Universität Regensburg

FAKULTÄT FÜR PHYSIK

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Elektronische Eigenschaften von
Nanostrukturen auf Kohlenstoffbasis

Einladung

zum

Seminartag

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"Bose-Einstein Condensation in a Polymer: Towards Quantum Simulation"

Abstract:

During recent years polaritonics has emerged as a new field of solid-state physics based on the unique quantum properties of mixed light-matter quasiparticles, so called exciton-polaritons. Recent discoveries of Bose-Einstein condensation (BEC) and superfluidity provide opportunities to harness these coherent quantum effects in a new generation of opto-electronic devices. Until now BECs have been realized either with laser-cooled gases at nano-Kelvin temperatures or with high-quality semiconductor crystals produced by only a few laboratories worldwide. By utilizing the extremely large oscillator strength, exciton binding energy and saturation density of organic semiconductors we demonstrate BEC at room temperature in a polymer. Since no crystal growth is involved, our approach radically reduces the complexity of experiments to investigate BEC physics and paves the way for a new generation of opto-electronic devices, taking advantage of the processibility and flexibility of polymers.

In a microcavity with a spin-coated thin layer of ladder-type conjugated polymer (MeLPPP) embedded between dielectric distributed Bragg reflectors, we observe the avoided crossing of the cavity mode with the exciton energy characteristic of the strong coupling regime. We create exciton-polaritons by off-resonant excitation with incoherent picosecond laser pulses. At room temperature thermalization of these quasi-particles occurs while it is suppressed at low temperature because of a relaxation bottleneck. Above a certain excitation threshold, we observe the emergence of non-equilibrium BEC in the lower polariton branch. This is evidenced by several distinct features such as a blue-shifted emission peak at zero in-plane momentum, accompanied by a nonlinear increase in the emission intensity and a sudden drop of the linewidth. Furthermore, the emission becomes polarized and the emission dynamics is drastically shortened. In contrast to conventional lasing, we find a strong increase in threshold when decreasing the temperature, which can be explained by the peculiar thermalization properties. Spatially-resolved measurements with a Michelson interferometer show a macroscopic phase relation over almost the whole excitation area. In addition, experiments on sub-micron sized defect cavities, a first step towards realizing potential landscapes for polaritons, will be discussed. In combination with tunable Gaussian-defect cavities, this opens the door to study quantum fluids at room temperature in strongly confined geometries and arbitrary potential landscapes that can mimic crystal lattices.

Gastgeber: Prof. Dr. John Lupton