The influence of Breit interaction and E1-M2 quantum interference on polarization following inner-shell electron-impact excitation of Li-like ions

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Synopsis The total and magnetic sublevel cross sections of electron-impact excitation from the ground state $1s^22s\ ^2S_{1/2}$ to the inner-shell excited states 1s2s2p (J=3/2) are calculated based on a relativistic distorted-wave method for highly charged Li-like ions. The important influence of the Breit interactions and quantum interferences between electronic dipole (E1) and magnetic quadrupole (M2) transition on polarization of emitted X-ray are systematically studied.

The magnetic sublevels of excited states, which are produced by electron-impact excitation, may not be populated statistically. The radiation emitted during the decay of these unequally populated sublevels to a lower level is polarized. The degrees of polarization of X-ray, which depend on the degree of anisotropy of the velocity distribution, can provide an important diagnostic tool studying the vacuum spark plasmas, Z-pinches, and laser-produced plasmas [1-3].

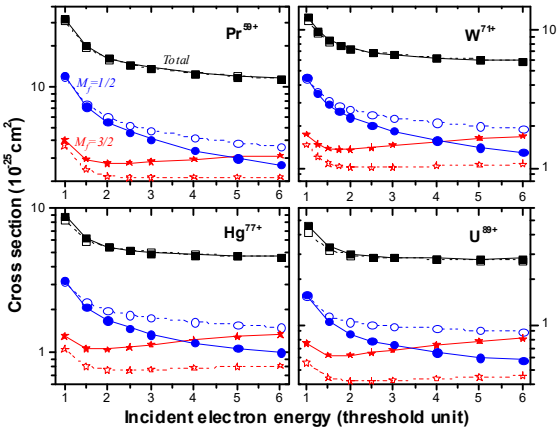

Figure 1. The total and specific magnetic sublevel cross sections for the excited state $1s2s2p(^1P)\ ^2P_{3/2}$ from the ground state $1s^22s\ ^3S_{1/2}$ for the Li-like Pr^{59+}, W^{71+}, Hg^{77+}, and U^{89+} ions as functions of incident electron energy in threshold unit. The solid line with symbols indicate the results with inclusion of Coulomb + Breit interactions, and the dash line with symbols indicate the results with only Coulomb interaction included in the calculations.

In this report, we performed a detailed calculation for the total and magnetic sublevels cross sections of inner-shell electron-impact excitation of the highly charged Li-like Pr^{59+}, W^{71+}, Hg^{77+}, and U^{89+} ions from the ground state to the excited states $1s2s2p(^3P)\ ^2P_{3/2}$, $1s2s2p(^1P)\ ^2P_{3/2}$, and $1s2s2p(^3P)\ ^4P_{3/2}$, based on our developed relativistic distorted-wave code [4]. The polarization of X-ray emissions following the electron-impact excitation are obtained for $1s2s2p(^3P)\ ^2P_{3/2}$-$1s^22s\ ^2S_{1/2}$ (labeled q), $1s2s2p(^1P)\ ^2P_{3/2}$-$1s^22s\ ^2S_{1/2}$ (s), $1s2s2p(^3P)\ ^4P_{3/2}$-$1s^22s\ ^2S_{1/2}$ (u) transition lines. Figure 1 and 2 illustrate the present results of the cross sections and polarizations for s-line of Li-like ions, which show significantly influences of the Breit interaction [5] and E1-M2 interferences.

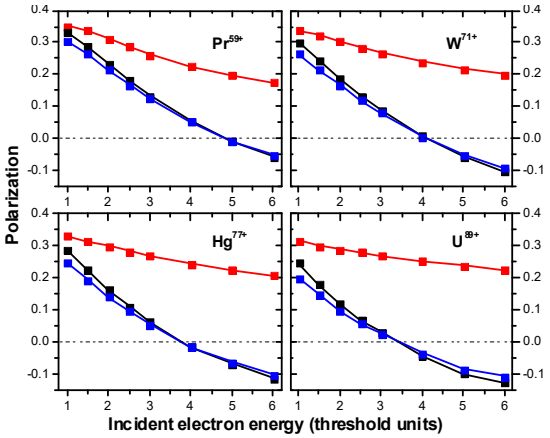

Figure 2. The polarization of s-line in Li-like Pr^{59+}, W^{71+}, Hg^{77+}, and U^{89+} ions. red solid (Coulomb interaction included only), black solid (Coulomb + Breit interactions included), and blue solid (Coulomb + Breit + E1-M2 quantum interference considered).

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