N14a The Herschel Planetary Nebula Survey (HerPlaNS): the best-fit dusty photoionisation model of the Galactic PN NGC6781

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We performed a comprehensive analysis of the planetary nebula (PN) NGC6781 in order to investigate physical conditions of atomic gas, dust grains, and molecules in the nebula and evolution of the central star based on our own *Herschel* data and the rich archival data in the wavelengths from UV to far-IR. *Spitzer*/IRS mid-IR spectrum shows the 6-9 μm and 11.3 μm PAH bands, pure rotational H_2 lines, and the featureless amorphous carbon dust continuum in $\sim$15-40 μm. An excitation curve plot for the H_2 lines can be fitted by a single temperature curve. Comparison with theoretical shock models suggests that H_2 could be excited by shock interaction with the remnant AGB circumstellar envelope. We performed a detailed chemical abundance analysis. By comparing with AGB models, we found that the progenitor would be a 2.25-3.0 $M_\odot$ star. The current evolutional status and nebular elemental abundances of the H_2-rich PN NGC6720 are in excellent agreement with NGC6781, suggesting that both PNe have originated from progenitor stars with similar masses and shared similar evolutionary paths. We constructed the photoionisation model using CLOUDY to be self-consistent with all the observations. About $\sim$40 % of the total dust mass measured in NGC6781 would be from warm-cold dust components. We found that other heating sources are necessary to explain the observed H_2 line fluxes. By introducing warm regions with a constant kinematic gas temperature $\sim$1000 K within PDRs, we obtained better fitting for the observed H_2, CO, and OH line fluxes as well as the other derived quantities.