Mapping of the H2 rotational lines in the Helix nebula

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Abstract

We report infrared images of the Helix nebula centered at 6.9 μm (LW2 filter) and 15 μm (LW3 filter) using ISOCAM on board the Infrared Space Observatory (ISO). Three fields were also measured using the ISOCAM circular variable filter (CVF). The CVF spectro-imaging shows that the 5 to 18 μm spectrum is dominated by the rotational lines of molecular hydrogen from 0-0 S(7) to 0-0 S(2). The strong 0-0 S(5) H_2 line accounts for most of the emission detected in the LW2 filter. The only atomic lines present are: the 12.81 μm [NeII] which is weak, and 15.55 μm [NeIII] which is strong and dominates the emission in the LW3 filter. No emission bands of dust particles are detected despite the carbon-richness of the Helix nebula.

The intensities of H_2 rotational lines are well fit with a rotational temperature of 950$\pm$30 K and peak column densities of $\sim 5\,10^{18}\,\mathrm{cm}^{-2}$. The H_2 emission traces the individual cometary globules of the molecular envelope of the nebula. The [NeIII] emission (LW3) is distributed along this envelope towards the inner regions of the ionized cavity. The significant absence of mid-infrared dust features could indicate that, in the case of the Helix which is an evolved planetary nebula, the small grains and the molecular-sized dust particles (PAHs) have been destroyed due to the long ($\sim 10^4$ years) exposure of the dust reservoir (formed during the AGB phase) to the strong radiation field of the hot central star.