CHARGE-IMBALANCED POLARITON CONDENSATES

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Polariton condensation is a well-established phenomenon featuring all the signatures of an ordinary condensate: U(1) symmetry breaking, superfluidity, vortices [1]. However, in the context of polariton condensation, almost exclusively balanced systems, with equal densities of electrons and holes, have been studied. This misses a whole class of potential exotic imbalanced condensed states like an FFLO in superconductors [2,3] or a breached-pair state proposed in the QCD systems [4].

Inspired by pioneering works on imbalanced electron-hole systems (due to applied bias voltage) in TMDC monolayers strongly coupled to a cavity photon [5], we explore whether a combination of strong matter-light coupling and electric field biasing promotes imbalanced condensed states, which do not exist otherwise. To address this question, we use a variational mean-field approach [6] to construct a finite temperature phase diagram.

On top of a balanced polariton and a dark imbalanced FFLO condensates, we find novel imbalanced polaritonic states with coexisting polariton condensate and unpaired electrons with either isotropic or anisotropic Fermi surface (see Fig. 1) depending on applied bias voltage. These states arise due to combination of strong matter-light coupling and long-range Coulomb potential. Moreover, akin to a usual balanced polariton condensate, these new states are stable at high temperatures (within a mean-field approximation).

Therefore, we predict new imbalanced polariton states, which should be possible to observe in an existing experimental platform of electrically biased TMDC monolayers.

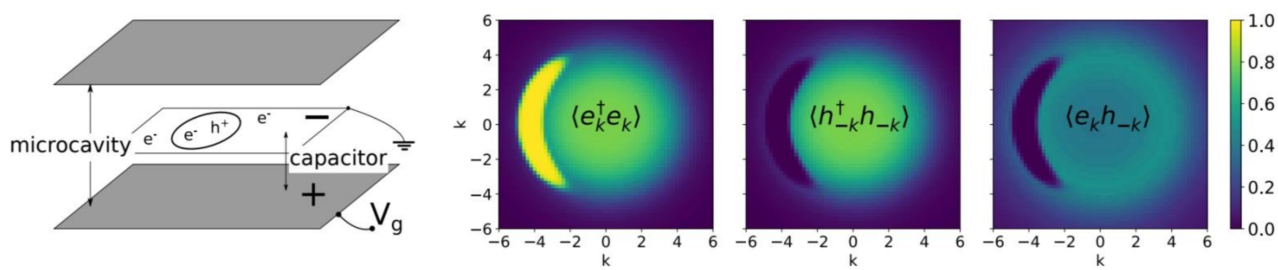

Fig. 1. Crescent state. From left to right: system cartoon, electron and hole mode populations, coherence in the momentum space.

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