SORBONNE UNIVERSITÉ

Master thesis proposal

LPTMC

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Title: The viscosity of a 2D Fermi fluid

Keywords: Quasiparticules, Fermi liquids, Quantum transport, Renormalisation

Scientific description: We will compute the viscosity of a 2D fluid of fermionic particles in the low-temperature limit. In this regime, the system effectively behaves as a fluid of Landau quasiparticles, described by Fermi liquid theory. The first objective of the internship will be to write down (based on existing studies in 2D and 3D) an effective action for these Landau quasiparticles, including an effective mass and a quasiparticle collision amplitude. This could be done through a renormalization procedure that progressively incorporates high-energy processes into the properties of the quasiparticles. Once this is done, the second objective will be to solve the quasiparticle Boltzmann equation, and deduce the Navier-Stokes equations of the Fermi liquid. In 2D, one expects the relaxation terms of the Boltzmann equation to be dominated by pairing collisions, where the incidence angle approaches π. This will require a careful treatment of the collision amplitude, which is expected to diverge logarithmically with the renormalization cutoff. Finally, we will confront the theoretical results to measurements using ultracold gases. The shear viscosity is an easily accessible observable that determines the attenuation of hydrodynamical flows, in particular the attenuation of sound waves.

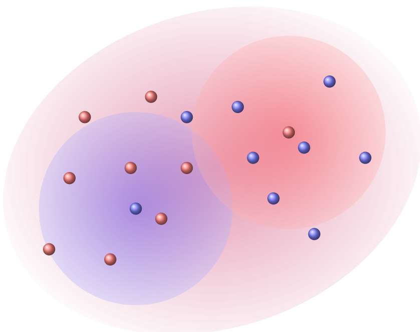

Figure 1 : A collision between a spin-↑ and a spin-↓ fermionic quasiparticle (red and blue clouds), mades of fermionic particles (red and blue dots)

Techniques/methods in use: Renormalisation group, Boltzmann equation
Applicant skills: Quantum mechanics, field theory, second quantization (idealy)
Industrial partnership: N

Internship supervisor(s): Hadrien Kurkjian (hadrien.kurkjian@cnrs.fr)
Internship location: LPTMC, 4 place Jussieu 75005 Paris

Possibility for a Doctoral thesis: no, a priori