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Atomic physics of fast ions –slow ion collisions: The FISIC Project (Spiral II)

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Knowledge of the fundamental mechanisms at stake in fast ion –slow ion collision in atomic physics can provide a real breakthrough in the understanding of energy transfers in various plasmas such as inertial confinement fusion plasmas or stellar/interstellar plasmas. Crossing two multicharged ion beams, under well controlled conditions, has always been a very challenging task, whatever the domain of physics under consideration. So far, ion-ion collisions for atomic physics have been performed mainly in the context of magnetically confined plasmas using crossed beam device in the low-energy domain where the charge transfer is the dominant process. Measurements and reliable theoretical predictions are completely lacking for fast ion-slow ion collisions, a regime in which ion stopping power is maximum, and all the primary electronic processes (electron capture, loss and excitation) reach their optimum. It corresponds to a real "terra incognita"for atomic physics. The forthcoming availability of intense and stable beams of high optical quality on French and German Large Scale Facilities (GANIL/SPIRAL2 [1] and FAIR/CRYRING [2]) opens new opportunities to probe a large variety of systems. With the FISIC project, we propose an experimental crossed-beam arrangement to measure absolute cross sections. Besides the possibility to reach the pure three-body problem (bare ion on hydrogenic target) as a benchmark, we will explore the role of additional electrons bounded to the target and/or to the projectile –one by one–to quantify the effects of closure and/or opening of different channels, the electron-electron interactions, the role of multi-electron processes and of Coulomb forces in the entrance and exit pathway of the collision. FISIC will provide a unique worldwide experimental program covering the existing gap in ion-ion collisions, which besides of fundamental interest is also of prime importance for applications. The FISIC project is supported by an international collaboration led by INSParis and involving CIMAP (Caen), HI Jena, GSI and EMMI (Darmstadt).

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