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(G*) Dynamical instability as a PT-symmetry breaking phase transition in a rotating Bose-Einstein condensate

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We consider a dilute gas of bosons in a slowly rotating toroidal trap, focusing on the two-mode regime consisting of a non-rotating mode and a rotating mode corresponding to a single vortex. This system undergoes a symmetry breaking transition as the ratio of interactions to 'disorder potential'is varied and chooses one of the two modes spontaneously, an example of macroscopic quantum self-trapping. Analyzing elementary excitations around the BEC using Bogoliubov theory, regions of energetic instabilities with negative excitation frequencies are found, as well as dynamical instabilities, where excitations have complex frequencies. For the latter, amplitudes grow or decay exponentially. Instabilities can occur at bifurcations where the classical field theory provided by the Gross-Pitaevskii equation predicts that two or more solutions appear or disappear. Those complex eigenvalues confirm that the Bogoliubov Hamiltonian is non-Hermitian as picking a phase for the BEC breaks U(1) symmetry. In non-Hermitian quantum theory, the requirement of self-adjointness is replaced by a less stringent condition of PT-symmetry, which still ensures that Hamiltonians exhibit real and positive spectra if PT-symmetry is unbroken. We are investigating how the occurence of the dynamical instability is connected to a PT-symmetry breaking phase transition.

Keyword-1

dynamical instability

Keyword-2

PT symmetry

Keyword-3

non Hermitian

Author: KAMP, Denise

Co-author: O'DELL, Duncan

Presenter: KAMP, Denise

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