

30 Years of Photodissociation Regions:

A symposium to honor David Hollenbach's lifetime in science
Asilomar, CA, USA - June 28th to July 3rd, 2015

The Herschel Planetary Nebula Survey (HerPlaNS): Molecules in the Far-Infrared Spectra of Planetary Nebulae

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The Herschel Planetary Nebula Survey (HerPlaNS) is an imaging and spectroscopy survey of 11 planetary nebulae (PNe) in the far-IR using the PACS and SPIRE instruments aboard the Herschel Space Observatory. A line survey in these PNe over the entire spectral range between 51 and 672 μm revealed the first detections of OH⁺ emission in PNe (Aleman et al. 2014; Etxaluze et al. 2014). The rotational emission lines of OH⁺ at 152.99, 290.20, 308.48, and 329.77 μm were detected in the PACS and SPIRE spectra of three PNe: NGC 6445, NGC6720, and NGC 6781. Rotational lines of OH, CO, and CH⁺ have also been detected only in these three objects from our sample. From the observations, we derived excitation temperatures and column densities for OH⁺ in the range of 27-47 K and $2 \times 10^{10} - 4 \times 10^{11} \text{ cm}^{-2}$, respectively. In these objects, the OH⁺ rotational line emission is mostly likely produced in the photodissociation region (PDR). The emission of OH⁺ is observed only in PNe with hot central stars ($T_{\text{eff}} > 100000 \text{ K}$), with ring-like or torus-like structure. The fact that we do not detect OH⁺ in objects with $T_{\text{eff}} < 100000 \text{ K}$ suggests that the hardness of the ionizing central star spectra (i.e. the production of soft X-rays, $\sim 100\text{-}300 \text{ eV}$) could be an important factor in the production of OH⁺ emission in PNe, as seems to be the case in recent OH⁺ detections in ultraluminous galaxies and supernovae remnants.

REFERENCES

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