SMALL AND LARGE MOLECULES IN THE DIFFUSE INTERSTELLAR MEDIUM

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Although molecules with a wide range of sizes exist in dense clouds (e.g. H(C≡C)_nC≡N with n = 0 − 5), molecules identified in diffuse clouds are all small ones. Since the initial discovery of CH, CN, and CH^+ , all molecules detected in the optical region are diatomics except for H_2^+ in the infrared and C_3 in the visible. Radio observations have been limited up to triatomic molecules except for H_2CO and the ubiquitous C_3H_2. The column densities of all molecules are less than 10^{14} cm^{-2} with the two exceptions of CO and H_2^+ as well as CH and C_2 in a few special sightlines. Larger molecules with many carbon atoms have been searched for but have not been detected.

On the other hand, the observations of a great many diffuse interstellar bands (380 toward HD 204827 and 414 toward HD 183143) with equivalent widths from 1 to 5700 mÅ indicate high column densities of many heavy molecules. If an electronic transition dipole moment of 1 Debye is assumed, the observed equivalent widths translate to column densities from 5 \times 10^{11} cm^{-2} to 3 \times 10^{15} cm^{-2}. It seems impossible that these large molecules are formed from chemical reactions in space from small molecules. It is more likely that they are fragments of aggregates, perhaps mixed aromatic/aliphatic organic nanoparticles (MAONS). MAONS and their large fragment molecules are stable against photodissociation in the diffuse ISM because the energy of absorbed photons is divided into statistical distributions of vibrational energy and emitted in the infrared rather than breaking a chemical bond. We use a simple Rice-Ramsperger-Kassel-Marcus theory to estimate the molecular size required for the stabilization.

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\(^a\)Snow, T. P. & McCall, B. J. 2006, ARA&A, 44 367  