Investigating the Near-IR Properties of PN: Deep Imaging of Molecular Hydrogen Emission

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We present the first results of a deep near-infrared narrowband imaging study of several planetary nebulae. The data were acquired using the University of Hawaii 2.2m telescope on Mauna Kea and the "QUIRC" 1024 × 1024 array camera. With these sensitive high spatial resolution imaging data, we are able to explore in detail where H_2 is found relative to the ionized region in planetary nebulae at various stages of evolution (See Figure 1, for an example). The objects were selected from previous studies to have evidence for extended emission from H_2, and they are at several differing phases of central star evolution. The presence of molecules in the UV–flooded environment of a planetary nebula cannot be explained without highly non-spherical geometries and high densities, or clumping. Although there can be an ambiguity in the excitation mechanism (UV photons or shocks), the location of H_2 emission identifies regions of the nebula with sufficient dust shielding and density for the survival of molecular species. The emission morphology also provides information that helps identify which excitation mechanism is most likely. When combined with data provided by other molecular studies, we can examine how the photodissociation region evolves through the circumstellar envelope as the planetary nebula tracks across the top of the HR diagram. We can also consider how morphological evolution of the nebula, through interacting winds and shocks, might provide the conditions necessary for molecular survival.

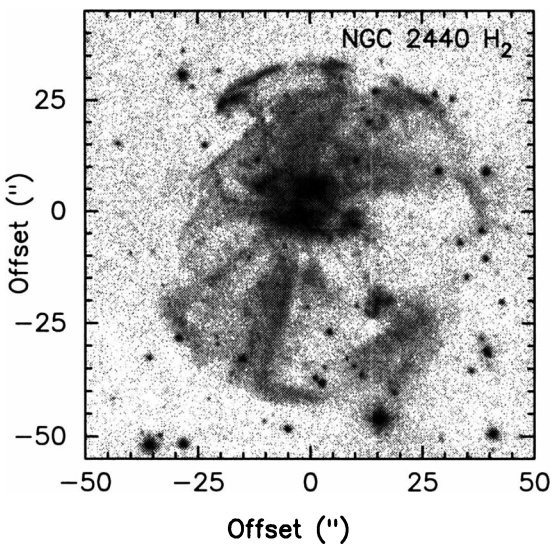

Figure 1: NGC 2440 is an extreme example of a PN with molecular material remaining for a significant period of its evolution. The H_2 is very extended in a nearly circular ring with radial spoke-like structures.

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