Nonlinear 2D Semiconductor Photonic Crystals

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Abstract: Experimental results demonstrating strong nonlinear effects due to manipulation of photonic modes in 2D photonic crystals slabs show the potential of these objects as platforms for reconfigurable photonic circuits.

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2D photonic crystals (PC) constitute an unique platform for low power and versatile nonlinear optical interactions, due to their potential for engineering the photonic modes. Indeed, the control of phase and group velocities gives a handle on the electromagnetic field localisation, nonlinear refractive index, phase matching etc.

After a brief summary of the main nonlinear optical assets of 2D PCs and a review of recent progress on nonlinear operation of 2D PCs, we will present our experimental results. We have experimentally demonstrated the strong nonlinear effects that we predicted theoretically both in InP and GaAs based semiconductor 2D PC slabs. Some illustrative demonstrations such as large frequency shifts via intrinsic or resonant optical Kerr effect, amplification and switching will be presented. All of these effects are obtained using low pump powers, which under certain conditions, display ultrafast behaviour.

Finally, we will discuss how these results constitute the first steps towards versatile multifunctional devices, that is single PC platforms where optical response is reconfigured at will via nonlinear interactions.