Implementation of an *AND* gate with Bose-Einstein polariton condensates

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The use of polariton condensates in all optical logic devices has been the subject of intense research in recent years, promising ultrafast switching times, low losses, spin information transport and low power consumption.[1,2] In this communication we report on the realization of a novel *logic AND gate* mediated by **propagating Bose-Einstein exciton-polariton condensate bullets** in a quasi-1D semiconductor microcavity.

The combination of two 2 ps-long, quasi-resonant light pulses [dubbed A and B, separated by a distance of 50 μm and delayed by 80 ps, see Fig. 1(i)] *optically controls* the switch response. The system dynamics is fully studied both in momentum and real space, and at different emission energies, obtaining a complete account of the velocities [Figs. 1(a-c)] and positions [Figs. 1(i-iii)] of the polariton bullets as well as of their energy relaxation. The operation of a related switch, using the same sample, has been published recently.[3]

The ON state of the gate is constituted by a long-lived (~200 ps) trapped polariton condensate at the border of the ridge [Fig. 1(iii)]. The ignition of this state is mediated by the parametric scattering between two oscillating polariton bullets that are enclosed in a half-parabolic potential [Fig. 1(ii)]. This potential is sculpted by the border of the ridge and the photo-generated excitonic barrier of pulse B.[4] Our data also reveal the amplification of the polariton bullets intensity, arising from stimulated relaxation of reservoir excitons into the polariton condensate. Finally, coherent interference phenomena between polariton bullets, in real and momentum spaces, are evidenced [Figs. 1(b,ii)].

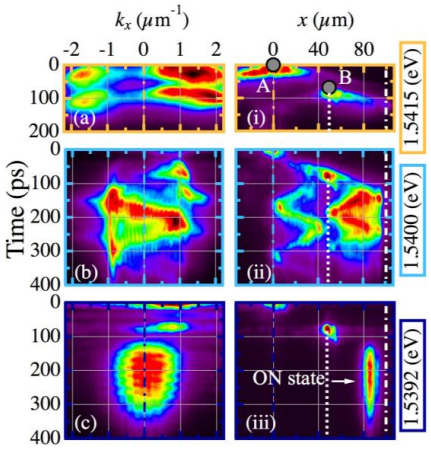

Figure 1. Emission in momentum/real space along the k_x/x-axis parallel to the ridge versus time in the left/right column for different energies. The grey dots in (i) mark the coordinates of the laser beams. In the right column the vertical lines depict the positions of the barriers created by the pulsed laser A, B and by the edge of the ridge, respectively. The upper row shows the movement of short-lived hot polaritons. The S-shaped profiles (ii) arise from the oscillation of these bullets bounded by the barriers. The oscillations are also seen in momentum space (b); mutual coherence between bullets propagating at the same speed is demonstrated by the appearance of interference fringes. The bottom row shows the ON state of the *AND* gate constituted by a trapped condensate (iii), which weakly oscillates at the bottom of the half-parabolic potential (c).

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