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Inner-shell resonance photodetachment of Si^- negative ion.

Photodetachment from the deep inner shells of negative ions stand out as extremely sensitive probe and theoretical test-bed for important effects of electron-electron interaction because of the weak coupling between photon and target electrons.

One can expected that the possibility of a photoexitation to the ion state Si^{-*} $(1s^22s^2p^63s^23p^4\ {}^4P)$ reveals itself as a resonance structure in photodetachment cross sections in the energy range of the 2s and 2p inner shells thresholds similar to the 1s inner-shell photodetachment from C^- where where the strong near-threshold resonance is predicted within the DEM&RPAE (Kashenock and Ivanov 2006) in good agreement with the experiment (Walter *et al.* 2006) and the complex, mixed ("shape-Feshbach") nature of the resonance is revealed. The system is more complex compared to C^- since we need to consider the partial cross sections for 4 close spin-polarized inner subshells (6 phototransitions):

$$\mathrm{Si}^-...2p^3\uparrow\downarrow...3p^3\uparrow\ ({}^4S)+\omega\to \mathrm{Si}...2p^2\uparrow\downarrow...3p^3\uparrow\ ({}^{3,5}P)+\varepsilon s\uparrow\downarrow;\varepsilon d\uparrow\downarrow;$$
$$\mathrm{Si}^-...2s\uparrow 2s\downarrow...3p^3\uparrow\ ({}^4S)+\omega\to \mathrm{Si}...2s\downarrow...3p^3\uparrow\ ({}^3S)+\varepsilon p\uparrow;$$
$$\mathrm{Si}^-...2s\uparrow 2s\downarrow...3p^3\uparrow\ ({}^4S)+\omega\to \mathrm{Si}...2s\uparrow...3p^3\uparrow\ ({}^5S)+n,\varepsilon p\downarrow.$$

For the last phototransition we have emphasized the existence of photoexitation to the $3p\downarrow$ $(n=3$ discrete state in half-filled outer p-shell. This channel is expected to be a "resonance channel" as we have seen in the case of "$1s2s^22p^4$" resonance in C^-. However, the resonance channel for Si^- inner-shell photodetachment is open at the $2s\downarrow$ threshold in the vicinity of the thresholds of the others inner-shells photodetachment channels. So the RPAE correlations become important together with the strong influence of the dynamical relaxation. The problems becomes especially intriguing in the presence of the resonance "$...3p^4$" where a simultaneous account of all-type many-electron correlations in its one-channel description as well as inter-channel interference becomes crucial. We have performed the analysis of the collective response of the ionic many-electron system Si^- on electromagnetic field in the different levels of approximation: the "fr ozen-field" RPAE, the static relaxation approximation (GRPAE) and also within the DEM&RPAE approach when the dynamic relaxation and polarization are included simultaneously with the RPAE corrections.

The existence of the both limit "$3p\downarrow$" states - as a bound state, or Feschbach resonance, in the "frozen-core" approximation and a quasi-bound state, shape resonance, in the static relaxation approximation - allow us to suppose that the real situation is subtler.

Due to strong electron correlation in many-electron system the resonance type should be considered as a mixed Feschbach-shape structure. To investigate the many-electron mechanism of forming the resonance near $2s\downarrow$ threshold in details we have used DEM&RPAE approach. We predict the strong resonance peak at the energy E_{res} =11.82 Ry, ε_{res}= 0.04 Ry with resonance width of Γ =0.02 Ry. The photoelectron phaseshift and parameters of angular anisotropy behaviour reveals the dual nature of the "$3p\downarrow$" resonance. The additional peculiarities of the Fano-profile type appear due to RPAE interactions in the total photodetachment cross section. However, the total Si^- ph otodetachment cross section in the energy region under investigation is dominated by the strong resonance peak of complex "shape-Feschbach" nature at the 2s threshold. Our conclusion is that the dynamical relaxation is the most pronounced effect in this strong correlated system.