IRAS SURFACE BRIGHTNESS MAPS OF VISIBLE REFLECTION NEBULAE: EVIDENCE FOR NON-EQUILIBRIUM INFRARED EMISSION

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Surface brightness maps at 12 μm ($\Delta\lambda$ = 6.5 μm), 25 μm ($\Delta\lambda$ = 11 μm), 60 μm ($\Delta\lambda$ = 33μm), and 100 μm ($\Delta\lambda$ = 34 μm) of 16 visible reflection nebulae were extracted from the IRAS (Infrared Astronomical Satellite; Neugebauer et al. 1985, Ap.J., 278, L1) database. The maps were produced by coadding IRAS survey scans over areas centered on the illuminating stars, and have spatial resolutions of 0.9' x 4' at 12 and 25 μm, 1.8' x 4.5' at 60 μm, and 3.6' x 5' at 100 μm. Extended emission in the four IRAS bandpasses was detected in fourteen of the reflection nebulae.

The IRAS data was used to measure the flux (νF_ν) of the infrared emission associated with each source. The energy distributions show that the 12 μm flux is greater than the 25 μm flux in 11 of the nebulae, and the peak flux occurs in the 60 or 100 μm bandpass in all 16 nebulae. The 60 and 100 μm flux can be approximated by blackbodies with temperatures between 30 and 50 K, consistent with temperatures expected from grains in thermal equilibrium. The IRAS 12 and 25 μm fluxes are orders of magnitude in excess of that expected from extrapolation of greybody fits to the 60 and 100 μm data.

The excess 12 and 25 μm emission is attributed to a non-equilibrium process such as emission from thermal fluctuations of very small grains (0.001 μm) excited by single ultraviolet photons (Sellgren 1984, Ap.J., 277, 623; Leger and Puget 1985, Astron. Ap., 137, L5), or emission from polycyclic aromatic hydrocarbons (PAHs) excited by ultraviolet radiation (Allamandola, Tielens, and Barker 1985, Ap.J. Letters, 290, L25). The common features of the energy distributions of the 16 reflection nebulae, also seen in the reflection nebulae associated with the Pleiades (Castelaz, Sellgren, and Werner 1986, submitted to Ap.J.), suggest that PAHs or very small grains may be found in most reflection nebulae.