Multi-Exciton and Multi-Photon Interactions in Perovskite Nanoplatelets

Perovskite nanoparticles have emerged as a promising new class of material for application in lighting technologies. In addtion to the narrow emission bandwidth, high emission quantum yield, and composition and size controlled wavelength tunability, perovskite quantum dots exhibit unique multi-exciton characteristics with a extrmely strong biexcitonic Coulomb interaction. Those strong interactions can spoil the efficiency of these nanomaterials for applications in LEDs, but favors amplified spontaneous emission (ASE), allowing for low threshold optical gain either by one or two photon excitation. Consequently, being able to control the multi-exciton interactions in these materials is fundamental for further application developments. One way to do this is by controlling the nanoparticle shape as it has already been demonstrated for other nanomaterials. Despite the fact that synthesis of perovskite nanoplatelets and nanorods have already been reported, no investigation of the influence of those shapes in the multi-exciton dynamics has been reported. Furhtermore, we have recently shown that perovskite quantum dots present very large two-photon absorption cross section, favoring two-photon pumped lasing. Recent results in CdSe nanoplatelets have suggested that the 2D structure could enhance even further the two-photon absorption cross section in nanomaterials and this should be tested also in perovskites.

In this project, the student will investigate how the aspect ratio of the nanoplatelets influences the multi-exciton and multi-photon interactions. Using state-of-the-art ultrafast spectroscopy techniques, such as transient absorption and transient photoluminescence, and by analyzing the multi-exciton dynamics and spectral characteristics for those samples in the single particle regime, the student will help to shine light into the fundamental physical origin of the strong Coulomb interactions in these nanomaterials.