Postdoc Position

Wave turbulence simulations and theory

Duration: 2 years**,** starting early 2020

Institution: Institut de Physique de Nice, Université Côte d'Azur.

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

Contact: Sergey Nazarenko (https://inphyni.cnrs.fr/webpages/sergey-nazarenko)
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Deadline for application: 15/10/2019

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 in a similar way. 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 phenomenon is called wave turbulence. This is the case for instance of waves in the surface of the ocean, in plasmas, in superfluids and gravitational waves, among many others. 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 WTT deals with weakly nonlinear waves, for which one can systematically derive a wave-kinetic equation governing the wave spectrum evolution.

For some non-linear wave systems, WWT predicts an inverse cascade of wave action—a process of propagation of the wave spectrum toward lower wave numbers. These systems include surface waves on deep water, waves described by the Gross-Pitaevskii equation, waves on stretched elastic membranes and gravitational waves described by the vacuum Einstein equations. Moreover, sometimes such a process occurs in an explosive way: the largest scale of the system, no matter how large, is excited in a finite time. In very large systems, WWT can describe only an initial stage of the wave condensation because the WWT assumption of small nonlinearity inevitably breaks down for the explosive inverse cascade before the largest scale is reached. After becoming strong, waves give way to coherent structures. The understanding of the WWT breakdown and the interaction of out-of-equilibrium non-linear waves with coherent structures is one the most challenging of problems form the point of view of mathematics and non-linear and statistical physics.

This project aims at developing solid theoretical foundations for wave turbulence systems and modelling experiments in wave turbulence performed in laboratory by partners of this collaboration. The applicant will perform large-scale numerical simulations of different wave systems and confront numerical and theoretical results coming from WWT. Depending on the candidate profile, kinetic wave equations will also be studied numerically or theoretically.

Applicant profile:

Applicants should have a 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 on high-performance computing (HPC) and/or and use of GPUs 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/