Studies of molecular and cluster relaxation processes in DESIREE

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Synopsis The novel DESIREE (Double ElectroStatic Ion Ring ExpEriment) facility at Stockholm University allows for studies of molecular and cluster relaxation processes in new time domains. These include electron emission, fragmentation, and radiative cooling processes. In this talk, I highlight recent results from such studies of small metal cluster anions, carbon cluster dianions, intact and defect Polycyclic Aromatic Hydrocarbons (PAHs), and fullerenes.

The DESIREE infrastructure has two electrostatic ion storage rings for studies of reactions between oppositely charged ions at sub-thermal collision energies [1,2]. DESIREE is cryogenically cooled to 13 K and has an extremely low residual background pressure (~10^{-14} mbar), which allows measurements of mutual neutralization reactions involving atoms, molecules, and clusters under astrophysical conditions. The excellent experimental conditions are also ideal for lifetime measurements and action spectroscopy on isolated atomic or molecular ions in single ring experiments [3-7].

In this talk, I will present a selection of recent results from studies of spontaneous decay and cooling of molecules and clusters in DESIREE. In these single ring experiments, we monitor the yield of neutral particles and/or charged daughter products as functions of the ion beam storage time.

I will show results for anionic metal cluster dimers, where the branching ratios for electron emission versus fragmentation completely alter on timescales ranging from hundreds of microseconds up to ten seconds. I will also discuss spontaneous electron emission from internally hot carbon cluster dianions, C_n^{2-} (n=7-11), and show that such systems are possibly stable or at least metastable on timescales up to tens of milliseconds (an example is shown in Fig. 1). Furthermore, I will discuss the stabilities of PAH fragments stemming from collision induced non-statistical single carbon atom knockout and from statistical (C_2H_2-loss) fragmentation processes, as well as the spontaneous decays of positively and negatively charged C_{60}-molecules. The experimental results will be discussed in view of results from statistical models for molecular and cluster relaxation processes.

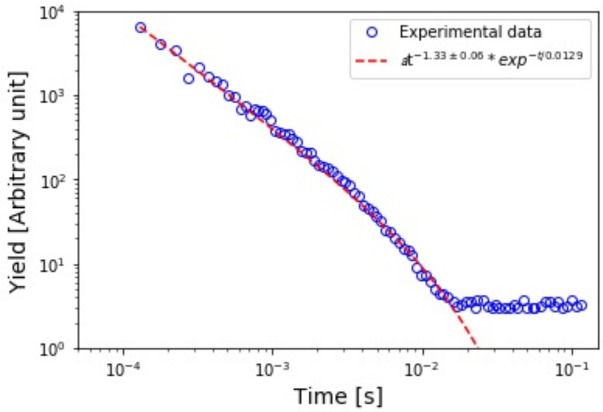

Figure 1. Time dependent yield of C_{10}^- due to spontaneous emission of electrons from a stored C_{10}^{2-} ion beam. The experimental data (blue circles) follow a quenched power law (red dashed line) as a function of time.

References

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