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Quantum fluids of light and quantum nonlinear optics in photonic nanostructures

Nanostructured materials display enhanced optical nonlinearities, allowing to study several intriguing phenomena in condensed matter systems, ranging from fundamental studies on the quantum fluid properties of electromagnetic radiation to single-photon nonlinear behavior, which may ultimately be exploited in prospective quantum information processing applications.

In the first part of the poster I will review recent works showing Bose-Einstein condensation of electromagnetic excitations in topologically-protected bound-states; based on these studies, an exotic “supersolid” phase due to parametric scattering from the condensate into finite momentum side-branches has been recently realized. These findings enable exploration of exotic matter phases through photonic lattice engineering.

In the second part of the poster, I will show how such enhanced nonlinearities can be exploited to achieve quantum operations at the single photon level in quantum photonic interferometers on-chip, suitably engineered through machine learning optimization, opening the route to exploitation of quantum states of light for quantum computing tasks.

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