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Engineered Rydberg Atom-Surface Interactions Using Metamaterials[1] YUANXI CHAO, JITENG SHENG, JONATHAN SEDLACEK, JAMES SHAFFER, University of Oklahoma — We report on studies of Rydberg atom-surface interactions aimed at engineering Rydberg atom coupling to metamaterials. Rydberg atoms posses large electric dipole moments that can be strongly coupled to the tightly confined electromagnetic fields of surface phonon polariton (SPhP) modes of a properly constructed piezoelectric superlattice (PSL). Coupling of Rb87 Rydberg atoms, typically in microwave range, to real SPhP resonances on a periodically poled lithium niobate surface is studied theoretically for different periodic domain and surface orientations. Coupling constants, much larger than the dissipation of the atom-surface system, are calculated for atom-surface separations in the near field. This remarkable result opens up a simple way to design and conduct experiments to study the atom-surface interactions in the strong coupling regime which is usually hard to reach in other systems. The light-matter interaction described can be used for a quantum hybrid system that has potential applications for quantum photonic devices. Experimental studies of surfaces showing the efficacy of our calculations are also presented.

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