Polaronic polariton quasiparticles in a dark excitonic medium

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Microcavity exciton-polaritons are neutral quasiparticles, hybrid between matter and light, that arise from the strong coupling between semiconductor excitons (bound electron-hole pairs) and cavity photons. The investigation of these systems has become a vast research field [1, 2, 3] which continues to grow nowadays with the appearance of novel two-dimensional semiconductor materials [4, 5]. However, the creation of polaritons in semiconductor microcavities is often accompanied by the appearance of an incoherent bath of optically dark excitonic states that can interact with polaritons via their matter component. In this talk, I shall present a recent theoretical work [6] in which we show that the presence of such a dark excitonic medium can "dress" polaritons with density fluctuations to form coherent polaron-like quasiparticles, thus fundamentally modifying their character.

We employ a Green's function approach that naturally incorporates correlations beyond the standard mean-field theories applied to this system. With increasing exciton density, we find a reduction in the light-matter coupling that arises from the polaronic dressing cloud rather than any saturation induced by the fermionic constituents of the exciton. In particular, we observe the strongest effects when the spin of the polaritons is opposite that of the excitonic medium. In this case, the coupling to light generates an additional polaron quasiparticle—the biexciton polariton—which emerges due to the dark-exciton counterpart of a polariton Feshbach resonance. Our results can explain recent experiments on polariton interactions in two-dimensional semiconductors [7] and are in qualitative agreement with recent observations of Bose polaron polaritons [8].

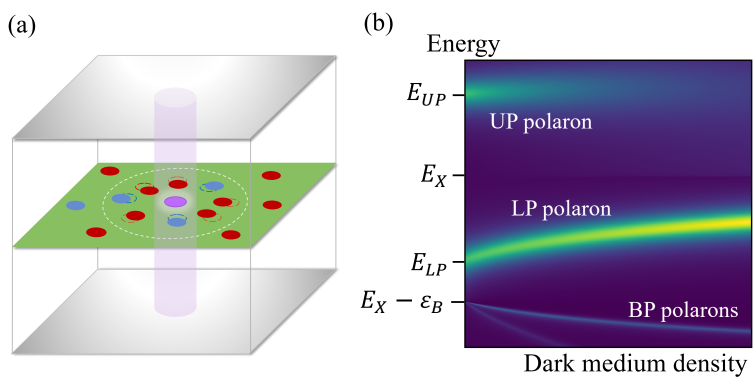

Fig. 1. (a) Sketch of a polaron quasiparticle in a semiconductor optical microcavity. (b) A typical energy spectrum at zero photon-exciton detuning with increasing dark medium density.

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