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Time Evolution of the internal energy distribution of molecules studied in an electrostatic storage ring, the Mini-Ring

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Synopsis We report on studies about time evolution of internal energy of polycyclic aromatic hydrocarbon PAH and fullerene in a small electrostatic storage device. Laser heating at different time delays was used as the probe to determine the energy distributions.

We present here the latest development around our compact electrostatic ion storage ring, so called the Mini-Ring[1].
The detection system has been recently upgraded with a position sensitive detector (PSD) for recording the position of the neutral spot exiting the ring at each turn. In recent experiments, this PSD was used to measure the Kinetic Energy Release (KER) of fragmentation of anthracene cations.
A significant reduction of the Betatron oscillations has been accomplished by re-optimizing the potentials of the Mini-Ring's deflectors, lens and reflectors. Major improvements were obtained by taking pictures of the Ar^+ beam trajectory using a CCD camera (CANON 5Dmark2) equipped with 16-35 optical system placed in front of the window at the top of the experiment (Figure 1). In the past, one night was needed to take a picture of the 5 keV Argon beam (200nA) with an argentic camera. With the CCD camera, it takes 10s only to record a picture, which is good enough to optimize visualizing online the trajectory of the beam. These improvements were also possible due to a higher kinetic energy of the beam (12 keV) and therefore higher beam intensity up to 1.5µA. This fine tuning of the stored ions trajectories improved the overlap between the ion and LASER beams and reduced considerably the oscillations observed on the decay measurements.
The actual limitation of the storage time is due to collisions with the background gas (the pressure was $2\cdot10^{-9}$ mbars at the best conditions). We have stored ions with a rather large kinetic energy range from 2 q keV to 12 q keV.

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An ECR Nanogan ion source has been used to produce beams of cations or anions. Up to now beams of He^+, F^+, F^- Ar^+, SF_n^+ (n=1-5), SF_6^- as well as
PAH and fullerene have been stored. Intense beams of molecular cations and dications have been obtained using a 10 Ghz very low HF power (less than 0.5 W). Results concerning the evolution of the internal energy distribution will be presented for different PAHs. Cooling rates have been measured at different internal energies. The high values of cooling rates found for Anthracene cations are explained by a cooling process due to the "fluorescence of the thermally excited electrons" predicted 20 years ago [2].

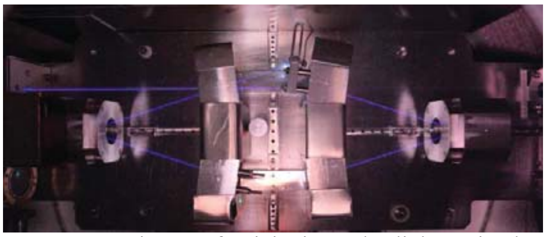

Figure 1. Picture of Mini-Ring. The light emitted along the Ar^+ beam trajectory is due to collisions with nitrogen gas injectd into the vacuum chamber at pressure of about 10^{-4} mbar. The blue light is due to the excitation of the N_2 molecules. The MCP imaging detector is placed at bottom left. A small spot due to neutralized Ar is well observed on the MCP.

References

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