Majorana bound states in Kitaev chains coupled to cavity photons

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Abstract

The entanglement of electronic states with quantum light in cavity embedded systems has opened new avenues to manipulate quantum materials. In this work we investigate the Kitaev chain coupled to a single mode photonic cavity. Using exact diagonalization we calculate the many-body energy spectrum of the electron-photon Hamiltonian in short Kitaev chains. We find in the non-trivial phase that while the ground state energies are insensitive to cavity coupling, even in the low frequency regime, higher excited states show strong dependence with the cavity coupling. Besides the electronic quantities, we also find that the photon number peaks at values of the chemical potential corresponding to Majorana parity switches. Therefore, photon number experiments could be used to detect the topological phase transition. Finally, calculation of photonic quadratures reveal squeezed states that are both captured by the exact diagonalization technique and mean field decoupling. However, the photon probability differs drastically within these two approaches.