Investigations of the decay of fullerene ions in a storage ring, and of delayed ionization of neutral fullerenes measured by time of flight.

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Highly excited finite systems like fullerenes can relax in a variety of ways such as by photon emission, by electron emission or by neutral particle emission. We have demonstrated that when hot fullerene ions are injected and stored in the ELectrostatic Ion Storage ring in Aarhus ELISA [1] their decay by electron or C2 emission follows a 1/t dependence when the initial energy of the ions is conserved, i.e. when photon emission can be ignored. Deviations from a 1/t distribution therefore gives information about the radiative cooling of the stored fullerene. By the use of the cooling rate for positively charged fullerene ions we have by comparing with calculated values extracted dissociation energies for C2 loss from several fullerene cations as shown in Figure 1 [2]. Hot fullerene anions have been produced in the ring after absorption of photons. Their decay by electron emission follows a 1/t distribution which again is perturbed by cooling at longer times and information on cooling rates for a given excitation energy is determined directly by the experimental parameters [3].

We have also studied delayed ionization of neutral C60 molecules in a time of flight (TOF) spectrometer. The molecules were produced in an effusive source filled with pure C60 which was heated until it produces a low density molecular beam. The C60 molecules in this beam were excited by a collinear laser beam and TOF spectra like the one shown in Figure 2 were obtained. At times larger than 20 µs this spectrum contains information on delayed ionization of C60. This part of the spectrum is shown in Figure 3 as a log log plot. The straight line fitted to the short time delay part of the spectrum has a time dependence which can be expressed as t^{-0.72}. The exponent contains information on the ratio between the ionization energy and the dissociation energy for C2 emission from C60 as discussed by Hansen and Echt [5]. The deviation from the straight line dependence at times larger than 100 µs is caused by the influence of radiative cooling. The experimental data are compared with a curve obtained from a numerical calculation including radiative cooling (see ref 4 and references herein).

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References