EMISSION OF (GIANT) ATOMS UNDER AN ELECTRIC FIELD

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Abstract: We explore giant atoms in photonic lattices with synthetic electric fields, demonstrating chiral light emission in photonic graphene and non-Markovian dynamics in 1D arrays, leveraging valleytronics and Bloch oscillations for quantum optical applications.

Giant atoms allow for two major effects: engineered coupling to field modes and time-delayed non-Markovian dynamics. Here, we discuss two novel paradigms for these phenomena, both arising in a photonic lattice (implemented through a 1D or 2D coupled-cavity array) with an applied synthetic electric field.

We first consider a 2D lattice implementing photonic graphene with an open gap. We propose that, by relying on giant atoms, one can combine ideas from valleytronics [1] with quantum optics to produce chiral light orthogonal to the electric field direction, without the need to break time-reversal symmetry of the lattice [2].

We then consider a simple 1D array with an applied electric field, where Bloch oscillations are known to occur. We show that an atom emitting into such a lattice generally undergoes non-Markovian dynamics. In a suitable regime, this resembles the dynamics of an atom in a long, multi-mode, perfect cavity (despite no true mirrors being present), with the photon time delay embodied by the Bloch oscillations period [3].

References

[1] J. R. Schaibley et al., Valleytronics in 2D materials, Nature Reviews Materials 1, 1 (2016).
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