Coherent population oscillations and an effective spin-exchange interaction in a PT symmetric polariton mixture

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ABSTRACT

Exciton-polaritons are elementary excitations of semiconductor microcavities. These hybrid quasiparticles consist of strongly coupled light (cavity photons) and matter (quantum well excitations), retaining the properties of both constituents. Here, we study a two-species mixture of exciton-polaritons with self- and cross-interaction nonlinearities in a double well structure. We identify the condition between the pumping rate and losses which render the system PT-symmetric and study its dynamic and static properties. Our analysis shows long-term, nearly perfect Rabi-like oscillations of the two polariton components between the two wells, when the system lies in the PT symmetric phase. Moreover, the system can be formally mapped on a quantum system of two-qubits (spin-1/2 particles), coupled via exchange interaction, and it can simulate quantum state transfer with high fidelity, despite being essentially a classical system of coupled BECs. Our work could open the prospects for analog simulations of interacting few- and many-body quantum systems with coupled exciton-polaritons in lattice potentials.