Photoluminescence by Interstellar Grains: A New Constraint on Dust Models

Adolf N. Witt
The University of Toledo

The recent detection of extended red emission (ERE) in the diffuse interstellar medium on a Galaxy-wide scale, in addition to the earlier ERE detections in reflection nebulae, planetary nebulae, dark nebulae, HII regions, and extragalactic systems supports the conclusion that a major component of interstellar dust is a highly efficient photoluminescent material. I will review the existing astronomical data related to the spectral characteristics of the ERE and the photon conversion efficiency of the ERE process and will derive a set of requirements which laboratory analogs proposed as ERE sources must meet. These include a broad emission band of 60 nm $<$ FWHM $<$ 100 nm with variable peak wavelengths W(pl) in the range 610 nm $<$ W(pl) $<$ 850nm, correlated with the density and hardness of the exciting radiation, high cosmic abundance, high photoluminescence quantum yield ($\gg 10\%$), a broad unstructured UV/visible absorption spectrum, and stability in a wide range of interstellar radiation and density environments. I will discuss how possible candidates, including variants of hydrogenated amorphous carbon (HAC), polycyclic aromatic hydrocarbons (PAHs), refractory organic residues derived from photolysis of ices, fullerenes, and silicon nanocrystals, meet these requirements. Based on existing laboratory evidence, the characteristics of silicon nanocrystals come closest to reproducing the astronomical ERE. Such particles should therefore be considered as a possible new component of interstellar dust.

References:

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Acknowledgments:

Support through NASA Laboratory Astrophysics Grants NAG5-3790 and NAG5-4338 is gratefully acknowledged.