Gas Phase Spectroscopy of Cold PAH Ions: Contribution to the Interstellar Extinction and the Diffuse Interstellar Bands

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We present and discuss the gas-phase electronic absorption spectra of selected ionized polycyclic aromatic hydrocarbons (PAHs) measured in the UV-Visible-NIR range in an astrophysically relevant environment. This report constitutes the early phase of a systematic investigation of the contribution of this class of molecular ions to the interstellar extinction curve and to the diffuse interstellar bands (DIBs). The study has been carried out using the ultrasensitive and versatile technique of cavity ringdown spectroscopy (CRDS) coupled to a cold plasma source following the approach developed during the feasibility studies that led to the first detection of the naphthalene ion in the gas phase.[1] The harsh physical conditions of the interstellar medium - characterized by a low temperature, an absence of collisions and strong VUV radiation fields - have been simulated in the laboratory by associating a pulsed-CRDS spectrometer with a supersonic slit jet seeded with PAHs and an ionizing, penning-type, electronic discharge.[2] We have first applied this new instrument to the measurement of the electronic spectrum of the cold naphtalene ion ($C_{10}H_8^+$) in order to compare with the results obtained during the feasibility phase.[1] The study has then been successfully extended to other mid-size PAHs that have been preselected from Matrix Isolation Spectroscopy (MIS) such as acenaphtene ($C_{12}H_{10}^+$) and pyrene ($C_{16}H_{10}^+$) ions among others.[3]

These experiments provide unique information on the spectra of free, large carbon-containing molecules and ions in the gas phase. A parallel effort has been attempted to quantify the mechanism of ion production in the free jet expansion and to model our simulation of the diffuse interstellar medium in the laboratory. We are now, for the first time, in the position to directly compare laboratory spectral data on free, cold, PAH ions with astronomical observations in the UV- NIR range. This new phase offers tremendous opportunities for the data analysis of current and upcoming space missions (e.g., HST data).

References:

[1] D. Romanini, L. Biennier, F. Salama, A. Kachanov, L. J. Allamandola and F. Stoeckel, *Chem. Phys. Lett.* **303** (1999) 165.

[2] L. Biennier, F. Salama, A. Kachanov, L. J. Allamandola, J. Scherer and A. O'Keefe, Ohio State University, 56th International Symposium on Molecular Spectroscopy, WH01 (2001)

[3] F. Salama, in Solid Interstellar Matter: The ISO Revolution L. d'Hendecourt et al. eds, EDP Sciences, Springer-Verlag, p. 65 (1999).

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