Fluids of light: from hydrodynamics to quantum phase transition

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Under specific conditions, photons could behave as a quantum gas with interaction, we refer this as a "fluid of light". In this talk, we present an experimental platform for fluid of light in a hot Rubidium vapor [1] allowing to model 2D+1 Hamiltonians using all-optical control. Using full-field retrieval of the quantum fluid, we are able to measure momenta distributions and hydrodynamical observables and use this information to probe the superfluid transition [2, 3] in a time-resolved manner. We also engineer the quantum fluid to study the dynamics of quantized vortices and scale it towards the study of turbulence [4]. Finally, we present future direction of the field on quantum phase transition.

[1] Glorieux, Q. et al. Hot atomic vapors for nonlinear and quantum optics. New Journal of Physics 25, 051201 (2023).

[2] Huynh, J. et al. Two-dimensional superflow past an obstacle of arbitrary penetrability: Exact results for the critical velocity 2023. arXiv: 2305.01293.

[3] Michel, C. et al. Superfluid motion and drag-force cancellation in a fluid of light. Nat. Comm. 9, 2108 (2018).

[4] Abobaker, M. et al. Inverse energy cascade in two-dimensional quantum turbulence in a fluid of light 2022. arXiv: 2211.08441.