Band-edge exciton fine structure of single InP nanocrystals

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Quantum dots (QD) are semiconductor nanocrystals (NCs) in which the quantum confinement of the charge carriers is restricted by the NC boundary, leading to tunable optical properties by the size of the NCs. Indium Phosphide (InP) based NCs are appealing luminescent materials as they offer broad color tunability and low toxicity. They appear in various technological applications, such as quantum-dot light-emitting devices (QD-LED), solar cells, and bio-imaging. However, InP-based NCs suffer from a lack of knowledge of the optical properties of the band-edge exciton, whose recombination is at the origin of the photoluminescence.

This work investigates the fundamental optical properties of core-shell InP/ZnS/ZnSe NCs with an InP core of 3.3 nm, a spheroidal shape, and a high quantum yield. To this end, we use magneto-photoluminescent spectroscopy of individual NCs at cryogenic temperatures. By removing ensemble averaging effects, single NC spectroscopy offers valuable insight into the properties of these materials. In addition, operating at low temperatures reduces the acoustic phonon population and provides highly resolved spectral fingerprints of the band edge exciton states. In particular, magnetic brightening of a dark exciton state is evidenced.