Cavity enhanced transport of excitons and photon bunching

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Keywords: *Excitons, Polaritons, Transport, Rydberg, Bunching.*

Abstract

We present two separated works on excitons in confined optical systems, where we consider photons coupled to an ensemble of two-level systems.

In the first work, we show that exciton-type transport in certain materials can be dramatically modified by their inclusion in an optical cavity: the modification of the electromagnetic vacuum mode structure introduced by the cavity leads to transport via delocalized polariton modes rather than through tunneling processes in the material itself. This can help overcome exponential suppression of transmission properties as a function of the system size in the case of disorder and other imperfections. These results have direct implications for experiments with disorderd organic semi-conductors.

In the second work, we study photon-photon interactions via both hard-core repulsion and dipolar forces between the two-level systems; hard-core condition ranges from kinematic interaction to Rydberg blockade. We demonstrate bunching of photons in a purely repelling system assisted by Rydberg blockade, and contrast it to bunching due to formation of bound bipolaritonic states in an attracting system. We describe bunching via a resonant-scattering mechanism. Finally, we discuss how the bunching can be controlled by the experimental parameters.