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## Synthetic gauge fields with linear optics and beyond

Photons provide a good quantum degree of freedom, with long coherence times, easy manipulation using linear optical elements, and the potential for high-efficiency detection. At the same time, advances in manipulating classical light–primarily in the form of linear optical elements built from photonics devices–suggest a unique opportunity to connect quantum science to emerging technological platforms. I will discuss recent advances towards implementation of nonlinear photonic devices for quantum information processing and quantum simulation of topological phases of matter. In the first, we consider a novel approach for manipulating microwave photons in high quality factor superconducting resonators by creating an effective nonlinear medium with Josephson devices. Using some of the same ideas, I will then consider implementation of a quantum simulator for topological states of matter using light. These states, such as those expected in the fractional Quantum Hall regime, provide the potential for fault-tolerant quantum computing.

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