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# $HCO^+$ emission possibly related with a shielding mechanism that protects water molecules in the young PN K 3-35

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**Abstract.** Water maser emission has been detected only toward three planetary nebulae (PNe). In particular, in K3-35, the first PN where water vapor maser emission was detected, the components are located in a torus-like structure with a radius of 85 AU and also at the surprisingly large distance of 5000 AU from the star, in the tips of the bipolar lobes. The existence of these water molecules in PNe is puzzling, probably related to some unknown mechanism shielding them against the ionizing radiation. We report the detection of $HCO^+$ ($J = 1 - 0$) emission toward K 3-35, that not only suggests that dense molecular gas ($\sim 10^5$ cm$^{-3}$) is present in this PN, but also that this kind of PN can enrich their surroundings with organic molecules.

**Keywords.** Planetary Nebula, stars: individual (K 3-35), radio lines: molecules, stars: circumstellar matter

## 1. Introduction

The presence of $H_2O$ maser emission in planetary nebulae (PNe) is opening a new field in the evolutionary study of intermediate mass stars (Gómez 2007, Gómez *et al.* 2008). Even when water maser emission is typically found in the envelopes of asymptotic giant branch (AGB) stars, it is not expected to persist in the PNe phase, where the envelope not only begins to be rarefied but also becomes ionized. Water maser emission has been detected toward three PNe (K 3-35, Miranda *et al.* 2001; IRAS 17347-3139, de Gregorio-Monsalvo *et al.* 2004; IRAS 18061-2505, Gómez *et al.* 2008). In the particular case of K 3-35, the radio continuum emission exhibits a point-symmetric morphology that has been modelled with a precessing jet evolving in a dense AGB circumstellar medium (Velázquez *et al.* 2007). OH and $H_2O$ maser emission has been reported toward this PN (Miranda *et al.* 2001), with the $H_2O$ masers located at the tips of the jets and toward the core in a torus-like structure (Gómez 2007, Uscanga *et al.* 2008 in preparation). In order to understand which is the mechanism that is maintaining the presence of water molecules, we made a search for molecular gas toward K 3-35 under the hypotesis that dense material can protect the water molecules from the UV radiation of the central star.

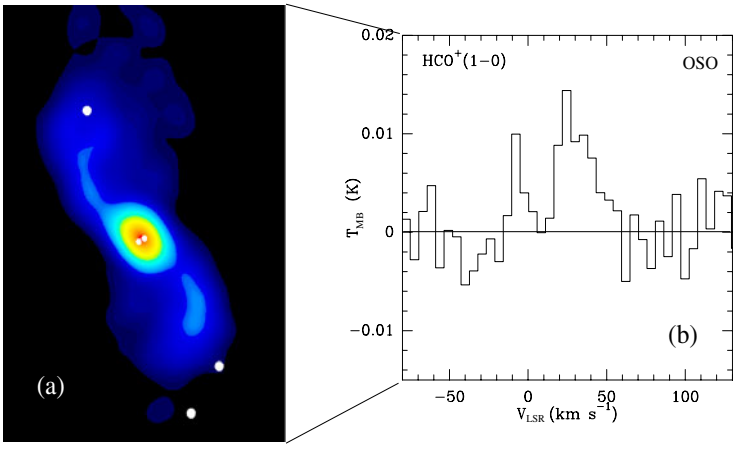


**Figure 1.** (a): VLA (3.6 cm) radio continuum image of K 3-35, white dots mark the position of the water masers detected by Miranda *et al.* (2001). (b): $HCO^+$ $(J = 1 - 0)$ spectra detected with the Onsala telescope (Tafoya *et al.* 2007).

## 2. Summary

The survey for molecular lines toward the young planetary nebula K 3-35 was made using the 20-m telescope of Onsala Space Observatory, the 45-m radio telescope of Nobeyama and the IRAM 30-m telescope. This survey included the molecules SiO, $HCO^+$, $H^{13}CO^+$, HNC, HCN, $HC_5N$, $HC_3N$, CS, CN, $CH_3OH$, $H_2O$, CO and $^{13}CO$. The details of these observations are published in Tafoya *et al.* (2007).

We discuss here the detection of $HCO^+$ $(J = 1 - 0)$ emission toward K 3-35 (see Figure 1). The $HCO^+$ peak emission is centered at $\sim$28 km s$^{-1}$ and the line has a FWHM of $\sim$20 km s$^{-1}$. We have found that the $HCO^+$ abundance in K 3-35 is $\sim 6 \times 10^{-7}$, which is similar to values found in other young PNe. Broad CO (2-1) and (1-0) emission were also detected toward K 3-35. Using the CO (2-1;1-0) emission we have estimated an excitation temperature $T_{ex}$ $\sim$20 K. Assuming LTE and that the CO emission is optically thin, a molecular mass for the envelope of $\sim$0.017 $M_\odot$ is derived. The ratio of molecular to ionized mass is $\sim$1.9. All these results support the presence of a massive molecular envelope in K 3-35 that could be responsible for the shielding mechanism that protects water molecules from being destroyed by the stellar radiation. High angular observations are needed to image the dense molecular gas envelope in this PN.

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