ICFO

SEMINAR: Excitons in Lead Halide Perovskite Nanocrystals: Investigation of the Fine Structure, Phonon Interactions and Energy transfers

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12:00 to 13:00
Seminar Room

Over the past decade, organic and inorganic lead halide perovskite (LHP) nanocrystals (NCs) have emerged as a new class of colloidal quantum dots with great potential for a wide range of optoelectronic applications, including LEDs, lasers, and photodetectors [1,2]. The exciton lies at the core of their optical properties and its fine structure-which results from the exchange interaction between the electron and the hole-has been the subject of intense research, motivated by the potential use of these systems in quantum technologies as a platform for single-photon emission [3].
This work focuses on two LHP materials: CsPbCl3 and FAPbBr3. In the case of CsPbCl3 NCs, micro-PL spectroscopy experiments are performed at cryogenic temperatures on single objects and reveal the bright states of the exciton fine structure (EFS), with energy splittings influenced by an interplay of the crystal symmetry, the dielectric environment and the NC shape anisotropy [4] (see Figure 1). This work also highlights the emission response of biexcitons and trions, and explores the role of exciton-phonon interactions in the emission and coherence properties. Time-resolved PL spectroscopy further explores the emission dynamics with varying temperature, revealing a two-phonon thermal mixing process between bright and dark excitonic states. This allows for the determination of the dark state energy position within the EFS [4]. FAPbBr3 NCs, which are embedded in a mesoporous matrix without surface ligands [5], are first investigated in low NC density samples to assess single-NC spectral responses. Samples of higher NC density are also examined and energy transfers between NCs are suggested by the emission dynamics. These results are compared to numerical simulations of the PL dynamics based on FRET between nearest neighbors allowing to obtain a first estimation of the transfer rate between ideally coupled NCs in this environment.

Hosted by: Prof. Dr. Gerasimos Konstantatos