Nontrivial Physics with Noninteracting Polaritons

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Exciton-polaritons ("Polaritons") in microcavities [1] are raising-stars in condensed-matter/solid-state optics, renowned mainly for two attributes: their bosonic properties (stimulation, condensation, coherent states, etc.) and their nonlinearities (inherited from exciton interactions). The latter has spurred considerable interest for polaritons as strongly-correlated quantum fluids [2] and promise great applications in quantum information processing as the long-sought strongly-interacting photons. Yet, polariton interactions are still largely unknown despite numerous in-depth investigations, sometimes with contradicting conclusions [3]. In parallel, recent years gave prominence to other aspects of the polariton dynamics that lead to nontrivial physics even in absence of interactions, powered instead by non-hermiticity brought by their dissipation [4], by blueshift from the exciton reservoir [3], by band-engineering [5], by Rabi [6] and Josephson dynamics [7], by emulates of oblique dark and half solitons [8], by topological edge modes [9], by interferences implementing Hebbian learning [10] or by fractional quantum-mechanical effects [11] to name a few but illustrative examples of variations on the *U=0* Schrödinger equation.

In this talk, we will focus on likewise nontrivial effects in the simplest possible polariton configuration, reduced to their most elementary expression as two coupled Schrödinger fields (no interactions, no potentials, no dissipation, etc.) We will show how, while they feature robust aspects of waves (i.e., in reciprocal space), they have a tricky structure as particles (i.e., in real space), for instance, a localized polariton is intrinsically a delocalized object in its exciton/photon components, or, equivalently, the localization of one field forces delocalization of the other (cf. Fig. 1). We will show how such a structure imposes strong constrains on the particles, including lifting the degeneracy between inertial and diffusive masses, imposing maximum velocities and a mass-wall that folds back wavepackets onto themselves resulting in "self-interfering polaritons" (SIP) [12], a variant of self-accelerating packets.

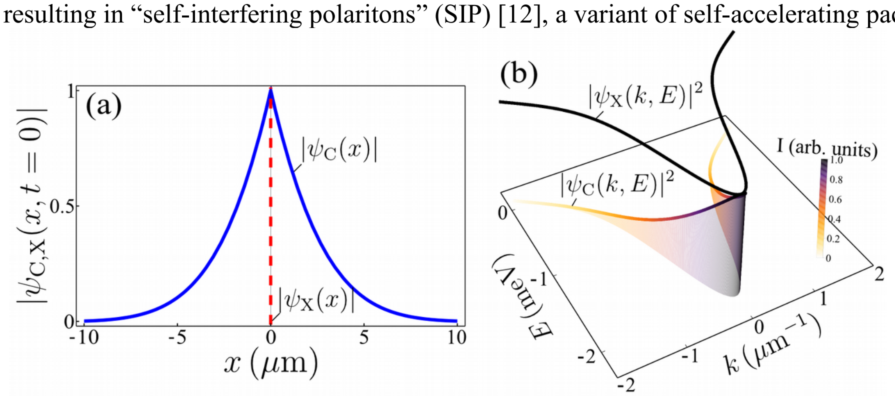

Figure 1. A lower-polariton wavepacket in (a) real space and (b) reciprocal space as seen through its photonic (solid blue/filled curve) and excitonic (dashed red/plain black line) components, here when localizing the exciton. The photon gets smeared out into a dented distribution to maintain the particle on its branch. Such a structure of the polariton particles has several consequences for their dynamics in space-time.

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