Double excitation of helium initiates interatomic Coulombic decay in helium nanodroplets

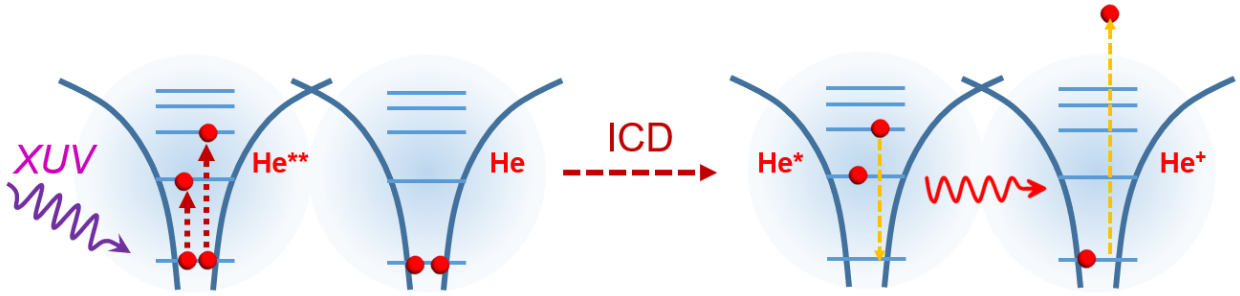
Björn Bastian,[1] Jakob D. Asmussen,[2] Ltaief Ben Ltaief,[2] Henrik B. Pedersen,[2]
Keshav Sishodia,[3] Subhendu De,[3] Siva R. Krishnan,[3] Cristian Medina,[4]
Nitish Pal,[5] Robert Richter,[5] Nicolas Sisourat,[6] Marcel Mudrich[2]

[1]Wilhelm Ostwald Institute, Leipzig University, Germany, [2]Department of Physics and Astronomy, Aarhus University, Denmark, [3]A Quantum Center of Excellence for Diamond and Emergent Materials and Department of Physics, Indian Institute of Technology Madras, Chennai 600036, India, [4]Max Planck Institute for Nuclear Physics, 69117 Heidelberg, Germany, [5]Elettra-Sincrotrone Trieste, 34149 Basovizza, Trieste, Italy, [6]Sorbonne Université, CNRS, Laboratoire de Chimie Physique Matière et Rayonnement, UMR 7614, 75005 Paris, France

Interatomic Coulombic decay (ICD) involving a doubly excited atom is observed for the first time. ICD is a non-local correlated electronic process which plays an important role in weakly bound complexes exposed to high-energy radiation. We use liquid helium nanodroplets (HNDs) as a well-suited model system and apply two methods for high-resolution electron spectroscopy in the extreme-ultraviolet (EUV) regime. This allows us to quantify the ICD probability and to analyze details of the process.[1]

Slow electrons from inelastic scattering of photoelectrons in the nanodroplet have the same energy as the ICD electrons. This experimental challenge is overcome by fine energy scans across the 2s2p+ resonance. We identify the ICD contribution that is shown to proceed by relaxation into He^{*} He^{+} atom-pair states. The process competes with the ultrafast autoionization of doubly excited He^{**} (17.5 fs decay time) and is expected to become more efficient in denser media. This type of ICD could consequently be relevant in other systems such as water and solvated metal atoms.

Fig 1. Schematics of the decay of a doubly excited He state by interatomic Coulombic decay (ICD)



References:

1. B. Bastian, J. D. Asmussen, L. Ben Ltaief, H. B. Pedersen, K. Sishodia, S. De, S. R. Krishnan, C. Medina, N. Pal, R. Richter, N. Sisourat, and M. Mudrich, *Phys. Rev. Lett.* (2024), accepted on April 25.