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Dissociation rate, fluorescence and Infrared radiative cooling rates of Naphthalene studied in electrostatic storage Miniring.

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Synopsis We report studies on fluorescence and Infra Red (IR) radiative cooling rates of naphtalene cation for a large time range (40ms). The dissociation rates versus internal energy have been estimated in a large energy range to reproduce the measured emitted neutral yield of the hot naphthalene.

Using action spectroscopy, we have studied the time evolution of internal energy distribution of naphthalene cations ($C_{10}H_8^+$) from 30µs to 40ms. The ions were produced in an ECR Nanogan ion source and stored in the small electrostatic storage ring call Miniring. The internal energy distribution of the population of the stored ion is broad and part of the hot molecules dissociate in the first three milliseconds. After 3 ms, the neutral emission is due to the collisions with the residual gas in the Miniring vacuum chamber (10^{-9}mbar). The fraction of hot molecules that has enough internal energy to dissociate has been estimated to be about 4% of the total number of the stored ions. This value is relatively constant for different experimental conditions of the ECR source. From 0.5 to 1.5 ms, 1% of store ions dissociated, whereas from 2.5 to 3.5 ms only 0.1% dissociated. In order to reproduce these neutral decay ratios from 30µs to 3ms and especially the ratio of 4%, we have simulated the evolution of the energy distribution assuming a Gaussian shape for the initial distribution. The cooling rates of fast fluorescence processes [1] have also been included in the calculations. The evolution of the internal energy distribution is very sensitive to the dissociation rates for a large range of internal energy. The dissociation rates were taken from the recent measurements of West et al[2]. In our simulations, for the time range up to 3ms, the extrapolation of their dissociation rates in the low energy range overestimates the neutral yield. We have modified the dissociation rates in the low energy range to reproduce our experimental decay. Therefore these results provide a limit for the dissociation rate at the corresponding low energy range.

Radiative cooling rates have been investigated for the naphthalene. We have studied the decay curves obtained after irradiation with the 532nm 1kHz Ekspla OPO LASER. Laser pulse was sent each ms. The figure 1 shows intensities of the first peaks of each decay curves versus the laser excitation time. The curve is nicely fitted using to exponential decays: a fast decay, attributed to fluorescence cooling process[1] and a slow decay attributed to the IR cooling process.

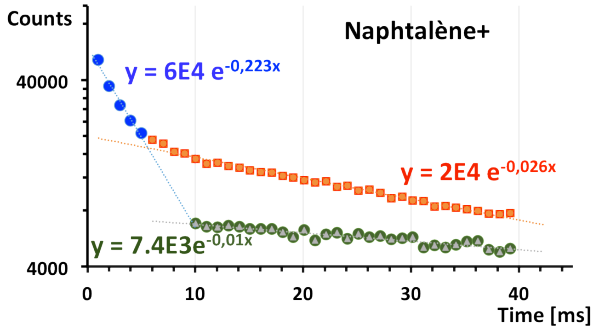

Figure 1. Fast (blue) fluorescence radiative cooling process and slow IR (red) cooling process of naphthalene. Background signal due to the collision with the residual gas (green).

References

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[2] B. West *et al* 2012 *J. Phys. Chem.*. **116** 10999

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