Bose-Einstein condensates in $\mathcal{PT}$-symmetric double-well and multi-well setups

Holger Cartarius, Dennis Dast, Daniel Haag, Manuel Kreibich, Rüdiger Eichler, Jörg Main, and Günter Wunner

Institut für Theoretische Physik 1, Universität Stuttgart, Germany
email: Holger.Cartarius@itp1.uni-stuttgart.de

Abstract:

In recent publications it has been shown that $\mathcal{PT}$-symmetric solutions of the nonlinear Gross-Pitaevskii equation describing Bose-Einstein condensates do exist [1,2]. Following a suggestion by Klaiman et al. [3] we first investigate theoretically a Bose-Einstein condensate in a double-well setup. When particles are removed from one well and coherently injected into the other the external potential is $\mathcal{PT}$ symmetric. We solve the underlying Gross-Pitaevskii equation and show that the $\mathcal{PT}$ symmetry of the external potential is preserved by both the wave functions and the nonlinear Hamiltonian as long as eigenstates with real eigenvalues are obtained. The linear stability analysis and the temporal evolution of condensate wave functions demonstrate that the $\mathcal{PT}$ symmetric condensates are stable and should be observable in an experiment [4]. We then extend the setup by introducing additional wells and discuss methods of embedding an effectively open double well in a closed multi-well structure. Suggestions for experimental realizations are presented.

References:

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