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The Internal Structure of a Vortex in a Two-Dimensional Superfluid with Long Healing Length

Igor ALEINER
Columbia University in the City of New York, USA

Abstract:

We analyze the motion of quantum vortices in a two-dimensional bosonic superfluid within Popov's hydrodynamic description. In the long healing length limit (where a large number of particles are inside the vortex core) the superfluid dynamics is determined by saddle points of Popov's action, which, in particular, allows for weak solutions of the Gross-Pitaevskii equation. We solve the resulting equations of motion for a vortex moving with respect to the superfluid and find the reconstruction of the vortex core to be a non-analytic function of the force applied on the vortex. This response produces an anomalously large dipole moment of the vortex and, as a result, the spectrum associated with the vortex motion exhibits narrow resonances lying {\em within} the phonon part of the spectrum, contrary to traditional view.

(in collaboration with O. Agam and A. Klein)