Wave dynamics and superfluidity of light in a hot atomic vapor

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A laser field propagating through a hot atomic vapor leads to a third-order nonlinear Kerr susceptibility. In the paraxial approximation the evolution of the transverse electric field is described by a 2D Gross-Pitaevskii equation. As such, this system is a promising platform to study phenomena related to Bose-Einstein condensation and superfluidity of light.

In this talk, we will report on the measurement of the dispersion relation of small amplitude density waves propagating on top of a photon fluid. We find a dispersion relation of Bogoliubov type: linear at small wave vector as expected in the superfluid regime and "particle-like" (quadratic) at larger wave vectors. In the superfluid regime, we characterize the dependence of the sound velocity with intensity (photon density) and compare our results with theoretical predictions.

When the perturbation on top of the photon fluid becomes large, it can propagate faster than the local speed of sound. This leads to the generation of dispersive shock waves. We will discuss and analyse the peculiar dynamics of these waves and confront our observations to analytical and numerical models.

Finally, we will discuss the potential application of this fluid of light to measure correlations that are analogous to spontaneous Hawking radiation.

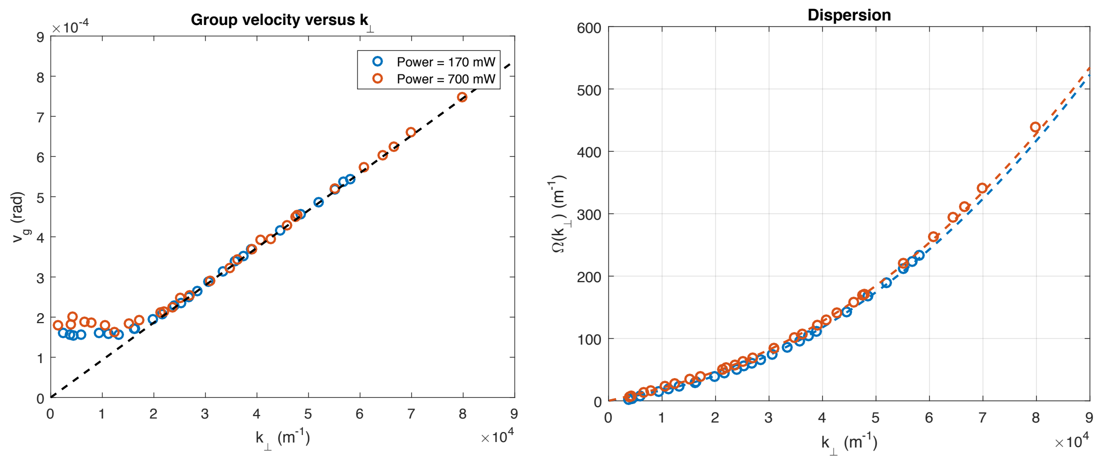

Figure : Left : group velocity as function of wavevector. Right : dispersion relation reconstructed from the group velocity measurement. Dashed lines are the best fit to the Bogoliubov dispersion relation.