Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

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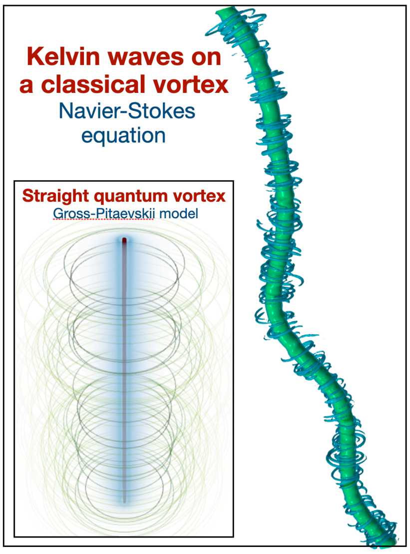
Internship location: Laboratoire Lagrange, Observatoire de la Côte d'Azur, Nice.

Thesis possibility after internship: YES
Funding: NO If YES, which type of funding:

Vortex dynamics in classical and quantum fluids



Vortices are highly rotating regions of a fluid and can be can be localised on thin filaments. The most common example in nature is tornadoes, which can have very long lifetimes. Vortices also appear in more exotic flows, such as quantum fluids, also known as *superfluids*. Superfluidity is a fascinating and exotic state of matter that originates due to quantum effects at very low temperatures. A superfluid is a liquid distinguished from a classical fluid by the absence of molecular viscosity. The main consequence is that an object that moves through it at low velocity does not experience any drag. Moreover, vortex filaments in superfluids are topological defects and their circulation is quantised. This last property makes quantum vortices extremely stable and "perfect" hydrodynamical objects. Examples of superfluids are low-temperature 3He and 4He and Bose-Einstein condensates. Over the last decade, vortices have been observed in quantum fluids, and we can now study their dynamics.

In a perfect vortex filament, waves propagate along them, producing helical oscillations. Such waves are solutions to the incompressible Euler equation discovered by Lord Kelvin in the late 19th century and have become an essential object in low-temperature superfluids. Indeed, they are responsible for transferring energy towards the smallest scales of superfluids. Although Kevin waves have a classical origin, they have not been well studied in classical fluids until recently.

This internship proposes to study the dynamics of Kelvin waves in classical fluids by performing simulations of the Navier-Stokes equations. We will study their propagation and nonlinear interactions, which could lead to the propagation of solitons and wave turbulence cascades. In the longer term, for a thesis project, I propose to address more general vortex dynamics problems, such as vortex reconnections in both classical and quantum flows.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES