Université de Lille

PhLAM

cnrs

PhD GRANTS 2024

PhD project title: Generalyzed Hydrodynamics of soliton gas

PhD Supervisor: F. Copie / P. Suret

PhD project summary (max. 20 lines):

Localized nonlinear solitary waves, termed solitons in the context of integrable systems, are an ubiquitous and fundamental feature of nonlinear dispersive wave propagation. They exhibit particle-like properties such as elastic collisions and have been extensively studied both theoretically and experimentally. A soliton gas is an infinite ensemble of interacting solitons characterized by random amplitude and phase distributions. The particle like properties of solitons, prompts the natural question of establishing a theoretical framework for the description of soliton gas using the concepts of statistical mechanics.

A relevant framework for such an investigation is provided by the ``generalized hydrodynamics" (GHD). GHD has been recently developed to describe the emergent large-scale behaviors of quantum many-body integrable systems out of equilibrium [1]. GHD provides, for instance, the full space-time profile of expectation values of local observables or the full space-time profile of their correlation functions.

The primary objective of this PhD research is to contribute to the GHD description of soliton gas and develop optical fiber experiments aimed at validating GHD theory. The proposed experiments involve the use of a phase modulator in a recirculating fiber loop, thereby emulating quantum systems described by the one-dimensional nonlinear Schrödinger equation with an external potential. The experimental study encompasses an examination of how the shape of the potential influences the thermalization of the soliton gas.

[1] Olalla A. Castro-Alvaredo *et al.*, Physical Review X 6, 041065 (2016)