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Electron Dynamics in transient high E-Fields during Heavy –Ion Collisions

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The heavy-ion storage ring CRYRING at GSI/FAIR is particularly suited to investigate the collision dynamics for very highly charged ions in the highly adiabatic and non-perturbative regime where the ratio of projectile charge state to projectile velocity qproj/vproj»1. We will discuss electron/lepton spectroscopy for studying leptons as authentic and precise messengers from extreme fields in very heavy transient quasi-molecules:
a) Resonant 1s to 1s electron transfer, e.g. in Xe54+ + Xe; via K-Auger electron –recoil ion time of flight (TOF) the impact parameter (b) dependence of the process can be determined and compared with recent ab initio calculations on oscillations in 1s to 1s transfer probabilities as function of b which arise from energy differences of involved quasi-molecular orbitals in these very heavy collision systems
b) Electron nucleus bremsstrahlung (enBS) at the high energy tip of the bremsstrahlung spectrum; theory predicts deep relations of the very high asymmetry of the radiative electron capture to continuum (RECC) cusp peak to corresponding asymmetries in radiative electron capture to continuum and pair production.
c) Near-threshold 1s ionization for slow collisions Zproj ⊠ Ztar in the presence of a large and dominant capture channel; here the precise molecular mechanism for promoting a 1s electron from the 1s⊠ molecular orbital up to the continuum threshold is still under open theoretical considerations. The angular distribution of corresponding electron continua as an experimental benchmark is highly desirable.
d) The complete atomic fragmentation (i.e. complete stripping down to bare target ions) focusing on topologically stable multi-electron continua accompanying the fragmentation. The dominance of multiple over single electron continua is an unsolved challenge for theory.
e) Kinematically complete (e,2e) collisions of iso- electronic sequences of H- and He like ions in inverse kinematics. The ab initio calculation of triple differential ionization cross sections (TDCS) for electron impact ionization of 1- and 2- electron atoms/ions has exhibited numerous open problems faced for the TDCS when a spectator electron is present; here benchmarks are urgently needed using TDCS for the isoelectronic sequences which accessible only in inverse kinematics in storage rings.

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