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Universality of an impurity in a Bose-Einstein condensate

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We consider the simplest strongly interacting Bose system, where an impurity particle (polaron) resonantly interacts with a Bose-Einstein condensate (BEC). Focusing on the ground state, we will introduce a variational wave function for the polaron that goes beyond previous work and includes up to three Bogoliubov excitations of the BEC, thus allowing us to capture both Efimov trimers and associated tetramers. We show that the length scale associated with Efimov trimers (i.e., the three-body parameter) can strongly affect the polaron's behaviour, even at densities where there are no well-defined Efimov states. However, by comparing our results with recent quantum Monte Carlo calculations, we argue that the polaron energy is a universal function of the Efimov three-body parameter for sufficiently low boson densities.