Double Core Hole dynamics in the tender x-ray domain

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Double Core Hole (DCH) states, with 2 electron vacancies in inner shell, are susciting an increasing interest because of the strong dependence of their binding energy from the chemical environment [1]. They have been observed by x-ray emission [2-3] and photoemission [4-6] by using XFELs or synchrotrons.

After single-photon absorption, these DCH states can be produced directly through electron-electron interaction or via a two step process photoionization followed by an Auger decay.

Below the DCH threshold, interesting electronic states having one electron ejected into the continuum and one electron promoted into an empty molecular orbital are formed [7]. We published recently a proof of principle of high resolution DCH by detecting only one electron [8]. The spectroscopy of these DCH states have been studied on different atoms and molecules [9-13].

The decay of the DCH can be measured by its hypersatellite Auger spectrum, revealing PCI and ultrafast nuclear motion [8, 14] or by Two Electron – One Electron (TEOE) process where two outer electrons fill the DCH and a third electron is ejected into the continuum [15].

DCH states have a lifetime about 2.8 times shorter than SCH states. Their potential energy surfaces can be very repulsive leading to ultrafast dissociation [16, 17]. A combined measurement of Resonant Inelastic X-ray Scattering (RIXS) with Resonant Auger did allow to determine the Potential Energy Potential as well as the DCH lifetime [18].

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