

CONDENSATES IN FLATLAND: BOSE GASES IN TWO DIMENSIONS

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Physics of a Bose gas in 2D is quite different from the usual 3D situation. In a homogeneous 2D system, long wavelength phase fluctuations destroy the long-range order at any finite temperature, and the phase correlation function is expected to decay algebraically. Further, when the temperature increases, bound vortex-antivortex pairs are expected to break, and a proliferation of free vortices is expected; this is the Kosterlitz-Thouless transition from a superfluid state at low temperature, to a normal state at high temperature.

Atomic gases are convenient systems to investigate the various aspects of quantum 2D physics. Using optical lattice potentials, we can create two parallel, independent 2D clouds with similar temperatures and chemical potentials, and then allow them to expand, overlap, and interfere [1]. This realizes a matter wave heterodyning experiment, which gives direct access to several features of the phase distributions in the two planes. Free vortices appear as sharp dislocations in the interference pattern, and long wavelength phase fluctuations create a smooth and random variation of the interference fringes.

I will give a short introduction to 2D physics of trapped quantum gases, and present some recent experimental results obtained with rubidium quasi-2D condensates, using the matter wave heterodyning technique.

[1] S. Stock, Z. Hadzibabic, B. Battelier, M. Cheneau, and J. Dalibard, Phys. Rev. Lett. 95, 190403 (2005).