Radiative stabilization of C_6^-

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Radiative stabilization of C_6^-

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Synopsis Absolute rate coefficients were determined for the recurrent fluorescence (RF) process in C_6^- anions at excitation energies above the adiabatic electron attachment energy. The RF process is an important ingredient in understanding the formation and stabilization of anions in the interstellar medium.

In collision-free environments like the interstellar medium (ISM), electron attachment to a neutral molecule having a positive electron affinity can yield a temporary negative ion (TNI), where the total electronic excitation energy has been rapidly converted into vibrational excitation due to non-adiabatic coupling between the electronic and vibrational degrees of freedom (intramolecular vibrational redistribution (IVR)). Since the total energy of the TNI is above the electron affinity, it can either decay back to the neutral molecule and a free electron (vibrational auto-detachment (VAD)), or it can stabilize by emitting infrared (IR) photons. In anions exhibiting excited low-lying electronic configurations, however, much faster radiative stabilization can occur by the emission of an optical photon (recurrent or Poincare fluorescence (RF) [1]). Here, we report about a measurement of absolute RF rates in C_6^- as an example for the importance of the RF process in the radiative stabilization of small, open-shell, cluster anions.

The experiment was performed by extracting C_6^- ions from a sputter ion source and storing them in a bent electrostatic ion beam trap [2]. After 1 s of storage, during which the anions cooled down to temperatures close to room temperature, they were excited by a short laser pulse to excitation energies above the adiabatic electron attachment energy of EA=4.18 eV, and the neutralization rate due to VAD was measured as a function of time at several laser wavelengths. Due to the different energy dependence of the two competing decay processes, RF and VAD their contributions to the measured total decay rate coefficients $k_{tot}(E)$ could be disentangled [3]. For energies E ≤4.7 eV, the decay is found to be dominated by the RF process with decay rate coefficients on the order of 5×10^4 s^{-1}.

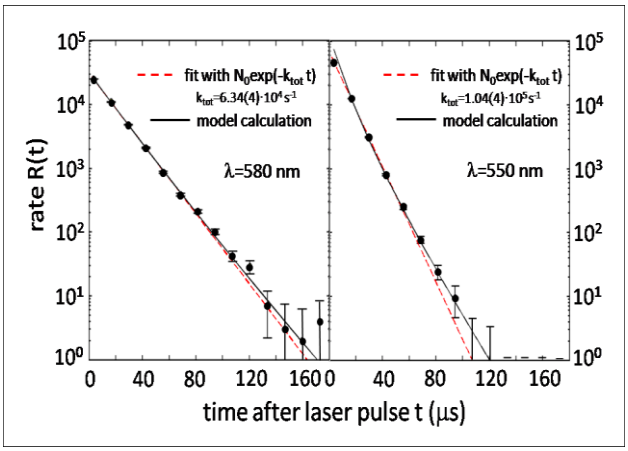

Figure 1. Neutralization rates observed as a function of time after two-photon excitation of C_6^- with a short laser pulse at two wavelengths. The laser was fired 1 s after the injection of the ions into the trap.

Our experiment constitutes the first quantitative measurement of RF rate coefficients in a small polyatomic molecule. The result can serve as a benchmark for the validity and accuracy of the statistical approach in describing the RF process even in small molecules, a process indispensable for understanding the formation and abundance of anions in the interstellar medium.

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