

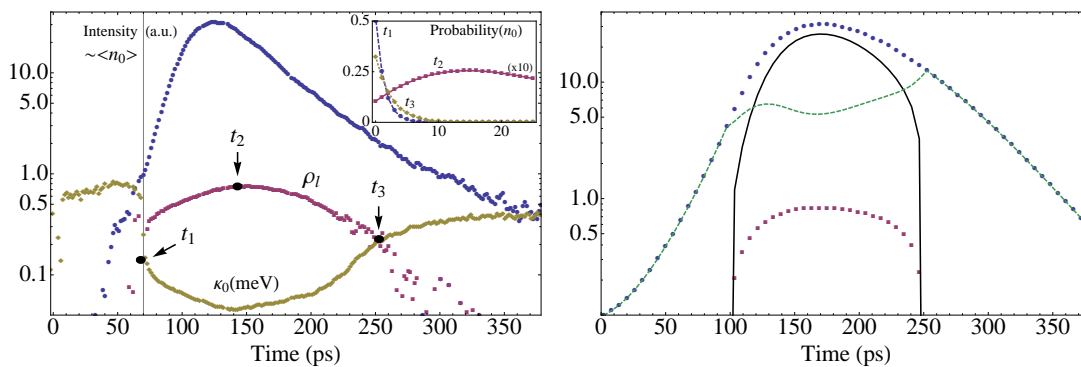
# Dynamics of formation and decay of coherence in a polariton BEC

E. del Valle, D. Sanvitto, A. Amo,  
D. Ballarini, F.P. Laussy, C. Tejedor, L. Viña.

Departamento de Física Teórica (C–V) y de Materiales (C–IV),  
Universidad Autónoma de Madrid, 28049, Madrid, Spain.

We report on the experimental observation of polariton BEC dynamics, by studying simultaneously the time resolved photoluminescence and the degree of linear polarization  $\rho_1$  [1]. We monitor the evolution of the condensate coherence from its spontaneous appearance till its complete decay (left figure). High energy polaritons are injected via a circularly polarised picosecond pulsed laser, and quickly relax into the ground state where they Bose condense. This is evidenced by the emission of linearly polarised light, whose degree provides an order parameter for the BEC transition [2]. After reaching a maximum value of about  $\rho_1 = 74.5\%$ , the order parameter goes to zero as the population decays (polaritons have a short lifetime at  $k = 0$ ), but with a different rate.

We support these experimental results with a simple model that contains all the ingredients to reproduce qualitatively this process (right fig.). We provide the quantum state of the ground state polaritons (inset of left fig.) and show that a coherent fraction can be extracted (right fig.) from the degree of linear polarization, explaining the lag between the linear polarization degree (coherence) and the total population of the ground state. We discuss the possibilities that polaritons open for investigation of out-of-equilibrium quantum phase transitions.



**Left:** Experimental results on the dynamics of BEC formation after the arrival of the non-resonant pulse. In blue dots, the population of the bottom of the lower polariton branch (photoluminescence intensity normalised so that the phase transition happens when  $\langle n_0 \rangle \approx 1$ ); in brown rhombus, the linewidth (in meV) of the emission peak; and in purple squares, the linear polarization degree, order parameter of the phase transition. In inset, the theoretical distribution of particles in the ground state corresponding to times marked with circles  $t_{1,2,3}$  in the plot. The phase transition occurs around the vertical line. **Right:** Theoretical dynamics with the same code of markers. The lines correspond to the extracted condensate (solid black) and thermal (dashed green) fractions.

[1] A. Amo *et al.*, unpublished.

[2] F. P. Laussy *et al.*, *Phys. Rev. B* **73**, 035315 (2006).