Soliton and vortex dynamics in quantum fluid of light using hot rubidium vapor

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Turbulence is common in nature, occurring in environments ranging from the ocean to financial markets, and at all scales, from quantum fluids to our own galaxy.
In quantum fluids, turbulence characterized by macroscopic vortex dynamics has been observed [1,2], exhibiting similar scaling laws in energy spectra as in classical fluids. However, in highly chaotic systems, vortices may annihilate each other, resulting in a fully wave turbulent regime [3]. Investigating the microscopic dynamics between quantum vortices can provide insights into the transition from vortex turbulence to wave turbulence.
Our project aims to experimentally realize and study the temporal dynamics of a two quantum vortices configuration using the quantum fluids of light platform. Specifically, we create a fluid of light by propagating a near-resonant laser into a hot atomic vapor and map the evolution of the electric field to that of a 2D superfluid.
We focus on the interaction of a dipole vortex (opposite sign vortices) in a hot atomic vapor. This setup allows us to observe the decay of the dipole into a quasi-soliton and study its behavior over time [4] in a quantum setting, within a fully controllable and measurable environment due to the extensive quantum detection toolbox available. This work offers a natural pathway for the experimental investigation of instabilities and out-of-equilibrium dynamics in light superfluids and wave turbulence.

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