Tuning material properties via light-matter hybridization

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In this talk, I will discuss different ways to exploit the hybridization between light and matter in solid-state devices to modify the properties of the host material. I will begin by demonstrating how coupling with the photonic field of a microcavity can substantially change the electronic wavefunctions of Wannier excitons in undoped semiconductor quantum wells [1] and create bound excitons in doped ones [2,3]. I will also show some related results obtained under applied magnetic field [4].
I will then discuss how hybridization of longitudinal and transverse degrees of freedom in polar dielectrics, due to crystalline structure [5] or nano-structuring [6], can alter the mid-infrared optical response of semiconductor heterostructures [7,8]. Finally, I will present some recent theoretical results showing how such longitudinal-transverse hybridization can lead to far-field resonant mid-infrared photon emission from electric currents [9].

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