Postdoc position

Wave turbulence in geophysics: internal, inertial and water surface waves

Duration: 2 year**,** starting no later than September 2024

Institution: Institute de Physique de Nice (INPHYNI), Université de la Côte d'Azur. Nice, France.

Funding: Simons Foundation international collaboration project "Wave Turbulence".

Contact: Sergey Nazarenko (https://inphyni.cnrs.fr/webpages/sergey-nazarenko)
Giorgio Krstulovic (https://www.oca.eu/krstulovic)

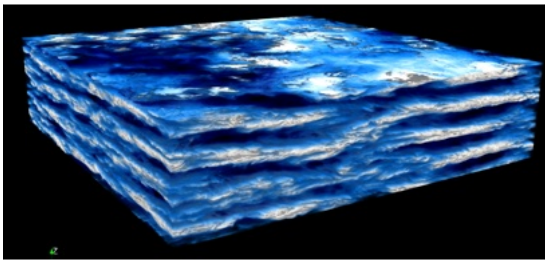
Deadline for application: 30/05/2024

The project:

Waves are one of the most ubiquitous phenomena in Nature. Wave systems are so diverse that they permeate the physical world, from the simplest everyday acoustic sound propagation to internal and inertial waves in the oceans and atmospheres, waves in quantum fluids, Alfven waves in plasmas and many more.

In general, the equations of motion that describe wave systems are not linear, which makes wave dynamics rich, complex and interesting. Waves with different wavelengths interact and excite new waves at different scales, which will again interact with other waves and repeat the process at different scales. In this manner, nonlinear wave systems can transfer energy along scales in a cascade process, leading what we know as wave turbulence. Such complex physics can, fortunately, be understood using the theory of weak wave turbulence. This theory is able to provide analytical predictions for the mean amplitude of waves at different scales, and explain and predict the energy cascade and the evolution of different statistical quantities.

More specifically, the wave turbulence theory furnishes a wave kinetic equation (WKE), analogous to the Boltzmann equation, but where waves at different wave numbers play the role of particles. The rigorous derivation of the WKE, its applications and its predictions have triggered important multi-disciplinary research among mathematicians and theoretical and experimental physicists [1].



Internal waves in a stratified fluid. Simulation made at the Fluid and Plasma Turbulence group of Laboratoire J.L. Lagrange.

Enormous progress has been achieved recently in understanding the wave turbulence theory for several systems, particularly when the system is stationary and in idealised conditions, with forcing and dissipation ranges well separated, wave phases randomised, wave amplitudes weak. Unfortunately, Nature is almost never in such idealised situations. Thus, one has to explore the robustness and validity of the wave turbulence approach beyond the idealised cases and, when this approach starts

[1] See for instance the SIMONS Collaboration Wave Turbulence https://cims.nyu.edu/wave-turbulence/

to fail, try to find extensions and corrections to the WKE descriptions. In addition to predicting the wave spectra, important practical questions arise on how these spectra affect the transport processes, for example mixing by the oceanic internal waves and momentum transfer through the surface by the water waves.

This Postdoc project aims at understanding the propagation and interactions of weakly nonlinear waves in geophysical media. **The main question to understand is how well the non-linear wave systems are described by the respective wave kinetic equations (WKEs). The secondary, but equally important questions are how to correct WKE to adopt it to cases when the idealised theory fails, and how to predict transport processes caused by wave turbulence.** The scientific problem will be addressed using the wave turbulence theory (in both idealised and non-idealised settings) and studying solutions of the associated wave kinetic equations. To complement theoretical predictions, the successful applicant will perform numerical simulations of the wave kinetic equation and the original dynamical equation describing the whole physics. Based on the data arising from numerics, a study will be undertaken on how to improve the WKE description in non-idealised (realistic) situations and how to predict the transport properties. This postdoc position is, therefore, theoretical with an important numerical part using existent numerical codes.

Applicant profile:

Applicants should have some background in fluid mechanics and numerical methods. A good general knowledge of statistical physics and mathematical methods for physics will be appreciated. Additionally, the postdoc researcher will gain knowledge in high-performance computing (HPC) and develop expertise in non-linear physics, statistical mechanics, and fluid mechanics.

Research environment:

The successful applicant will join the team "Nonlinear and Non-equilibrium Physics" led by Sergey Nazarenko, a CNRS researcher at the INPHYNI (https://inphyni.univ-cotedazur.fr/).

The group comprises experts in classical, wave and quantum turbulence, nonlinear optical and biological systems. The successful applicant will also take advantage of already established international collaborations of the group.

In addition, this project will carried out in close collaboration with Giorgio Krustolovic, also a member of the SIMONS Collaboration.

Enquiries and Application Process

To apply for this postdoc position or enquire about the project, please contact Sergey Nazarenko (**Sergey.Nazarenko at** Sergey.Nazarenko at unice.fr) **in the first instance.**

Additional information

The successful applicant will be part of the SIMONS Collaboration Wave Turbulence. Sergey Nazarenko and Giorgio Krstulovic are both members of this international collaboration. The postdoc researcher will be in a rich environment where experts from different countries meet regularly.