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Two-fluid hydrodynamics in strongly interacting Fermi gases[1]

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Landau's theory of two-fluid hydrodynamics provides an exact description of the finite-temperature, low-energy dynamics of all strongly interacting superfluids described by a two-component order parameter. Reliable solutions of the two-fluid equations in trapped Fermi gases through the BCS-BEC crossover are crucial for extracting information about the equation of state and transport coefficients from experiments in the superfluid phase. In this talk, I will present new accurate variational solutions for the first and second sound frequencies in a trapped Fermi gas at unitarity, highlighting similarities with superfluid Helium-4 as well as some surprising differences [1.]. I will also discuss proposals to detect these modes in experiments. For the uniform gas, we show that at temperatures of order $0.7T_c$ and higher, second sound enters with comparable weight to first sound in the dynamic structure factor, in agreement with the recent results of Arahata and Nikuni on the propagation of density pulses [2.].

[1.] E. Taylor, H. Hu, X.-J. Liu, L. P. Pitaevskii, A. Griffin, and S. Stringari, Phys. Rev. A **80**, 053601 (2009).
[2.] E. Arahata and T. Nikuni, Phys. Rev. A **80**, 043613 (2009).

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