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# Resonant defect states in atomic diamond lattices

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## Abstract

Despite considerable efforts over the years, convincing experimental evidence of Anderson localization of light in 3D systems has been obtained. According to recent theoretical advances, the existence of longitudinal modes could open a new channel for diffusion, suppressing localization phenomena in ensembles of resonant scatterers. Yet, as shown in tight-binding models, localization may occur via tunneling from one defect state to another across a spectral band gap. In this work, we establish the foundation for future studies of transport phenomena within the spectral band gap of a diamond lattice, the simplest known atomic lattice to exhibit a spectral band gap for electromagnetic waves. We begin by investigating the collective resonances of an atomic diamond lattice using the coupled dipole method, focusing on the density of states to characterize band gap formation. Finally, we employ a Bloch analysis of the perfect photonic crystal to compute the lattice's Green's functions, an object that enables us to investigate how states can be created inside the spectral band gap. We demonstrate good control over the detuning frequencies of resonant defect states induced by substitutional disorder in the lattice, and once these states formed, we study how they can hybridize with the surrounding lattice modes.

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