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Fully Differential Studies on Atomic Few Body Problems

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Within the last few years, using many-particle imaging techniques (so called reaction microscopes or COLTRIMS spectrometer), numerous fully differential studies of atomic break-up reactions induced by single photon impact, intense laser pulses in the optical and VUV (FEL pulses) as well as by electron and ion impact have been performed. The results of a few selected examples will be discussed during the talk with special emphasis on single ionization of atoms by fast ion impact, a subject that has been studied extensively over decades but measurements of fully differential cross sections (FDCS) were not possible before the advent of reaction microscopes. Such FDCS data are known to be very sensitive to the collision dynamics and they can be considered as the ultimate test of single ionization theories. Recent results for ionization of He in collisions with various projectiles over a wide range of perturbation strengths Z/v (projectile charge to velocity ratio) from Z/v = 0.1 up to 4.4 reveal significant discrepancies between theory and experiment. The experimental results are discussed in terms of possible higher order ionization mechanisms which are not taken into account in theory. In addition, the possible influences of experimental uncertainties, not considered in most of the theoretical models, will be discussed.