Interatomic Coulombic decay in excited large pure He nanodroplets

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Ionization of matter by energetic radiation generally causes complex secondary reactions which are hard to decipher. Using high-resolution electron spectroscopy, we report here on observation of an indirect ionization process—Interatomic Coulombic Decay (ICD) [1]—in large He nanodroplets irradiated by weak synchrotron radiation. It is based on the formation of two excited He atoms in the He nanodroplets following absorption of EUV photons of either low hν energies near the He ionization potential (IP) or high hν energies lying above the He photoelectron impact excitation threshold—h$\nu \geq 44.4$ eV. For sufficiently low hν near the He IP, formation of the two excited He atoms is due to two hν absorption events by the He nanodroplets [2]. For high h$\nu \geq 44.4$ eV, photoelectron impact excitation and electron-He^+ recombination are responsible for the formation of the two excited He atoms [3]. While the first excited atom is formed just via impact excitation driven by the primary photoelectron, the second excited atom is a result of electron-atom collisions and friction-induced slowdown of the inelastically scattered electron until it gets re-captured by the original residual ion (See Fig. 1). The correlated decay—ICD—of the pair of excited atoms formed at h$\nu \geq 44.4$ eV produces a characteristic ICD electron signal. We find that this ICD becomes the dominant process of electron emission in nearly the entire EUV range in droplets with radius ≥ 40 nm. It likely plays an important role in other dense systems exposed to ionization radiation as well, including biological matter.

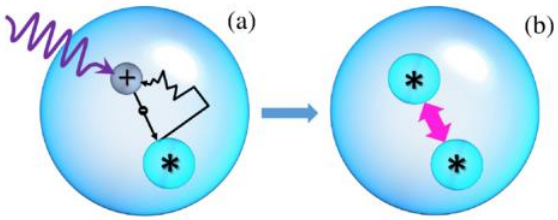

Fig 1. Illustration of ICD mechanism in He droplets induced by photoelectron impact excitation and electron-He^+ recombination (a), leading to two He excitations which subsequently decay by ICD (b).

References:

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