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**Minimal models of nonreciprocity with biharmonic pumps**

ARCHANA KAMAL, Univ of Mass - Lowell, ANJA METELMANN, Princeton University — Nonreciprocal transmission and amplification has emerged as a new and important outlook in the field of quantum-limited detection. There have recently been multiple proposals aimed at realizing on-chip nonreciprocity at acoustic, microwave and optical frequencies. In this talk, we present a general scheme for nonreciprocal photon dynamics that emphasizes minimality of both the amplification mode space and parametric pumping – a feature especially desirable for hardware-efficient and scalable implementations of nonreciprocal detection protocols. We focus on a three-mode parametrically coupled system pumped with a time-asymmetric biharmonic pump and show how this system can be readily configured to realize gainless photon circulation, and phase-preserving or phase-sensitive directional amplification. Explicit frequency-dependent calculations within this minimal paradigm highlight the separation of amplification and directionality bandwidths, generic to such schemes.

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