Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

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Amphithéâtre de l'IPVF

Valentin GOBLOT

"Polariton quantum fluids in 1D synthetic lattices: localization, propagation and interactions"

Jury members :

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Abstract :

Semiconductor microcavities have emerged as a powerful platform for the study of interacting quantum fluids. In these cavities, light and electronic excitations are confined in small volumes, and their coupling is so strongly enhanced that optical properties are governed by hybrid light-matter quasiparticles, known as cavity polaritons. These quasiparticles propagate like photons and interact with their environment via their matter part. They can macroscopically occupy a single quantum state and then behave as an extended coherent nonlinear wave, i.e. as a quantum fluid of light.

In this thesis, we study the nonlinear dynamics of polariton quantum fluids in various one-dimensional microstructures. The possibility to etch microstructures out of planar cavities, a technology developed at C2N, allows full engineering of the potential landscape for the polariton fluid, and implementing complex geometries. In a first part, we have studied the localization properties of the eigenstates in synthetic quasiperiodic lattices. Theoretical exploration of the localization phase diagram revealed a novel delocalization-localization transition in an original deformation of a quasicrystal and we have experimentally evidenced this transition. A second part of the thesis is dedicated to the study of the nonlinear dynamics of two counterpropagating polariton fluids in a one-dimensional channel. The interplay between kinetic and interaction energy is responsible for the formation of dark solitons, whose number and position can be controlled by optical means. We have evidenced a bistable behaviour controlled by the phase twist imprinted on the two fluids. The last part of this work addresses the study of nonlinearities for a fluid injected in a flat band. Therein, the kinetic energy of the fluid is quenched, so that propagation is frozen. We then observe the formation of nonlinear domains with quantized size.