Pendulum in a Fermi liquid

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The Fermi liquid theory formulated by Landau is a basic paradigm of the behavior of an interacting many-body system. We show that the interactions between quasiparticles lead to "Landau force" on a macroscopic object. We show that immersing a pendulum in a Fermi liquid can increase its oscillation frequency. We apply the Fermi liquid theory to study the mechanical impedance of a vibrating wire immersed in ^{3}He-^{4}He mixtures at low temperatures. We present numerical results based on a direct solution of Landau-Boltzmann equation for the ^{3}He quasiparticle distribution in the full scale of the quasiparticle mean-free-paths from the hydrodynamic to the ballistic limit. The two-fluid nature of the mixture is taken into account in the theory, and the effect of Fermi liquid interactions and boundary conditions are studied. The results are in fair quantitative agreement with experimental data. In particular, we can reproduce the anomalous increase of the oscillation frequency that has been observed in vibrating wire experiments reaching the ballistic limit. The essential effect of the experimental container and second-sound resonances is demonstrated. Further consequences of the Landau force are discussed.[1]

[1]T.H. Virtanen and E.V. Thuneberg, Phys. Rev. Lett. **106**, 055301 (2011), and arXiv:1101.3528.