Avoiding decoherence with giant atoms in a 2D structured environment

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Giant atoms [1] are quantum emitters that can couple to light at multiple discrete points, as has been demonstrated in recent experiments using superconducting qubits and microwaves [2-4]. Besides many other remarkable features, giant atoms have been shown to interact without decohering via a one-dimensional waveguide [2]. Here [5], we study how giant atoms behave when coupled to a two-dimensional square lattice of coupled cavities, an environment characterized by a finite energy band and band gaps. In particular, we describe the role that bound states in the continuum (BICs) play in how giant atoms avoid decoherence. By developing numerical methods, we investigate the dynamics of the system and show the appearance of interfering BICs within a single giant atom, as well as oscillating BICs between many giant atoms. In this way, we find the geometric arrangements of atomic coupling points that yield protection from decoherence. These results on engineering the interaction between light and matter may find applications in quantum simulation and quantum information processing.

References

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[3] AM Vadiraj et al., Phys. Rev. A 103, 023710 (2021)
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Figures

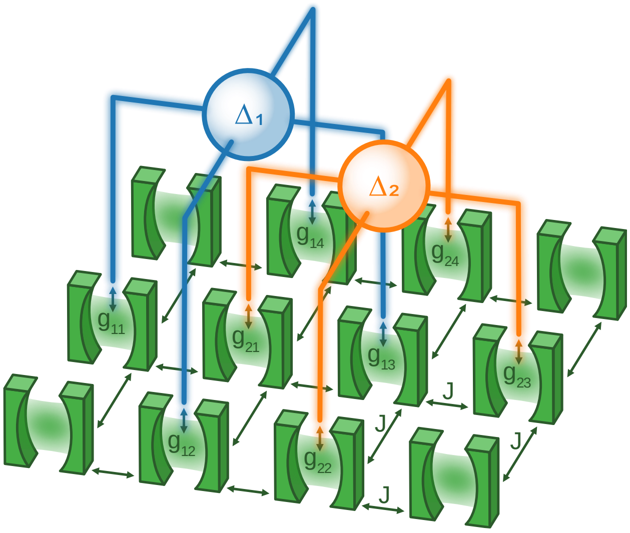

Figure 1: Sketch of the setup studied in this work. In particular, this shows two giant atoms in a braided configuration coupled to a 2D structured bath. The bath is modeled as a lattice of *NxN* cavities with nearest-neighbor coupling strength *J*. The atoms are two-level systems that are coupled to the cavities with strength g_{ip} at each coupling point, where *i* refers to the atom, and *p* to the connection point. The atomic transition frequencies are detuned from the bath frequency (i.e., from the middle of the band) by Δ_i.