

On Polycyclic Aromatic Hydrocarbon Molecules in Comets

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Polycyclic aromatic hydrocarbon (PAH) molecules might have been incorporated into comets if they are formed from relatively unprocessed interstellar material. The presence of PAHs in comets has been suggested by the 3.28 μm emission feature detected in some comets. More specifically, a 3-ring PAH molecule – phenanthrene ($\text{C}_{14}\text{H}_{10}$) – has been proposed as the carrier for the 342-375 nm fluorescence bands seen in comet 1P/Halley. We model the infrared emission process of phenanthrene as well as “generic” PAHs in cometary comae and obtain an upper limit on the coma PAH abundance based on the observed 3.28 μm emission feature and the absence of the 6.2, 7.7, 8.6, and 11.3 μm PAH emission features in coma spectra.

We find that the 1P/Halley 3.28 μm emission feature constrains the neutral phenanthrene production rate to be $< 10^{-3}$ of the total dust mass production rate. It is also found that the mass production rate of “generic” PAHs is only $\sim < 10^{-3}$ of that of the dust. This is at least ~ 100 times smaller than the mass fraction of interstellar PAHs relative to the total interstellar dust in the diffuse interstellar medium. In order for the PAH production rate in nucleus surfaces to increase to the level in agreement with the interstellar dust model expectation without violating observational constraints, PAHs should be photodissociated rapidly enough in comae (in a few seconds at a heliocentric distance of 1 AU) which is inconsistent with the photodissociation modelling results. Selective sublimation may be the process suppressing the coma PAH abundance.