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Strong-field QED and beyond in highly charged ions

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In this contribution, we discuss the quantum electrodynamic (QED) theory of strongly bound atomic systems. The ionic g factor can be measured nowadays to high precision with the combination of Penning traps and electron beam ion traps. The collaboration of theory and experiment enables impactful and detailed tests of QED in a strong background field, and a competitive determination of fundamental constants [1] and nuclear properties [2]. Very recently, we have shown that such studies also allow to test certain extensions of the Standard Model of particle physics, and set bounds on the strength of a hypothetical fifth force [3,4]. We summarize our ongoing calculations of radiative corrections in the non-perturbative Coulomb potential, which are necessary for further improvements in this field.

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[2] A. Schneider, B. Sikora, S. Dickopf *et al.*, Nature **606**, 878 (2022).
[3] V. Debierre, C. H. Keitel, Z. Harman, Phys. Lett. B **807**, 135527 (2020); arXiv:2202.01668 (2022).
[4] T. Sailer, V. Debierre, Z. Harman *et al.*, Nature **606**, 479 (2022).

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