DOCTORAL DEFENSE

Bose-Einstein Condensation of Polaritons in a Ring Microcavity

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Abstract: Excitons are bound states of electrons and holes formed when light is absorbed in a semiconductor. They have a radiative lifetime typically of the order of a few nanoseconds. Putting these excitons inside a cavity allows them to mix strongly with the cavity photons, which creates a new quasi-particle called an exciton-polariton. These dressed photons have a small effective mass and an effective repulsive interaction, allowing them to thermalize and undergo Bose-Einstein condensation within their lifetime.

In this talk, I will present some recent experiments which I performed in the Snoke group on Bose-Einstein condensation of exciton-polaritons in a ring-shaped semiconductor microcavity. In a first set of experiments, the ring geometry along with a unidirectional force acting on the polaritons helped us realize the rigid rotor potential for the polaritons. Exciton-polaritons are monitored by detecting the photons leaking from the microcavity allowing us to observe real-time dynamics of the polariton condensate in the potential. I observed pendulum-like oscillations of the polariton condensate which were damped about the potential minimum. By measuring the temporal evolution of the density and the spectral energy shift of the polariton emission, I made a direct measurement of the polariton-polariton interaction strength. In the course of these measurements, I found a non-equilibrium population of excitons travelling much further than previously anticipated, which demonstrates the anomalous ``polariton effect'' on the transport of excitons. The polaritons constitute an example of a pseudospin-1/2 Bose gas which shows distinct properties from electrons in a semiconductor. By quenching a gas of polaritons in the rigid rotor potential I observed the spinor dynamics, which showed characteristics of the optical spin hall effect, as the highly excited polariton gas thermalized in the trap. The role of the exciton and the free carrier reservoir on the energy dissipation of the condensate is theoretically investigated and is applied to the interpretation of the recently observed ``polariton drag effect", in our group, in which driving an electric current through the neutral polariton condensate produced momentum and energy shift of the condensate. These experimental and theoretical studies on transport and equilibration of the polariton condensate in narrow waveguide microcavities are a step towards making coherent polariton circuits for optical information processing.