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Fermionic Superfluidity with Imbalanced Spin Populations and the Quantum Phase Transition to the Normal State[1] MARTIN W. ZWIERLEIN, ANDRE SCHIROTZEK, CHRISTIAN H. SCHUNCK, WOLFGANG KETTERLE, MIT — Whether it occurs in superconductors, helium-3 or inside a neutron star, fermionic superfluidity requires pairing of fermions, particles with half-integer spin. For an equal mixture of two states of fermions ("spin up" and "spin down"), pairing can be complete and the entire system will become superfluid. When the two populations of fermions are unequal, not every particle can find a partner. Will the system nevertheless stay superfluid? In this talk we present our study of this intriguing question in an unequal mixture of strongly interacting ultracold fermionic atoms. The superfluid region vs population imbalance is mapped out by employing two complementary indicators: The presence or absence of vortices in a rotating mixture, as well as the fraction of condensed fermion pairs in the gas. Due to the strong interactions near a Feshbach resonance, the superfluid state is remarkably stable in response to population imbalance. The final breakdown of superfluidity marks a new quantum phase transition, the Pauli limit of superfluidity.

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