SUPERFLUIDITY OF LIGHT IN QUANTUM OPTICAL SYSTEMS

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Summary

To test theoretical models in fundamental physics when experimental data is inexistent is one of the struggles of modern physics. In this context, the similarity between the mathematical model for light propagation in the paraxial approximation and models from other areas of physics offer an exciting opportunity to realize tabletop analogue experiments to test concepts that otherwise remain hypothetical.

In the past three years, the hydrodynamic description of light, which maps the laser intensity into a fluid density and the spatial phase gradient into a fluid velocity, has captured a renovated interest of a scientific community due to the apparent superfluid properties of light[1,2,3]. Still, the realization of these experiments strongly depends on the optical properties of the media, which are usually fixed. In this work we explore theoretically how quantum atomic optical systems, can be manipulated as a highly tunable optical media, with enhanced nonlinear properties due to quantum coherence phenomena. Moreover, we introduce the hydrodynamic description of light and the concepts of superfluidic behavior of light, and review some of computational tools developed using GPU-enhanced platforms. Finally, we discuss how the versatility of such systems can be used to develop new optical analogue experiments and address other phenomena yet to be explored, such as the case of persistent currents, two-stream instability and rotons[5,6].

References:

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