Charged Polarons at Finite Momentum

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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. Using second-order perturbation theory, we characterize the effective mass, self-energy, decay rate and bound-state formation as functions of the tunable interaction parameters and the polaron momentum. Our results are compared to those obtained by contact interaction in the static polaron scenario, finding notable differences that could be of both theoretical and experimental relevance for ongoing research.

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