Interstellar and Circumstellar Fullerenes

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A particularly stable class of species that might be formed abundantly in the outflows of carbon stars and survive the harsh conditions of the ISM are fullerenes, known as a class of carbon based molecules in the shape of a hollow sphere or ellipsoid. Once injected into the ISM, these stable species survive and are thus probably widespread in the Galaxy where they contribute to interstellar extinction, heating processes, and complex chemical reactions. In recent years, the fullerene species C60 (and to a lesser extent C70) have been detected in a wide variety of circumstellar and interstellar environments (post-AGB, PNe, RCrB stars, reflection nebulae, HII regions, and young stellar objects), showing that when conditions are favorable, fullerenes are formed efficiently.

The detection of fullerenes, offer a great diagnostic tool to describe the environment in which they reside, and provide clues as to the key chemical pathways leading to the formation of large complex organic molecules in space. Fullerenes are the first and only large aromatics identified in space. Since fullerenes share many physical properties with PAHs, understanding how fullerenes form, evolve and respond to their physical environment will yield important insights into one of the largest reservoirs of organic material in space. In spite of all these detections, many questions remain about precisely which members of the fullerene family are present in space, how they form and evolve, and what their excitation mechanism is. In this talk, we will present an overview of what we know from astronomical observations of fullerenes in these different environments. We will discuss current thinking about the excitation process, and show that fluorescence is the most likely mechanism for their excitation. We will highlight the various formation mechanisms that have been proposed. Finally, we will include a brief discussion on the physical conditions conducive for the formation and/or detection of fullerenes in PNe and their possible connection to PAHs, HACs and other dust features.