Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Topologically Reconfigurable Atomic Lattice Quantum Metamaterial. PANKAJ JHA, MICHAEL MREJEN, JEONGMIN KIM, CHIHHUI WU, YUAN WANG, Univ of California - Berkeley, YURI ROSTOVTSEV, Univ of North Texas, Denton, XIANG ZHANG, Univ of California - Berkeley — Metamaterials have attracted unprecedented attention owing to their exceptional light-matter interaction properties. However, harnessing metamaterial at single photon or few photon excitations is still a long way to go due to several critical challenges such as optical loss, defects to name a few. Here we introduce and theoretically demonstrate a novel platform toward quantum metamaterial, immune to aforementioned challenges, with ultra-cold neutral atoms trapped in an artificial crystal of light. Such periodic atomic density grating –an atomic lattice- exhibits extreme anisotropic optical response where it behaves like a metal in one direction but dielectric along orthogonal directions. We harness the interacting dark resonance physics to eliminate the absorption loss and demonstrate an all-optical and ultra-fast control over the photonic topological transition from a close to an open topology at the same frequency. Such atomic lattice quantum metamaterial enables dynamic manipulation of the decay rate of a quantum emitter by more than an order of magnitude. Our proposal brings together two important contemporary realm of science – cold atom physics and metamaterial for applications in both fundamental and applied science. Atomic lattice quantum metamaterial may provide new opportunities, at single or few photon level, for quantum sensing, quantum information processing with metamaterials.

Pankaj Jha
Univ of California - Berkeley

Date submitted: 02 Nov 2015 Electronic form version 1.4