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A New Apparatus for Deterministic Atom Arrays in Photonic Crystal Waveguides ALEXANDER BURGERS, XINGSHENG LUAN, JEAN-BAPTISTE BEGUIN, ZHONGZHONG QIN, LUCAS PENG, H JEFF KIMBLE, Caltech — Integrating ultracold atoms with nanophotonics enables the exploration of new paradigms in quantum optics and many body physics. Advanced fabrication capabilities for low-loss dielectrics materials provide powerful tools to engineer band structure and light-matter coupling of photons and atoms. For example, dispersion-engineered photonic crystal waveguides (PCWs) permit not only stable trapping and probing of ultracold neutral atoms via interactions with guided mode (GM) light, but also the possibility to study the physics of strong, photon-mediated interactions between atoms, as well as atom mediated photon-photon interactions. Our current Caltech system to explore such phenomena consists of a quasi-one-dimensional PCW whose band structure arises from periodic modulation of the dielectric structure. Our upgraded system utilizes a silicate bonding technique to adhere the chip containing the PCWs to a glass cell for large optical access and ultra-high vacuum operation. With the improved optical access and small glass cell we are able to deterministically couple single atoms to the PCWs using an optical tweezer. The extension of the single tweezer to arrays of atoms in optical tweezers allows us to investigate the string atom-light interactions mediated by the PCW.

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