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Strong single-photon nonlinearities in a multimode optomechanical system in the weak coupling regime KJETIL BORKJE, Department of Physics, University of Oslo, STEFAN WALTER, Department of Physics, University of Basel — We theoretically study the dynamics of two optomechanical cells, where each cell consists of an optical cavity mode whose resonance frequency is modulated by the position of a mechanical resonator. The two cells are furthermore coupled via photon and phonon tunneling, such that both the photon and the phonon modes hybridize to form symmetric and antisymmetric supermodes. This setup can for example be implemented in an optomechanical crystal. We show that by laser driving one of the optical supermodes with appropriately chosen power and frequency, the system can display strong single-photon effects already when the optomechanical single-photon cooperativity becomes larger than unity. This means that single-photon nonlinearities become important at significantly smaller coupling rates than in a single-mode system. We study how this system can be used to manipulate light at the single-photon level and to realize interactions between individual photons.

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