Post-Doctoral position for 12 months, available immediately

Modelling and HPC numerical simulations of Quantum Turbulence. Models for coupling Gross-Pitaevskii and Navier-Stokes equations.

Advisors :

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Context:

This study is part of a national (ANR) research program entitled QUTE-HPC (*QUantum Turbulence Exploration by High-Performance Computing*). The project gathers 10 researchers from physics and mathematics and is aimed at providing a new state-of-the-art for the mathematical-physical modelling and High Performance Computing (HPC) of Quantum Turbulence (QT) in superfluid quantum fluids, such as superfluid Helium (He) and atomic Bose-Einstein condensates (BEC). The primary focus of the project is the study of QT in liquid Helium. More information on the project can be find at http://qute-hpc.math.cnrs.fr/

Research topic:

Superfluid He is a very low temperature system in which two interpenetrating fluids with different behaviors exist: a normal viscous flow, governed by the Navier-Stokes (NS) equation, and an inviscid (zero viscosity) superfluid flow, introducing quantum effects and governed by the Gross-Pitaevskii (GP) equation. QT is a highly multiscale phenomenon, ranging from Angstrom for the superfluid vortex diameter, to centimeters/meters for the size of the cryostat, which explains why mathematical-physical models and simulations covering accurately all scales do not exist nowadays.

In the framework of the QUTE project, several numerical codes using spectral methods are available to solve the models at the two ends of this multi-scale description: the GP model for the superfluid fraction and the NS model for the normal viscous fluid. Codes implementing the two-fluid HVBK model are also available in the project.

Objectives:

The objective of the postdoc is to address theoretically and numerically the critical gap between a close-up view of the interaction between normal-fluid and quantized superfluid vortices and a coarse-grained representation of QT dynamics. The final goal of the project is to offer a unified theoretical and numerical representation of QT, describing accurately all scales present in the system.

For this purpose, the following steps will be taken:

• Explore existing numerical systems in the QUTE-HPC project to perform large HPC simulations for limiting (GP and two-fluid HVBK) models. Explore QT in the zero-temperature limit (GP model) using high space and time resolution HPC computations going beyond existing simulations. Include thermal effects in the GP model and the GPS (Gross-Pitaevskii Simulator) code.

• Perform HPC simulations with the two-fluid HVBK model. Ensure the HPC compatibility between the (existing) NS solver and the GPS solver.

• Model the coupling between numerical solvers for superfluid (GP) and normal fluid (NS) to simulate the QT system up to the inter-vortex length scale and beyond.

Requirements:

The successful candidate is expected to hold (or about to have) a PhD in the area of computational physics or applied mathematics. Programming experience is essential. Experience in using high-performance computing facilities (HPC) would be an advantage.

Practical information:

Applicants should email a statement of interest, a CV, and a list of publications.

Salary:	$\sim$ 2100 euros net/month,
Location:	Rouen, France,
Dates:	available immediately for 12 months (renewable for another one year),
Contact:	ionut.danaila@univ-rouen.fr marc.brachet@gmail.com

Bibliography (with links when available) :

QUTE-HPC ANR project.

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