Electron pair escape from fullerene cage via collective modes

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Synopsis Experiment and theory evidence a new pathway for correlated two-electron release from many-body compounds following collective excitation by a single photon.

In the few-electron systems the emission of two electrons, following the absorption of a single photon, is dominated by the Coulomb interaction. The two electrons exchange momentum and interact mutually and with the residual ion up to infinite distances. The detection in coincidence of the two electrons allows a complete investigation of the different active mechanisms depending on the total energy and energy sharing between the two electrons. A detailed understanding of double photoemission has been achieved in two-electron systems like the He atom and H_2 molecule [1].

In this work the double photoemission of C_{60} has been investigated at the Gas Phase beamline of Elettra at a few photon energy (about 10, 20 and 30 eV excess energy) in equal energy sharing conditions. Auger decay following C1s ionization populates the same dication states as direct double photoemission. Thus, for sake of comparison the Auger spectrum and photoelectron-Auger electron coincidence spectrum have been measured.

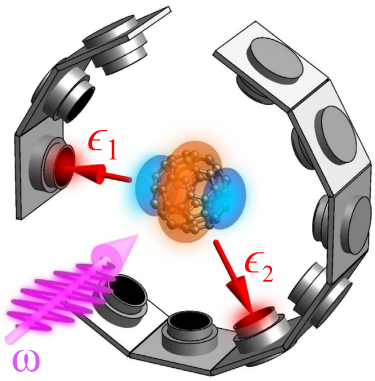

Figure 1. Scheme of the double photoemission setup.

The experimental results have been compared with the prediction of an *ab-initio* model which uses the non-equilibrium Green's function approach to take into account collective excitations. In this way different plasmonic modes can be selectively included in the calculation. The emerging physical picture is a three-step model: (i) photoabsorption promotes a valence electron to a high-energy state; (ii) this electron scatters inelastically from charge-density fluctuations (plasmon creation) that (iii) decay emitting a second valence electron (whose energy and angular correlations with the first one is measured in the coincidence set-up, revealing how charge-density fluctuations mediate e–e interaction).

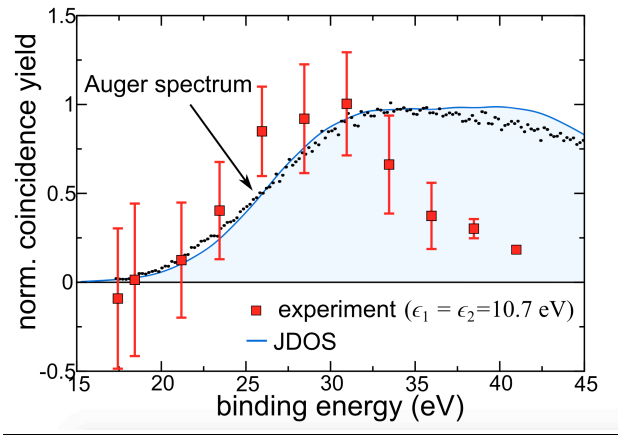

Figure 2. The normalized coincidence yield versus C_{60} binding energy (red squares with error bars) at $\varepsilon_1 = \varepsilon_2 = 10.7$ eV compared to the Auger spectrum measured at $\hbar\omega = 340$ eV (black dots) and the calculations of the joint density of states (JDOS)(shaded blue line).

The agreement between theory and experiments proves that the correlated two-electron photoemission is a powerful tool to access electronic correlation also in complex systems.

References

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