Nuclear recoil effect on the g factor of lithiumlike ions

Aleksei V. Malyshev, Vladimir M. Shabaev, Dmitry A. Glazov, Ilya I. Tupitsyn

St. Petersburg State University, Universitetskaya 7/9, 199034 St. Petersburg, Russia

The nuclear recoil effect on the g factor of highly charged Li-like ions is studied [1, 2]. The fully relativistic quantum electrodynamics (QED) calculation of the one-electron recoil contribution to first order in the electron-to-nucleus mass ratio is performed. The two-electron part is evaluated within the lowest-order relativistic (Breit) approximation employing the novel four-component approach. The results for the two-electron recoil term are found to be in disagreement with the previous calculations based on the effective two-component Hamiltonian [3, 4, 5]. The obtained value for the nuclear recoil effect is used to calculate the isotope shift of the g factor of lithiumlike ${}^{A}\mathrm{Ca}^{17+}$ with $A = 40$ and $A = 48$ which has been recently measured [6]. As the result, the agreement between experiment and theory is significantly improved [1].

In addition, prospects for tests of the QED recoil effect on the g factor in experiments with heavy ions are studied [2]. It is found that, while the QED recoil effect on g-factor value is masked by the uncertainties of the nuclear size and nuclear polarization contributions, it can be probed on a few-percent level in the specific difference of the g factors of H- and Li-like heavy ions. This paves a way to test QED in a new region — strong-coupling regime beyond the Furry picture.

This work was supported by the Russian Science Foundation (Grant No. 17-12-01097).

---

[1] V. M. Shabaev, D. A. Glazov, A. V. Malyshev, I. I. Tupitsyn, Phys. Rev. Lett. **119** (2017) 263001.

[2] A. V. Malyshev, V. M. Shabaev, D. A. Glazov, I. I. Tupitsyn, JETP Lett., in press.

[3] Z.-C. Yan, Phys. Rev. Lett. **86**, 5683 (2001).

[4] Z.-C. Yan, J. Phys. B: At. Mol. Opt. Phys. **35**, 1885 (2002).

[5] R. A. Hegstrom, Phys. Rev. A **11**, 421 (1975).

[6] F. Köhler, K. Blaum, M. Block, S. Chenmarev, S. Eliseev, D. A. Glazov, M. Goncharov, J. Hou, A. Kracke, D. A. Nesterenko, Y. N. Novikov, W. Quint, E. M. Ramirez, V. M. Shabaev, S. Sturm, A. V. Volotka, and G. Werth, Nat Commun. **7**, 10246 (2016).