# COMPUTATIONAL ELECTRON FLUID DYNAMICS

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Description: Molecular friction in classical liquids and in electric conductors usually have very different interpretations. The latter is most commonly attributed to "external scattering", i.e., momentum relaxation of electrons upon interaction with impurities or phonons in the conductor. On the other hand, molecular friction in liquids is most commonly attributed to "internal scattering", akin to molecules "rubbing" against each other. In certain regimes however, electrons can in fact scatter internally and behave in a way that is similar to classical fluids. Recent work, including some by T.S.[1] and propelled by interest in the properties of graphene, has renewed interest in this peculiar regime. Electron and classical fluid dynamics have in common that theoretical predictions are extremely difficult to verify experimentally. Computational fluid dynamics (CFD) has emerged over the past decades as an essential tool to provide solutions that come very close to actual (classical) fluid behaviour, as a third pillar on equal footing with theory and experiments. N.G. has been using such a code, Dedalus[2], in the past few years, to study fluid dynamics of the ocean. This tool could be adapted to help us shed light on electron flow regimes that are currently both inaccessible to experimentation[3] and analytically intractable.

Requirements and Potential Outcomes: In this project, the student would adapt Dedalus to solve for the PDEs that govern electron transport in the hydrodynamic regime. In particular, they will explore highly non-linear (high Reynolds number) regimes, and effects of Hall viscosity. They will use, or learn about, concepts in fluid dynamics, electron transport, partial differential equations and their numerical resolution. We expect candidates to have completed their third year or higher.
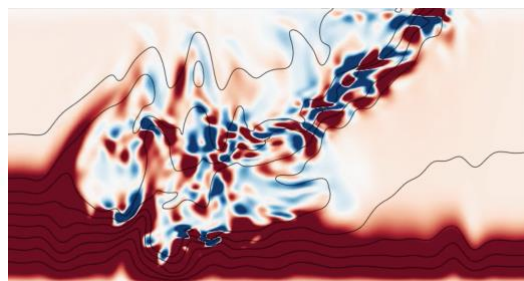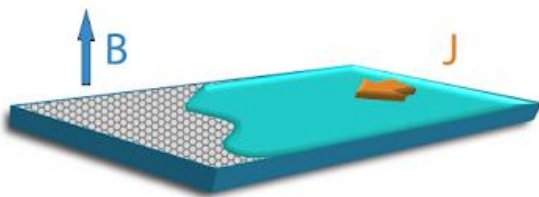
Bibliography:

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