Title: Enhanced Light-Matter Interactions with Photonic Bound States in the Continuum

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Abstract: Photonic bound states in the continuum (BICs), embedded in the spectrum of free-space waves with diverging radiative quality factor, are topologically non-trivial dark modes in open-cavity resonators that have enabled important advances in photonics. Achieving maximum near-field enhancement is challenging, as this requires matching radiative and non-radiative losses. Here we first discuss the theoretical framework of supercritical coupling in near-field coupled resonances close to the Friedrich–Wintgen condition. This enables a quasi-BIC field to reach maximum enhancement imposed by non-radiative loss, even when the radiative quality factor is divergent, and is applied to a photonic-crystal slab covered with upconversion nanoparticles. A coherent upconversion luminescence enhanced by eight orders of magnitude is observed. Then, we present our experimental findings on BIC-driven polariton Bose-Eistein condensation within a 2-dimensional transition metal dichalcogenide at room temperature. This approach is relevant to various physical processes, with potential applications for light-source development and quantum processing. Our results also shed light on the manipulation of the polariton emission by virtue of the BIC, opening new pathways for harnessing RT polariton BEC in advanced materials.