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Two-loop QED corrections to the bound-electron g factor involving the magnetic loop

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The g factor of bound electrons in light and medium-light hydrogen-like ions (e.g. C, Si) has been measured with an accuracy of a few parts in 10^{11} [S. Sturm et al., Nature 506, 467 (2014)]. Experiments such as ALPHA-TRAP and HITRAP aim at reaching this accuracy with heavy, few-electron ions, motivating the evaluation of two-loop radiative corrections.

We calculate a specific set of two-loop corrections to the bound-electron g factor in the hydrogen-like ground state. Diagrams belonging to this set include the magnetic loop as a subprocess and vanish in the free-loop approximation [V.A. Yerokhin and Z. Harman, Phys. Rev. A 88, 042502 (2013)]. At the lowest nonvanishing order, they involve the scattering of the external magnetic field in the Coulomb field of then ionic nucleus. We computed the electric-loop-magnetic-loop diagram, the magnetic-loop-after-loop diagram, and the self-energy-magnetic-loop diagrams, while also shedding light on some other diagrams, which feature a self-energy loop inside the magnetic loop. Our approach treats the binding of the electron to the nucleus nonperturbatively.

The computed corrections to the g factor are of order up to 10^{-7} in the case of ^{82}Pb. These corrections will be relevant to the projected determination of the fine-structure constant from g-factor measurements.

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