N09b Physical Properties of Fullerene-containing Galactic Planetary Nebulae

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We searched the *Spitzer* Space Telescope data archive for Galactic planetary nebulae (PNe), that show the characteristic 17.4 and 18.9 μm features due to C_{60}, also known as buckminsterfullerene. Out of 338 objects with *Spitzer*/IRS data, we found eleven C_{60}-containing PNe, six of them are new detections. The strongest 17.4 and 18.9 μm C_{60} features are seen in Tc 1 and SaSt 2-3, and these two sources also prominently show the C_{60} resonances at 7.0 and 8.5 μm. We analyzed the spectra, along with ancillary data, using the photo-ionization code CLOUDY to establish the atomic line fluxes, and determine the properties of the radiation field, as set by the effective temperature of the central star. In addition, we measured the infrared spectral features due to dust grains. We find that the polycyclic aromatic hydrocarbon (PAH) profile over 6-9 μm in these C_{60}-bearing carbon-rich PNe is of the more chemically-processed class A. The intensity ratio of 3.3 μm to 11.3 μm PAH indicates that the number of C-atoms per PAH in C_{60}-containing PNe is small compared to that in non-C_{60} PNe. The *Spitzer* spectra also show broad dust features around 11 and 30 μm. The chemical abundances of C_{60}-containing PNe can be explained by AGB nucleosynthesis models for initially 1.5-2.5 $M_{\odot}$ stars with Z=0.004. We plotted the locations of C_{60}-containing PNe on a face-on map of the Milky Way and we found that most of these PNe are outside the solar circle, consistent with low metallicity values. Their metallicity suggests that the progenitors are an older population.