PhD proposal on

Condensation of Photons with atomic vapors

At Institut de Physique de Nice

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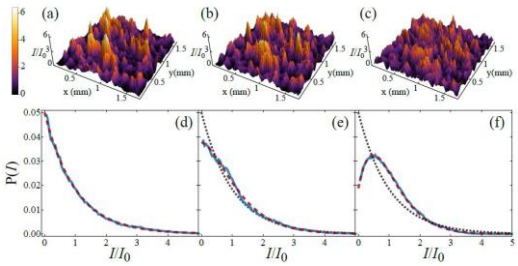
Bose-Einstein condensation has been reported in a variety of quantum systems, such as ultracold atoms and molecules, exciton polaritons, where the bosonic character of the particles is crucial. On the other hand, it is known that an ensemble of classical waves can exhibit a phenomenon of condensation [1], whose thermodynamic properties are analogous to those of the genuine quantum Bose-Einstein condensation, despite the classical nature of the system. Indeed for waves traveling in random directions in a nonlinear medium, wave thermalization and condensation can occur. Such spontaneous formation of large scale coherent structures is encountered in many fields of physics, such as astrophysics, low-temperature condensed matter, hydrodynamics, plasma physics and optics. Here we propose to exploit an experimental system allowing us to study the time evolution of such wave condensation in two dimensions. In contrast to ultracold atom experiments, the wave under consideration is the electromagnetic field of a laser beam, rendered spatially incoherent by passing through a diffuser. Recently we have studied the initial evolution of random waves with Gaussian statistics using atomic vapors as an efficient two dimensional nonlinear medium. Experimental and theoretical analysis of near field images reveal a phenomenon of nonequilibrium precondensation, characterized by a fast relaxation towards a precondensate fraction of up to 75% [2]. Such precondensation is in contrast to complete thermalization to the Rayleigh-Jeans equilibrium distribution.



Reduction of speckle fluctuations as a signature of precondensation

The next step is to study thermalization looking into the far field and the classical analogue of the Berezinskii-Kosterlitz-Thouless transition (in 2D) or to study turbulent like flow in 2D. This PhD is mainly experimental but numerical studies are highly encouraged with collaborations in Nice, France and Brazil.

[1] Condensation of Classical Nonlinear Waves, C. Connaughton, C. Josserand, A. Picozzi, Y. Pomeau and S. Rica, Phys. Rev. Lett. 95, 263901 (2005).
[2] Non-equilibrium precondensation of classical waves in two dimensions propagating through atomic vapors, N. Santic, A. Fusaro, S. Salem, J. Garnier, A. Picozzi, R. Kaiser, Phys. Rev. Lett. 120, 055301 (2018).

Funding is provided by the Flagship project 'Phocus'.
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And look at http://www.kaiserlux.eu/coldatoms for further information on our group.