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Ion-Impact Induced Ionization of Atoms and Molecules in Single-Pass Experiments and Storage Rings

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In the last decade cold target recoil ion momentum spectroscopy (COLTRIMS) and so-called Reaction Microscopes became standard tools to study the dynamics of atomic and molecular break-up processes. They enable to obtain a complete momentum analysis of all final state fragments produced in single collisions with electrons, ions, single photons, or with strong laser fields. In combination with ion storage rings, which provide excellent experimental conditions w.r.t beam intensities and emittances, they represent the ideal tool to obtain highly differential information on fundamental processes like ionization or charge transfer in ion-atom collisions. An overview on recent advances in collision studies in single-pass experiments at the tandem accelerator of the MPI in Heidelberg, at the ion storage ring CRYRING at MSL in Stockholm and the experimental storage ring ESR at the GSI in Darmstadt will be given. With the COLTRIMS setup implemented in CRYRING, single and double electron capture from hydrogen molecules in collisions with protons and He^{2+}-projectiles has been investigated. A variation in the total electron-transfer cross section as function of the molecular orientation has been observed which is attributed to interference in analogy to a Young-type double-slit scenario. Recently, for the first time a fully-equipped Reaction Microscope allowing the momentum-resolved detection of electrons in coincidence with recoil ions was operated in a storage ring, the ESR at GSI in Darmstadt. The results of the first experiments on target ionization and charge transfer in collisions between He, Ne, and Ar targets and highly charged projectiles ranging from 13 AMeV U^{92+} to 400 AMeV Ni^{28+} will be presented.