Fullerenes shells as resonators and amplifiers

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The aim of the talk is to discuss different resonances that appear in photoionization cross-sections and probabilities of vacancy decay of endohedral atoms $A@C_N$ due to multi-electron nature of the fullerenes shell with N collectivised electrons. The endohedral is an exciting object by itself and atom A works like a “lamp” that illuminates the fullerenes from inside.

Rightfully neglecting the variation of the carbon shell under the action of the atom A and vice versa, we concentrate on two major effects – the reflection and refraction of photoelectrons from A by the fullerenes potential and modification of the incoming photon due to polarization of the fullerenes electron shell under the action of the photon beam.

The first effect is determined by the static fullerenes potential. Its action leads to *confinement resonances* that are caused by reflection of the atom’s A photoelectron wave by the fullerenes shell. Depending upon the energy of photoelectrons, they may or may not modify drastically such atomic features as Giant resonances.

The dynamic action of the fullerene shell leads to *polarization resonances.* Their common action makes the situation rather complex, producing *giant endohedral resonances* that replace outer monotonic atomic shell cross-section by huge maximums that are up to hundred times higher than the atomic cross-sections. In considered cases polarization essentially increases the pure atomic cross-section. Reflection and polarization modifies considerably also the endohedral photoelectrons’ angular distribution and spin polarization.

Interaction of two (and more) atomic subshells, the cross-section of which is modified by fullerenes action, produces *endohedral interference resonances*. Attention will be given also to photoionization of two-shell endohedrals $A@C_{N_1}@C_{N_2}$.

The presence of the fullerene modifies essentially the vacancy decay probabilities. It opens Auger decay channels where in an isolated atom only radiative decay is energetically permitted. This increases the decay probability, if A is a noble gas atom, by four to six orders of magnitude.

The calculations described are performed within the framework of models that substitute the real fullerene potential by pseudo-potential, represented either by infinitely thin layer or by finite width well. The polarization effects are expressed via the isolated atom’s A photoionization cross-section.

Concrete objects of our consideration as A are mainly noble gas atoms and as fullerene the famous C_{60}. The approaches developed can be generalized for other atoms and fullerenes but additional data on these objects is needed.