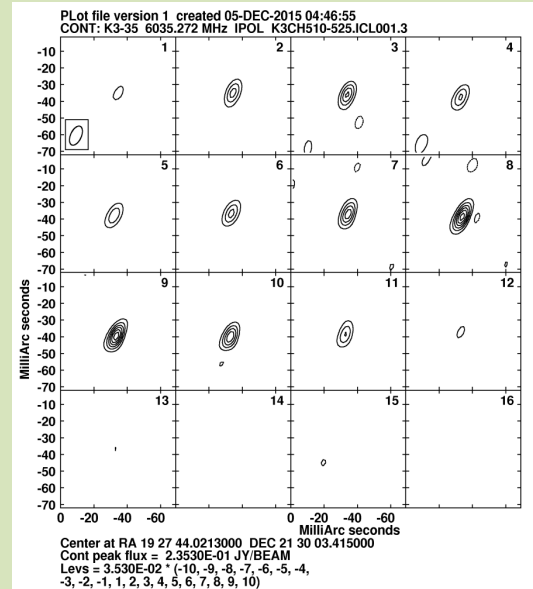


Figure 2. 6035 MHz OH maser channel map of K3-35 obtained with the EVN.

4. Conclusion

In order to study the morphology and kinematics of 6 GHz OH maser in PN K 3-35, and understand the role of the magnetic field in shaping the envelope of the stellar system, an exploratory EVN epoch was carried out on 16 June, 2014. The milliarcsecond resolution map of the rare 6 GHz OH maser resided in PNe is obtained for the first time, which indicating that the excited state of OH maser spots in K3-35 are detectable and compact enough at mas scale, and suitable for the kinematics study and the determination of magnetic field strength.

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References

- Aaquist, O.B. 1993, A&A, 267, 260
- Desmurs, J.-F., Baudry, A., Sivagnanam, P., et al. 2010, A&A, 520, A45
- Miranda, L. F., Gomez, Y., Anglada, G., & Torrelles, J. M. 2001, Natur., 414, 284
- Tafuya, D., Imai, H., Gomez, Y., et al. 2011, PASJ, 63, 71
- Uscanga, L., Gomez, Y., Raga, A. C., et al. 2008, MNRAS, 390, 1127

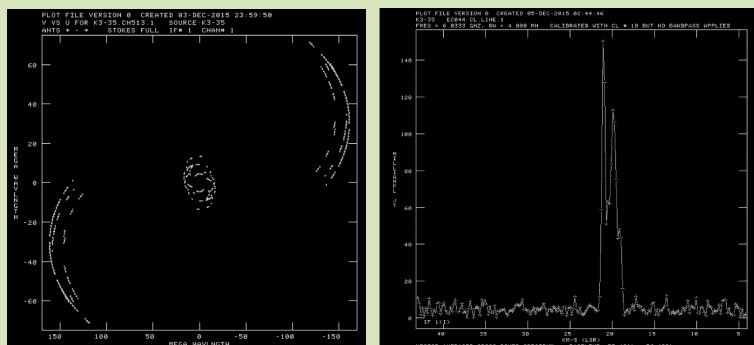


Figure 1. The uv-coverage (left) and cross-power spectrum (right).