Contribution ID: **267** Type: **Oral (Student, In Competition) / Orale (Étudiant(e), inscrit à la compétition)**

Ultrafast relaxation of exciton-polaritons in organic microcavities

Tuesday 17 June 2014 16:30 (15 minutes)

Exciton-polaritons are half-light, half-matter quasi-particles formed by excitons strongly coupled to the confined electromagnetic field of a microcavity. Their very low effective mass ($< 10^{-4}m_e$) and their bosonic character allows a phase transition to a Bose-Einstein Condensate (BEC) at relatively high temperature. Quantum effects such as spontaneous macroscopic coherence and superfluidity can then be observed. The proprieties of a BEC in inorganic quantum-well microcavities are well understood, but this effect in organic materials has not been clearly demonstrated. However, the large oscillator strength and the high exciton binding energy in such materials should allow formation of polariton condensates at higher temperature than achieved in inorganic microcavities and even to reach room temperature.

In this presentation, I will describe our recent experimental efforts to reveal dynamics of polariton-polariton coupling in organic-semiconductor microcavities, which leads to the formation of quantum condensates. We employ two-dimensional electronic coherence spectroscopy (2D-ECS), an ultrashort technique belonging to the family of 2D Fourier spectroscopy. This technique uses a sequence of four ultrafast pulses with controlled spectral phase and delay to excite coherently a material system. Each pulse modifies the quantum states of the system in a known way. The signal emitted after the pulse sequence permit to build a correlation map revealing the nature of the coupling between different energy level. In our microcavities, it allows to probe polariton-polariton interactions along the dispersion curve, which ultimately leads to the formation of a BEC.

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Session Classification: (T3-6) Control of dynamical properties- DCMMP / Contrôle de propriétés dynamiques - DPMCM

Track Classification: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)