Exploring bio-inspired collective light-matter interactions

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Abstract

We investigate the effect of vibrations on experimentally measurable signatures of cooperativity in a bio-inspired coupled-dimer system. We consider mode-selective detectors of various efficiencies and calculate the photon coincidences, where an antidip at zero-time delay indicates inter-emitter correlations. We observe their dependence on the relative orientation of the dipoles and on the angle of photon detection in photon correlation experiments. Static disorder in the dimer configuration, present in realistic multi-emitter systems under strong phonon coupling, washes away most of these features. Exploring superradiance and measurement-induced cooperativity across different dimer configurations, we find the instrument response required to detect these signatures in an actual experiment. This work enhances our understanding of the cooperative emission in two coupled-emitters under realistic environments, like molecular dimers, and provides insights for future applications in quantum technologies and light-harvesting devices.

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