Fast radiative cooling of Anthracene observed in the Miniring

L. Chen¹, J. Bernard¹, R. Brédy¹, B. Concina¹, C. Joblin²,³, M. Ji¹, C. Ortega¹ and S. Martin¹

¹Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Université de Lyon 69622 Villeurbanne cedex, France
²Université de Toulouse, UPS-OMP, IRAP, Toulouse, France
³CNRS, IRAP, 9 Av. colonel Roche, BP 44346, F-31028 Toulouse cedex 4, France
E-mail: chen@univ-lyon1.fr

Fast radiative cooling of anthracene (C₁₄H₁₀)⁺ was studied using a compact electrostatic storage ring, called Miniring [1,2]. Hot (C₁₄H₁₀)⁺ molecules from an electron cyclotron resonance ion source were accelerated to 10 keV and stored in the Miniring. After a given storage and cooling time (several ms), the punch of stored ions was excited along one of the straight sections (of 9.2 cm long) by a nanosecond laser pulse (3.55 eV). Owing to the compactness of the ring, neutral fragments lost at the opposite straight section were detected with a channeltron detector from the very first microseconds. The neutral decay curves (fig.1) recorded with laser pulse fired at tₐₗₐₜₐₜ=4, 5, 6, 8 ms were fitted using a simple unimolecular statistical dissociation model in order to extract the internal energy distributions (fig.2) of the excited molecular ensemble.

From fig.2, by subtracting the energy of the absorbed photon, we obtained the time evolution of the internal energy distribution of the stored molecules before laser excitation. Mean radiative decay rates of about 120 s⁻¹ to 250 s⁻¹ were estimated for internal energies in the range from 6.6 eV to 6.8 eV. Such a high decay rate is by two orders of magnitude larger than the infrared (IR) emission cooling rate expected for vibrational transitions. It is attributed to fluorescence from thermally excited electrons.

This fast radiative cooling mechanism may have important implications in astrophysics concerning the lifetime and the critical size of polycyclic aromatic hydrocarbons (PAHs) in interstellar conditions.

References