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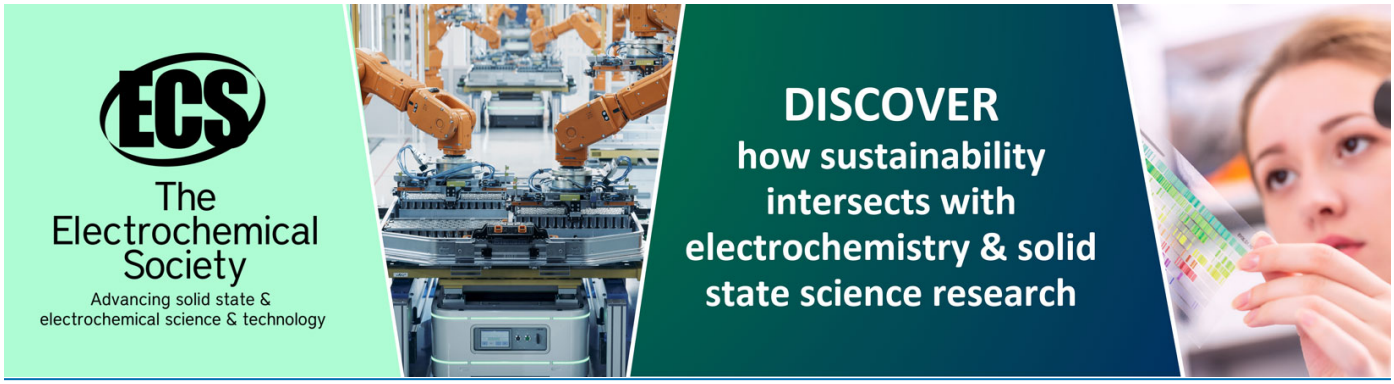

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Interatomic Coulombic Decay in Low Energy Ion-Dimer Collisions

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Synopsis Low energy collisions between ions and neon dimers are investigated, focusing attention on the dissociation of the ionized molecular target. The results show a clear dependance of the processes with the projectile charge state and an unexpected appearance of inner-shell single electron capture from one site of the neon dimer leading to interatomic coulombic decay process and low energy electrons emission.

Interaction of slow multi-charged ions (MCIs) with dimers is of great interest in various scientific fields, not only to study the electron capture by the projectile, but also to have access to insightful information about the target and its relaxation processes [1, 2, 3]. We present here an experimental and theoretical study of collisions between MCIs and Ne dimers including the identification and analysis of the possible processes.

The experiment was performed at GANIL facility (Caen, France), on the low energy beam line. Three different projectiles O^{3+}, Ar^{9+} and Xe^{20+}, produced by an ECR ion source and accelerated to 15 qkeV, were used to collide with neon dimers provided by a supersonic jet. A COLTRIMS setup with multi-hit capability combined with a position-sensitive detector for scattered projectiles were employed to measure, in multi-coincidence, the projectile final charge state, the position and the time-of-flight of the ionic fragments. These measurements give access to the ionic fragments momentum and thus to the kinetic energy release (KER). The latter can be directly related to the internuclear distance prior dissociation (fig.1).

In the symmetric $Ne^+ + Ne^+$ fragmentation channel, we have identified three different competing processes [3] illustrated in fig.1. Beside the direct coulomb explosion (CE), wherein the projectile captures one electron from each center of the dimer which directly dissociates, two other electronic relaxation mechanisms were observed: the interatomic coulombic decay (ICD) and the radiative charge transfer (RCT). The ICD process results from the single capture of an electron from the 2s inner valence state by the projectile. Then, the excited ion decays to Ne^+ ($2p^{-1}$). The excess energy is transferred to the neighboring atom of the dimer by ejecting an outer valence electron from the 2p state, causing molecular ion fragmentation. For the RCT process, two electrons from the outer valence states of one center of the dimer are first captured by the projectile. Electron transfer from the doubly ionized center to the neutral one can then occur by photon emission leading to molecular dissociation into two Ne^+ ($2p^{-1}$) ions.

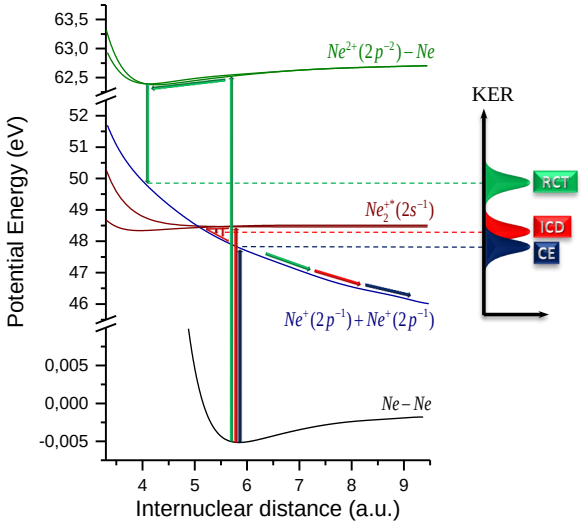

Figure 1. Illustration of the CE, RCT, and ICD processes in collisions between MCIs and Ne dimers.

For these three processes, the dependance on the initial and final projectile charge state [3] and, on the angular correlation between projectile scattering direction and dimer orientation has also been investigated, providing further insight into the dynamics of the collision.

References

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