Polaronic polariton quasiparticles in a dark excitonic medium

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Exciton polaritons are hybrid particles of excitons (bound electron-hole pairs) and cavity photons, which are renowned for displaying Bose Einstein condensation and other coherent phenomena at elevated temperatures. However, their formation 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. Here 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 many-body 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. As shown in the figure, our calculations can explain recent experiments on polariton interactions in two-dimensional semiconductors [2]. Our results potentially provide a route to tailoring the properties of exciton polaritons and their correlations.

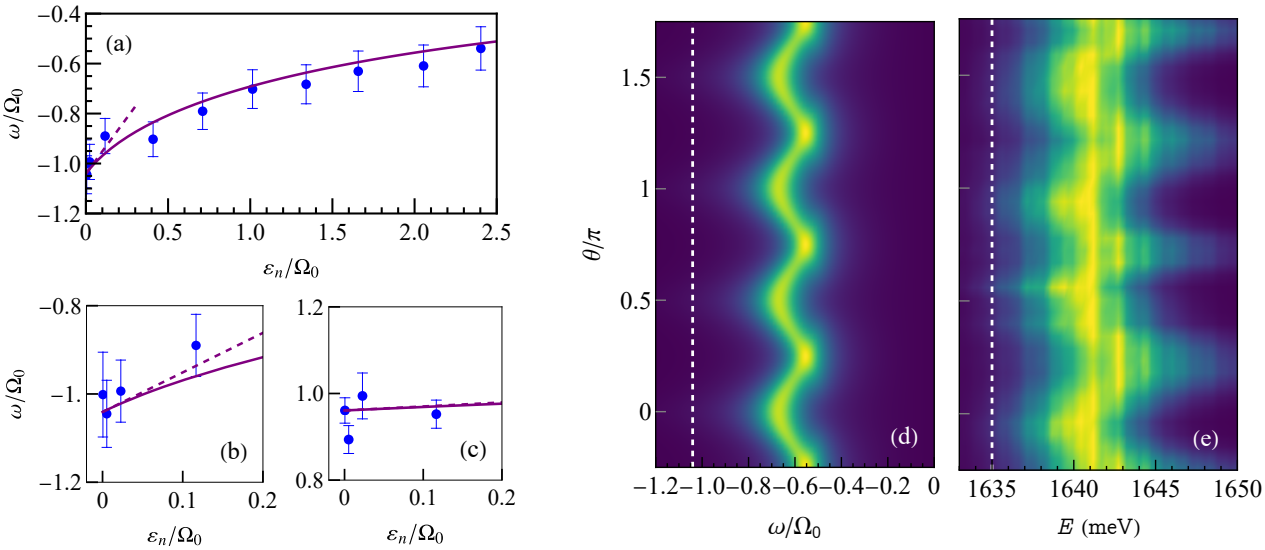

Figure 1: Comparison to experimental results (blue symbols) in [2] for (a-c) linear polarization and (d,e) varying polarization. (d) is theory and (e) experiment. (a,b,d,e) Lower polariton and (c) upper polariton.

References

[1] Kenneth Choo, Olivier Bleu, Jesper Levinsen, Meera M. Parish, *Physical Review B* **109**, 195432 (2024)

[2] P. Stepanov, A. Vashisht, M. Klaas, N. Lundt, S. Tongay, M. Blei, S. Höfling, T. Volz, A. Minguzzi, J. Renard, C. Schneider, and M. Richard, *Phys. Rev. Lett.* **126**, 167401 (2021)

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