Polarization of *M*2 line emitted from highly-charged beryllium-like ions following electron-impact excitation

Y. L. Shi[*,†1], C. Z. Dong[†2], X. Y. Ma[†], Z. W. Wu[†], L. Y. Xie[†] and S. Fritzsche[§]

[*] College of Physics and Information Science, Tianshui Normal University, Tianshui 741001, China
[†] Key Laboratory of Atomic and Molecular Physics & Functional Materials of Gansu Province, College of Physics and Electronic Engineering, Northwest Normal University, Lanzhou 730070, China
[§] Helmholtz-Institut Jena, Fröbelstieg 3, Jena D-07743, Germany and Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, Jena D-07743, Germany

Synopsis The contributions of the Breit interaction to the linear polarization of the $1s2s^22p_{3/2}$ *J*=2 → $1s^22s^2$ *J*=0 magnetic quadrupole (*M*2) line following electron-impact excitation have been investigated systematically for the beryllium isoelectronic sequence with $42 \le Z \le 92$. It is found that the Breit interaction depolarizes significantly the linear polarization of the *M*2 fluorescence radiation and that these depolarization effects increase as the incident electron energy and/or the atomic number is enlarged.

When the highly charged ions are excited by a (directed) beam of electron, the excited state can be aligned with respect to the direction of the incident beam after the collision. In the subsequent radiative stabilization of the excited ion, this alignment is then partially transferred to the lower-lying levels of the final ion and also affects the emitted radiation, leading in many cases to an anisotropic angular distribution and linear polarization of the characteristic radiation [1]. The analysis of these photons may provide a promising and alternative route for studying the relativistic corrections to the *e-e* interaction in electron-ions collisions.

In this work, detailed calculations have been carried out for the electron-impact excitation (EIE) cross sections to the individual magnetic sublevels of the $1s2s^22p_{3/2}$ *J*=2 excited state of highly-charged beryllium-like ions by using a fully relativistic distorted-wave (RDW) code REIE06 [2]. Emphasis is placed on the question of how the population of the excited state and polarization properties of subsequent *M*2 radiation is affected by the relativistic terms (Breit) in the *e-e* interaction.

The details of the calculations are presented in [3] and only the main results are summarized here. Figure 1 shows the degree of linear polarization of the $1s2s^22p_{3/2}$ *J*=2 → $1s^22s^2$ *J*=0 *M*2 line as function of the nuclear charge Z ($42 \le Z \le 92$) for incident electron energies of just 5 times the corresponding threshold energy. While the linear polarization of the *M*2 line decreases slowly (in magnitude) with increasing nuclear charge of the ions if only the Coulomb repulsion is included, a much stronger depolarization is found for this transition for the full account of the *e-e* interaction (C + B). For Z ≈ 66, moreover, the linear polarization of the *M*2 line becomes *zero* and changes its behaviour from a dominantly *perpendicular* to an *in-plane* polarization with regard to the scattering plane if the nuclear charge Z is further increased. With the recent advancements in the design of position-sensitive solid-state detectors [4], such a strong relativistic effect will become measurable in experiment with the present-day facilities, both at heavy-ion storage rings and electron-beam ion trap (EBIT) devices.

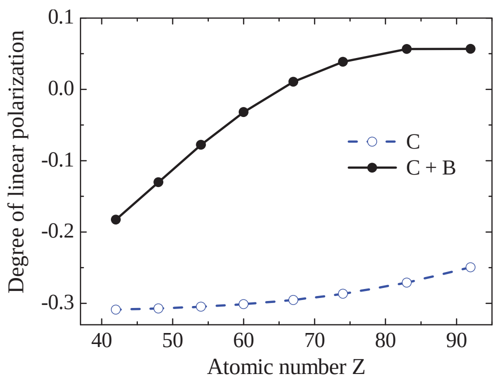

Figure 1. Degree of linear polarization of the $1s2s^22p_{3/2}$ *J*=2 → $1s^22s^2$ *J*=0 *M*2 line emission following EIE for beryllium-like ions as function of the atomic number at 5 times the threshold energy.

References

[1] E G Berezhko and N M Kabachnik 1977 *J. Phys. B: At. Mol. Phys.* **10** 2467
[2] J Jiang, Dong C Z, L Y Xie and J G Wang 2008 *Phys. Rev.* A **78** 022709
[3] Y L Shi, C Z Dong *et al* 2013 *Chin. Phys. Lett.* **30** 063401
[4] G Weber *et al* 2010 *Phys. Rev. Lett.* **105** 243002

[1] E-mail: shiyinglong331@163.com
[2] E-mail: dongcz@nwnu.edu.cn