Field-assisted post-collision interaction during Auger decay of atoms

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If an inner-shell electron is removed from a multi-electron atom by absorption of a high-energy (XUV) photon, a singly-charged ion in an excited state and a photoelectron with distinct energy in the continuum are created. As a consequence of configuration interaction, the electrons in the ion rearrange on the femtosecond timescale with the emission of a secondary electron, an Auger electron. Its energy is determined by the electronic structure of the atomic species and its relative timing with respect to the time of core-hole creation is governed by the decay law. This implies a constant distribution of kinetic energies over time.

In this contribution, we show evidence from both theory and experiment [1] that the Auger electron emission under certain conditions shows a chirp, which is, a time-dependent variation of the kinetic energy. The origin of this behaviour can be attributed to an interaction of a slow photoelectron and the faster Auger electron in the presence of the remaining ion, i.e., post-collision interaction (PCI).

Experiments based on the light-field-driven terahertz streak camera [2] in combination with XUV photons from the free-electron laser FLASH and a higher-harmonics generated source are modelled [3] utilizing the time-dependent Schrödinger equation (TDSE) and a classical treatment of the electrons' trajectories in the combined fields of the ion and the streaking field. To single out PCI effects, closed expressions for the time-delay-dependent line shapes of the streaked Auger electrons (field-assisted PCI) are derived and compared to the numerical and experimental results.

The validity of the theory is demonstrated by considering two atoms: xenon, for which at the chosen excitation conditions small PCI effects are expected, and krypton with large PCI contributions. For both cases, good agreement between theory and experiment is achieved.

References:

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