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Computing the Polaron to Bubble Crossover of an Impurity in a Bose-Einstein Condensate[1] ALINA BLINOVA, Rice University, MALCOLM BOSHIER, EDDY TIMMERMANS, Los Alamos National Laboratory — Cold trapped atoms provide an ideal laboratory for exploring many-body quantum phenomena. We study the case of a distinguishable neutral atom - an impurity - immersed in a dilute Bose-Einstein condensate (BEC). When strongly coupled to the BEC, the impurity self-localizes, resembling an electron in a dielectric crystal in the polaron system described by Landau. When the BEC-impurity interaction is increased further, we discover that the system gradually changes to a state resembling the "bubble" formed by an electron in superfluid helium. Because the BEC-impurity interaction can be Feshbach-tuned over a wide range, this system offers a unique way to study the cross- over between the polaron and bubble regimes. We obtain the ground state wavefunctions of the impurity and of the BEC by numerically minimizing the Gross-Pitaevskii energy functional for the system using an iterative conjugate gradient scheme implemented in spherical polar coordinates. The results allow us to study the cross-over from polaron to bubble regimes. This poster will discuss our numerical method, describe the behavior of the system in the polaron, cross-over, and bubble regimes, and also present a phase diagram for the BEC-impurity system which can serve as a roadmap for future experiments.

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