Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Optomechanical nonreciprocity: Minimal conditions for ideal isolation and circulation EWOLD VERHAGEN, FREEK RUESINK, FOM Institute AMOLF, MOHAMMAD-ALI MIRI, ANDREA ALU, University of Texas at Austin — Artificial systems that allow a specifically tailored flow of electromagnetic radiation are important for the design of nonreciprocal components such as isolators and circulators as well as multimode systems exhibiting nontrivial topological transport of photons. A possible route to breaking reciprocity without a magnetic field relies on a spatiotemporal modulation of the refractive index, which is straightforwardly achieved in optomechanical systems. We derive the minimal requirements to create nonreciprocity in a wide class of optomechanical systems that involve a pair of optical modes parametrically coupled to a mechanical mode, and can be implemented for both microwave and optical photons. These conditions highlight the importance of an appropriately tailored phase difference between the intracavity bias photons of the two optical modes. Suitable modal symmetry with respect to coupling channels allows near-ideal isolation and circulation over tunable bandwidths. We illustrate these general principles in an optomechanical ring resonator, demonstrating up to 10 dB optical isolation at telecom wavelengths. In line with our theoretical model, nonreciprocal transmission is preserved in the case of non-degenerate modes and also yields unidirectional parametric amplification.

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Date submitted: 11 Nov 2016 Electronic form version 1.4