Measurements of anion lifetimes in the Double Electrostatic Ion Ring Experiment DESIREE: Preliminary results

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The Double ElectroStatic Ion Ring ExpEriment (DESIREE) is a new tool with the primary goal of investigating interactions between internally cold anions and cations at very low center-of-mass energies [1,2]. The storage rings are situated within a cooled chamber (∼11 K) which limits the amount of black-body radiation. This enables the storage of loosely bound atomic and molecular ions – ions that would rapidly photo-detach at ambient temperatures. The rings also have excellent vacuum conditions (10^{-14} mbar) which means that beams can be stored for long periods of time before they are lost due to collisions with the residual gas – 1/e lifetimes of more than 10^3 seconds have been measured for several anions.

We are at present finalizing measurements of the lifetimes of the excited, metastable, $^2P_{1/2}$ fine structure levels in the Te^-, Se^-, and S^- ions yielding preliminary results of about half a second, a few seconds, and a few minutes respectively. These are the only excited states for these ions and they decay to the $^2P_{3/2}$ ground states through magnetic dipole (M1) transitions. Our results appears to be consistent with earlier measurements and theory for Te^- [3,4] and Se^- [4], while no previous measurements of the S^- lifetime is available. This demonstrates that the excellent ion storage conditions in DESIREE enables lifetime studies in a new time domain presenting new challenges for theory.

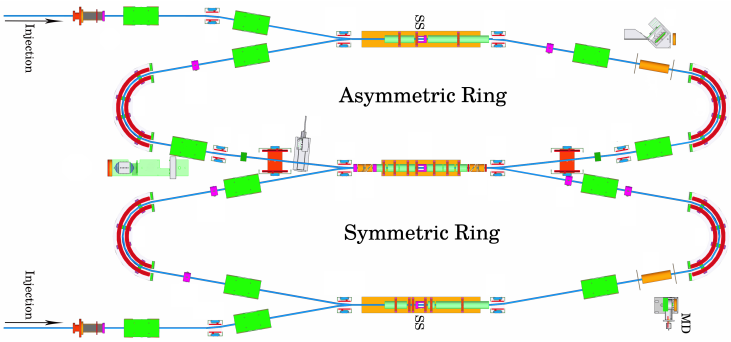

Figure 1: *A schematic overview of the DESIREE ion optics [5]. The blue line represents the ion orbit. The measurements were done by probing the stored ion beam with a short laser pulse at the straight section (SS) of the symmetric ring. This neutralizes a minuscule fraction of the ions which could then be detected by the movable neutral detector (MD). By selecting a laser frequency that would only neutralize ions in the metastable state, we could thus monitor the population of ions in this state over time. This, together with measurements of the total ion beam lifetime, allows for the determination of the lifetimes of the metastable states.*

References

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