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Mirror effects and optical meta-surfaces in 2d atomic arrays
EPHRAIM SHAHMOON, DOMINIK WILD, MIKHAIL LUKIN, Department of Physics, Harvard University, SUSANNE YELIN, Department of Physics, Harvard University; Department of Physics, University of Connecticut — Strong optical response of natural and artificial (meta-) materials typically relies on the fact that the lattice constant that separates their constituent particles (atoms or electromagnetic resonators, respectively) is much smaller than the optical wavelength. Here we consider a single layer of a 2d atom array with a lattice constant on the order of an optical wavelength, which can be thought of as a highly dilute 2d metamaterial (meta-surface). Our theoretical analysis shows how strong scattering of resonant incoming light off the array can be controlled by choosing its lattice constant, e.g. allowing the array to operate as a perfect mirror or a retro-reflector for most incident angles of the incoming light. We discuss the prospects for quantum metasurfaces, i.e. the ability to shape the output quantum state of light by controlling the atomic states, and the possible generality of our results as a universal wave phenomena.

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