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Fast Ion –Slow Ion Collisions for Atomic Physics (FISIC @ CRYRING)

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Electronic processes in ion-ion collisions are of fundamental interest from atomic physics point of view and they play an important role in astrophysical and fusion plasmas as well as in ion-matter interaction. At the same time, the ion-ion collisions are mostly unexplored up to now. This is especially true for the so-called intermediate velocity regime where the ion stopping power is maximum, and where there is a lack of both experimental and theoretical data on the electronic cross sections. To precisely investigate this regime, the study of ion-ion collisions are necessary for a large variety of systems with the needed option to scan the charge state of each ion partner. Besides the possibility to reach the pure three-body problem (bare ion on hydrogenic target) as a benchmark for theories, the role of additional electrons bounded to the ions -one by one- should allow disentangling and quantifying electron effects such as:
• electron-electron interactions: besides correlations, the presence of additional electrons can also directly increase (anti-screening) or decrease (screening) the mechanism probabilities ;
• closure and/or opening of different channels: such as capture channels, that are open for bare projectiles but may be closed (or less likely) for other charge states;
• multi-electron processes: often neglected, they can become as large as single processes in some cases.
The FISIC set-up is a complex experiment designed to perform collisions between fast (MeV/u) ion beams from CRYRING with slow (keV/u) ion beams provided by the FISIC platform, to measure absolute electronic cross sections using coincidence methods. The FISIC platform can deliver ions from carbon to argon ( ) with charge states from 1+ to fully stripped. The intermediate regime is reached when the relative target (slow ions)-projectile (fast ions) velocity is of the same order as the ones of the active electrons in their initial state. Below are a few examples with rather "light"ions:
Fast projectile ions from CRYRING Slow target ions @ a few keV/u from the FISIC platform
CQ+ at around 1 MeV/u Cq+
ArQ+ at around 4 MeV/u Neq+
ArQ+ at around 8 MeV/u Arq+

where for the fast ions (Q+), fully stripped and a few-electron ions are of interest. By scanning the target charge state (q+), already a significant amount of experimental data never investigated so far may be obtained. Beyond these symmetrical or moderately asymmetrical collision systems, the intermediate regime can be approached by choosing very asymmetrical systems, i.e. by choosing much heavier fast ions such as KrQ+ and XeQ+ (with energies up to 14 MeV/u).

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