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Superfluid fraction in an interacting spatially modulated Bose-Einstein condensate

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At zero temperature, a Galilean-invariant Bose fluid is expected to be fully superfluid. We investigate theoretically and experimentally the quenching of the superfluid density of a dilute Bose-Einstein condensate due to the breaking of translational (and thus Galilean) invariance by an external 1D periodic potential. Both Leggett's bound [1] fixed by the knowledge of the total density and the anisotropy of the sound velocity provide a consistent determination of the superfluid fraction. The use of a large-period lattice emphasizes the important role of two-body interactions on superfluidity.

[1] A.J. Leggett, "Can a solid be "superfluid"?" Phys. Rev. Lett. 25, 1543–1546 (1970)

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