SFB/TRR 21 - Kolloquium
5. November 2010, Stuttgart

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Critical Velocities for Superfluid Flow Instability

A superfluid can flow past an obstacle without dissipation. As Landau has first shown, the energy can indeed be transferred into excitations only above a finite critical velocity, because there is both macroscopic phase coherence and interaction among the fluid constituents. This two basic ingredients are contained in the Gross-Pitaevskii mean-field equation, which proves very accurate in the description of Bose-Einstein condensates. For an infinitesimal perturbation to a homogeneous flow of a condensate, the critical velocity is the sound speed, and the corresponding excitations are phonons. On the other hand, when the obstacle considerably modifies the flow configuration, there isn't a unique criterion determining the critical velocity. We study a Bose-Einstein condensate flowing through a constriction, and we observe the nucleation of vortex lines/rings at a critical velocity lower than sound. We find a criterion which correctly predicts our critical velocities, but differs from known criteria for superfluid instability. This difference opens to an interesting interpretation.

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