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Ultrafast neutralization dynamics of highly charged ions upon impact on 2D materials

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The impact of ions on atoms, molecules and solid surfaces involves many different processes, among them charge exchange, electron excitation and ionization of the target, and subsequent deexcitation of both projectile and target. Experiments with slow (v < 1a.u.) highly charged ions (q < Z, Z » 1) scattered off solid surfaces or transmitted through thin solid films revealed already some years ago the presence of a fast deexcitation process of the projectiles. This fast deexcitation was described by a rapid Auger-type cascade in the projectile proceeding in parallel combined with a continuous feeding of electrons from the target. By using a freestanding layer of graphene as the target and normal ion incidence with keV-100keV energies, we limit the interaction time of our ions with the material to some femtoseconds only, thus excluding any additional electron feeding from the target to the projectile during its deexcitation. Nevertheless, we observe a similarly fast de-excitation and neutralization of highly charged Ar and Xe ions within a time frame of <10fs.Here we present a model of resonant electron capture in front of the surface according to the classical-over-the-barrier model and an interatomic deexcitation process with electrons of the surrounding target atoms (Interatomic Coulombic Decay (ICD)).We can now put observed charge exchange, energy loss and electron emission of slow highly charged ions impacting on solid surfaces on a common footing.

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