Postdoc Position

Wave turbulence simulations and theory

Duration: 2 years**,** starting autumn 2021
Institution: Laboratoire J.L Lagrange. Observatoire de la Côte d'Azur. Université Côte d'Azur.
Funding: Simons Foundation international collaboration project "Wave Turbulence".
Contact: Giorgio Krstulovic (https://www.oca.eu/krstulovic)
Sergey Nazarenko (https://inphyni.cnrs.fr/webpages/sergey-nazarenko)
Deadline for application: 15/06/2021

The project:

Waves are common and important in a vast number of physical systems, from quantum to cosmological scales. Very often, the physical properties pertinent to waves, lead very different physical systems to behave similarly. In general, the equations describing such physical systems are non-linear. As a result, waves at different scales, interact with each other, transferring energy along scales in a cascade process. Because of the similarities with hydrodynamical turbulence, such a phenomenon is called wave turbulence. This is the case for instance of waves on the surface of the ocean, in plasmas, in superfluids and gravitational waves, among many others systems. Many properties of wave turbulence can be studied within the so-called Weak Wave Turbulence approach. Weak Wave Turbulence theory (WWT) describes the evolution of random nonlinear wave fields. The most developed and rigorous part of WWT deals with weakly nonlinear waves, for which one can systematically derive a wave-kinetic equation governing the wave spectrum evolution. Such a kinetic equation can provide analytical predictions that need to be confronted with numerical and experimental data.

This project aims at providing numerical and theoretical support to two experimental groups of the SIMONS Collaboration Wave Turbulence (see below). The following physical system will be studied during this project:

- *Inertia-Gravity waves:* First, waves in vastly rotating fluids will be considered. This study will complement the experimental studies performed at FAST by the group of Pierre-Philippe Cortet. Recent experimental advances of this group allowed them to observe WWT predictions in a rotating fluid by suppressing the "Taylor Columns" (TCs) — strong two-dimensional non-wave motions interaction with which invalidated the WWT assumptions in preceding efforts. For the first time, we will perform numerical simulations of rotating turbulence with suppression of the TCs aiming at validation of both WWT and the mentioned experiment. On the other hand, such TCs do play an important role in practical applications, e.g. in rotating planetary atmospheres. Our second goal will be compute numerically and characterise theoretically interactions of WWT and TCs in rotating fluids thereby generalising the WWT in rotating fluids for description of real life atmospheric wave phenomena. Further, in the second part of the project, we will study internal gravity wave (IGW) turbulence in stratified fluid thereby providing theoretical support to the current experiments of this type at FAST and LEGI in Grenoble (group of Nicolas Mordant). This part will be also performed in collaboration with Pierre Augier from LEGI. In addition to testing the WWT predictions in this case, we will focus on the practically important study of energy transport across the isopycnal surfaces caused by the IGW turbulence (problem

important for the climate modelling). Finally, we will study turbulence in presence of both rotation and stratification—this is the most relevant situation realised in atmospheres and oceans.

Applicant profile:

Applicants should have good theoretical knowledge in fluid dynamics, turbulence, nonlinear waves and/or wave turbulence. Solid experience in numerical modelling of partial differential equations arising in fluid dynamics, turbulence and theory of nonlinear waves is required. Some experience in high-performance computing (HPC) will be appreciated.

Research environment:

The work will be carried out within the framework of the Simons Foundation international collaboration project "Wave Turbulence" (https://cims.nyu.edu/wave-turbulence/people/). The successful applicant will join the team in Nice led by Sergey Nazarenko (Institut de Physics de Nice) and Giorgio Krstulovic (Laboratoire J.L. Lagrange). The successful applicant will also take advantage of experts in classical and quantum turbulence, magnethodrodynamics, plasmas, particle transport, applied mathematics and computational fluid dynamics of both labs. Thanks to the Simons Foundation, the successful applicant will be involved in an intense collaboration with theoretical, mathematical and experimental groups in France, USA, Italy, Brazil and Russia.

Enquiries and Application Process

For more information about this postdoctoral position, please contact Sergey Nazarenko (sergey.nazarenko_at_inphyni.cnrs.fr) and Giorgio Krstulovic (krstulovic_at_oca.eu). In case you are invited to apply, you will be asked to submit the following documentation: cover letter, recommendation letters and your CV through *Portail Emploi CNRS*.

Fundings and additional information

The successful applicant will be fully funded by the Simons Foundation international collaboration project "Wave Turbulence". https://www.simonsfoundation.org/2019/06/04/foundation-announces-simons-collaboration-on-wave-turbulence/