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:

Modelling turbulence in oceans and atmospheres

Turbulence is one of the most common physical phenomena occurring in nature. We observe it when we pour milk into a cup of coffee, when a plane flies over the sky, in rivers, oceans, and in the atmosphere. Turbulence is crucial for mixing and is responsible for transferring energy from the large scale of the flow, where it is injected, to the smallest one, where it can be efficiently dissipated. When the forcing and dissipation scales are well separated, the emerging physical phenomenon is universal. In geophysical systems, such as oceans and atmospheres, in addition to hydrodynamic turbulence, other essential ingredients add up. Planets are rotating, which creates inertial waves due to the Coriolis force. Oceans are stratified, leading to the propagation of internal waves due to buoyancy. Inertial and internal waves are unlike common waves: they propagate and disperse in orthogonal directions, interact nonlinearly, and are highly anisotropic. Understanding the role of internal and inertial waves in turbulent oceans and atmospheres is one of the main challenges and sources of incertitudes in the large-scale modeling of climate.

Scale separation in such geophysical systems is enormous. For instance, typical large scales of oceanic flows are of the order of 1-10km, whereas the smallest ones are typically ~1-10mm. In 3D, that would imply to resolve $\sim 10^{21}$ degrees of freedom, which is out of reach, even with the largest supercomputers available today. To provide some physical understanding of those flows, one thus needs to make drastic assumptions in the models we use. In this internship we propose to use a novel and rich approach to model turbulent flows based on a Log-Lattice description of fluid equations. Such models allow for the use of a laptop computer to simulate turbulent flows with enormous scale separations. More precisely, the internship will consist of studying, using numerical simulations, how internal and inertial waves interact within this model, how they modify energy transfers towards the smallest scales of the system, and provide hints on their relevance for mixing in the ocean.

This internship will be carried out in collaboration with Berengere Dubrulle (SPEC) et Guillaume Costa (Lagrange).

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: NO Theoretical Physics: YES