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Characterization of the FISIC Platform for Future Ion-Ion Collision Studies at CRYRING@ESR

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Study of electronic processes (ionization, excita-tion and capture) in ion-ion collisions is experimen-tally very challenging. So far, such collisions have been performed mainly in the low-energy regime (typically at center-of-mass energies ⊠ a few 100 keV) where the charge transfer is by far the dominant process. Specific experimental conditions are required to perform absolute cross section measurements such as crossed beam arrangements, ultra-high vacuum conditions, and ion beams of very good optical quality that must be able to be moved relative to each other to optimize their overlap.

Recently, a low-energy mobile platform capable of delivering keV/u ion beams, named FISIC, has been developed. As such ion beams constitute a rather dilute target (10^5 –10^6 particles.cm^{-3}), the use of an ion storage ring for an effective density increase offers most favorable conditions for ion-ion collision experiments. With the CRYRING@ESR facility at GSI/FAIR (Germany), we expect up to 10^7 ions stored at few MeV/u. Therefore, connecting the FISIC platform to CRYRING will enable collisions to be carried out between slow ion beams (a few keV/u) and fast ion beams (1-10 MeV/u) with high atomic numbers (from argon to uranium ions). This makes it possible to study the intermediate velocity regime, which is hitherto unexplored in atomic physics and where the cross-sections of elemantary electronic processes are unknown.

The FISIC platform consists of an electron cyclotron ion source and its beam line. As control of the charge state is mandatory when systematic measurements for different number of electrons are being considered, an omega-shaped system is installed prior to the collision chamber. Its role is to clean up unwanted charge states produced in the beam line by collisions with the residual gas. Just after this device, electrostatic deflectors enable the beam to be moved precisely into the collision chamber. Numerous ion beams (O^{q+}, Ne^{q+} and Ar^{q+}) have been produced and characterized in terms of currents, shapes and emittances.

In addition, the proportion of ions in metastable states that reach the collision zone is investigated. These data are of prime importance as the probability of a given electronic process in ion-ion colli-sions can be strongly affected if ions are initially in an excited electronic configuration. To determine the metastable states fraction produced in the source plasma, a x-ray detector having a good efficiency (> 0.2) for recording photons with energies ranging from 200 eV to a few keV was installed in the collision chamber located around 6 m from the ion source. There, the incident metastable ion (e.g. 1s2s O^{6+} with a lifetime of 900 µs) can excite directly via a M1 transition. Measurements have been carried out for O^{6+} and Ne^{8+} ions with differ-ent ion source parameters and will be presented at the conference.

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Autor: LAMOUR, EMILY (Sorbonne Université - INSP)

Co-Autoren: Herr DE MONTBEL, Augustin (Sorbonne Université - INSP); Dr. PRIGENT, Christophe (Sorbonne Université - INSP); Dr. GUMBERIDZE, Alexandre (GSI Helmholtzzentrum für Schwerionenforschung); Dr. LESTINSKY, Michael (GSI Helmholtzzentrum für Schwerionenforschung); Herr DELANNAY, Robin (Sorbonne Université - INSP); Herr STEYDLI, Sébastien (Sorbonne Université - INSP); Dr. TRASSINELLI, Martino (CNRS - INSP); Prof. STÖHLKER, Thomas (GSI Helmholtzzentrum für Schwerionenforschung); Frau TOSI, Elena (Sorbonne Université - INSP); Prof. VERNHET, Dominique (Sorbonne Université - INSP)

Vortragende: Herr DE MONTBEL, Augustin (Sorbonne Université - INSP); LAMOUR, EMILY (Sorbonne Université - INSP)

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