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A9: P-Wave Two-Body Bound and Scattering States in a Finite Volume including QED

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The mass shifts for two-fermion bound and scattering P-wave states subject to the long-range interactions due to QED in the non-relativistic regime in refs. [1, 2] are presented. Introducing a short range force coupling the spinless fermions to one unit of angular momentum in the framework of pionless EFT, we first report the two-body scattering amplitudes with Coulomb corrections in the infinite-volume context [3]. Motivated by the research on particle-antiparticle bound states, we show the T-matrix elements and the leading scattering parameters for fermions of identical mass and opposite charge. Second, we immerse the system into a cubic box with periodic boundary conditions and we display the finite-volume corrections to the energy of the lowest bound and unbound T1− eigenstates. In particular, power law contributions proportional to the fine structure constant and resembling the recent results for S-wave states are found [4]. Higher order terms in α are neglected, since the gapped nature of the momentum operator in the finite-volume environment allows for a perturbative treatment of the QED interactions. Some hints concerning the extension of the analysis to D-wave short-range interactions are eventually given.

[1] G. Stellin, Nuclear Physics in a finite volume: Investigation of two-particle and α-cluster systems (doctoral thesis), Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn (2020).
[2] G. Stellin and U.-G. Meiÿner, Eur. Phys. J. A 57, 26 (2021). ArXiv: 2008.06553
[3] G. Stellin, Bound and Scattering States in a Finite Volume including the Coulomb Interaction, 7th RDP School
& Workshop "Frontiers of QCD" (oral contribution), Tbilisi, Georgia (2019).
[4] S.R. Beane and M.J. Savage, Phys. Rev. D 90, 074511 (2014). ArXiv:1407.4846

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