Quantum Register of Fermion Pairs and Crystallization of Quantum Hall States

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I will discuss two recent quantum gas experiments at MIT: The demonstration of a quantum register made of fermion pairs and the crystallization of bosonic quantum Hall states. The "glue" between these rather orthogonal topics is the harmonic oscillator that underlies these experiments. For the quantum register we observed long-lasting coherence of the relative and center-of-mass motion of fermion pairs, which may serve as a novel type of qubit. In the work on rotating quantum gases, we empoly a harmonic trap to perfectly cancel the centrifugal force in the rotating frame, so as to be able to observe the pure evolution of a bosonic quantum Hall state – a Landau gauge wavefunction – in "flat land" - under the sole influence of interactions and the effective magnetic field provided by the Coriolis effect. We observe that this wavefunction is unstable against crystallization, and show that the instability smoothly connects from the quantum regime to the classical description of a Kelvin-Helmholtz-like instability of counterflow.

References:

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