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Trapping and probing atoms in one-dimensional photonic crystals CHEN-LUNG HUNG, SEAN MEENEHAN, California Institute of Technology, DARRICK E. CHANG, Institut de Ciencies Fotoniques, OSKAR PAINTER, H. JEFF KIMBLE, California Institute of Technology — Realization of strong radiative interactions between single atoms and the fields of nanoscopic optical waveguides and resonators presents new opportunities in atomic, molecular, and optical physics and quantum information science. A major challenge to this scientific frontier is trapping atoms in vacuum near dielectric surfaces (~100nm) while at the same time achieving strong interactions between one atom and photon. Here, we describe one-dimensional photonic crystals that support a guided mode suitable for atom trapping within a unit cell, as well as a second mode with strong atom-photon interactions [1]. We have identified new trapping opportunities combining optical forces from guided modes and vacuum forces from surface interactions to form stable traps for neutral atoms in dielectric nanostructures. With photonic band structure engineering, atomic decay rate to the guided mode can reach more than ten times higher than the vacuum spontaneous decay rate. We report on progress toward device fabrication, characterization, and experimental realization of trapping and probing ultracold cesium atoms in such nanophotonic waveguides.

[1] C.-L. Hung, S. M. Meenehan, D. E. Chang, O. J. Painter, and H. J. Kimble, arXiv:1301.5252 (2013).

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