Quantum Fluids of Interacting Photons

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Date: 9 January 2020, Thursday  
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Host: Professor Xiong Qihua  
Assistant Professor Timothy Liew

Abstract

There is a growing interest in the study of polaritonic systems, mixed states of photons and excitons, for both, the observation of quantum macroscopic phenomena, and the realisation of all-optical devices that could offer limitless advantages in terms of energy consumption, dissipation-less operation and high clock frequencies. More recently, by entangling one photon with one polariton, it has even been shown that these quasiparticles can also be ideal carriers of quantum information.

Here we show several macroscopic quantum phenomena that can be observed in polariton condensates, both at low temperature, in inorganic semiconductor microcavities— for which the very long lifetime can show behaviour associated to the Berezinskii-Kosterlitz-Thouless (BKT) regime, typical of 2D equilibrium system and in organic based polaritons, where superfluidity can be observed at room temperature in spite of the marked open, driven dissipative, nature of these polariton condensates. We also show the possibility of using hybrid semiconductors with reduced dimensionality to achieve the regime of highly interacting polaritons. These materials include monocrystalline two-dimensional perovskites and transition metal dichalcogenides that have demonstrated nonlinear responses up to those of low temperature inorganic semiconductors. Finally, we will show how such nonlinear systems could be used as hardware implementation of neuromorphic computing and eventually speculate on the possibility to reach the genuine quantum regime using single polaritons as quantum bits for the implementation of photonic nonlinear quantum devices.

Short Biography

Prof. Daniele Sanvitto is director of research at the Institute of Nanotechnology of the Italian National Research Council (CNR) and head of the group of Advanced Photonics, which he founded in 2010. After graduating in Rome "La Sapienza" and obtaining his Ph. D from the University of Cambridge, UK, he took up several fellowships (among which the Marie Curie and the Ramon y Cajal) in several European institutions, including the Institut Jacques Monod in Paris, the University of Sheffield in UK and the Universidad Autonoma de Madrid, in Spain where he held a tenure professorship until he was hired by the Italian Centre for National Research (CNR) as distinguished scientist to establish the group in Lecce. His research interests concern the studies of strong light matter coupling in semiconductors and nanostructures, plasmonics and quantum optics. In particular his recent activities include the study of quantum fluids of polaritonic particles on semiconductor heterostructures as well as different organic and hybrid material systems.