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Charged polarons at finite momentum

In the context of ultracold gases, hybrid ion–atom interaction systems, where charged polarons are formed, have become of significant interest for many fields, including condensed matter physics, solid-state systems, transport phenomena, quantum information, and quantum simulation. In this work, we investigate the properties of a charged polaron formed by an ion with finite momentum immersed in a weakly interacting Bose–Einstein condensate (BEC). In contrast to previous studies, the finite momentum of the ion enables us to go beyond the contact interaction approximation for the ion–atom potential. The polaron is going to have a finite momentum then, employing second-order perturbation theory, we characterize the effective mass, self-energy, bound-state formation and Cherenkov radiation as functions of the tunable interaction parameters. Our results are compared to those obtained in the static polaron scenario, finding notable differences that could be of both theoretical and experimental relevance for ongoing research.

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