AUTODETACHMENT RESONANCES IN PHOTOABSORPTION OF He^- AND B^- IONS

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The results of many-body theory calculations of resonance autodetachment structure in He^- and B^- photodetachment are presented. The polarization potential describing the interaction of detaching electron with atomic core is taken into account within the Dyson equation method[1,2]. The irreducible self-energy part Σ (polarization potential) of single-electron Green function is considered within the second order of perturbation theory.

The most interesting feature in He^- photodetachment is the strong narrow resonance just after the 2s threshold, which is attriibuted to the $1s2p^2$ (^4P) autodetachment state. To calculate the 2s photodetachment cross section using the Hartree-Fock (HF) wavefunctions as a basis and starting from the ground state 1s2s2p He^-, where 2p electron is bound due to the polarization potential[1], it is necessary to correct the 2s wave function. It is because of the HF energy $\varepsilon_{2s}^{HF} = -0.3485Ry$ differs significantly from the experimental one $\varepsilon_{2s}^{exp} = -0.0898Ry$[3]. Using the Dyson equation we have obtained the corrected 2s wave function and its energy equal to $\varepsilon_{2s} = -0.079Ry$, $E^{tot}(He^-) - E^{tot}(He\, 2^3P^0) = -0.086Ry$.

The improved 2s wave function is used for the photodetachment cross section calculations both with and without the account of polarization effects on outgoing electron. Without the polarization influence the 2s shape resonance is too far from the threshold and has a small peak value. The account of the polarization potential influence leads to the narrow shape resonance with the correct position[3] at the energy $\omega = \omega_{res} = 1.233eV$ and with peak value about $3500\ Mb$. The shape resonance $1s2p^2$ (^4P) acts strongly on the threshold 2s cross section, that agrees well with recent experimental data[3] and the Peterson et al's parametric formula for the behaviour of opening-channel cross sections in the vicinity of a shape resonance.

The resonance of another type appears in B^- photodetachment due to strong interaction between direct transitions of the 2p-electron into continuum and transitions of the 2s-electrons to quasi-discrete vacant states in the 2p subshell. The extra 2p-electron in B^- negative ion can be bound within the spin-polarized version of the HF approximation $1s\uparrow 1s\downarrow 2s\uparrow 2s\downarrow 2p^2\uparrow$ (^3P). However the calculated 2p single-electron energies in B^- ($0.72\ eV$) differs rather significantly from the electron affinity in B ($0.28\ eV$). The value obtained within the Dyson equation method with monopole, dipole and quadrupole excitations of the $2p\uparrow$ and $2s\downarrow$ subshells taken into account is equal to $0.27\ eV$. The $2s\downarrow$ energy and wavefunction are corrected the same way. The new wavefunctions are used in the photodetachment cross section calculations within the Random Phase Approximation with Exchange to take into account the interchannel interaction between the transitions from $2p^2\uparrow$ and $2s\downarrow$ subshells. The results of these calculations are compared with previous calculations[4] and recent experimental data[5].

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