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Room-temperature quantum fluids of light (I)

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In the strong light-matter coupling regime, energy is reversibly exchanged between the electromagnetic field and the polarization field. A microscopic description of this regime is usually presented in terms of hybrid light-matter quasiparticles called polaritons. These quasiparticles have a number of fascinating properties such as an ability to undergo Bose-Einstein condensation at high densities and possess very strong optical nonlinearities due to their matter component. For nearly two decades, the platform of choice for studying polaritons has been planar semiconductor microcavities composed of group III-V quantum wells. Unfortunately in these materials, exciton binding energies are well below kT and most polaritonic phenomena can only survive at low-temperatures.

We will describe semiconductor microcavities composed of organic semiconductors and two-dimensional (2D) materials where polaritonic phenomena can survive at room-temperature. Using these, we have recently demonstrated a broad range of nonlinear phenomena such as Bose-Einstein condensation of polaritons, room-temperature superfluidity, tunable third harmonic generation and polariton diodes. We will showcase some of the recent demonstrations and outline future steps for realizing polariton devices based on a room-temperature semiconductor platform.

Author: KENA-COHEN, Stéphane (Polytechnique Montreal)

Presenter: KENA-COHEN, Stéphane (Polytechnique Montreal)

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