



DEPARTMENT OF PHYSICS

**The Department of Physics at the University of Cyprus announces the
PhD Thesis Defence Seminar
by Andreas Manoli**

**Friday June 13th, 2025, 15:00 (Cyprus Time)
Room B228, Department of Physics**

“Photophysics and Stimulated Emission Studies of Cesium Metal Halide Perovskite Nanocrystals”

This thesis investigates the photophysical and photonic properties of all-inorganic cesium metal halide perovskite nanocrystals (PeNCs). The first part implements variable temperature optical spectroscopy to probe the impact of different surface passivation methodologies on the optoelectronic properties of weakly-confined CsPbBr₃ and CsPb(Br,I)₃ PeNCs provided by collaborators at ETH, Zurich. The studies reveal ligand-dependent effects on key exciton metrics such as the emission quantum yield and lifetime, as well as processes such as exciton trapping, ionization and coupling with phonons^{1,2}. Surface stabilization is further correlated with photonic functionality, guiding the design of light emitting structures based on optimized combinations of ligands and PeNCs.

Among the explored photonic applications, particular emphasis is placed on amplified spontaneous emission (ASE) of the CsPbBr₃ and CsPb(Br,I)₃ PeNCs. ASE serves both as the benchmark for optical performance and a diagnostic tool for laser development, leveraging the materials' high optical gain, fast exciton recombination and reduced non-radiative losses. Optimized PeNC thin films enable efficient waveguiding and room temperature ASE up to the continuous-wave regime, further enhanced through the fabrication of polymer–PeNC multilayers³. Additionally, stimulated emission is demonstrated in free-standing polymer membranes, paving the way for flexible, optically pumped perovskite lasers⁴.

The final part of the thesis explores lead-free tin iodide PeNCs, preserving key parameters from the earlier studies such as the weak confinement and all-inorganic composition, while addressing the toxicity concerns of lead. Despite their promise, tin halide PeNCs face stability challenges due to oxidation, structural polymorphism and ligand desorption. By exploiting an optimized synthesis developed by collaborators at the University of Groningen, stable CsSnI₃ PeNCs coexisting with 2D Ruddlesden–Popper phases were produced. This enabled one of the first detailed spectroscopic investigations of CsSnI₃ NCs in the form of thin films⁵, as well as the first demonstration of room temperature ASE from such material, paving the way for the development of practical lead-free perovskite lasers.

1. A. Manoli et al., ACS Appl. Nano Mater., 4, 5084-5097, (2021)
2. P. Papagiorgis, M. Sergides, A. Manoli et al., Adv. Opt. Mater., 12, 2301501 (2024)
3. M. Athanasiou, P. Papagiorgis, A. Manoli et al., ACS Photonics, 8, 2120-2129, (2021)
4. M. Athanasiou, A. Manoli et al., ACS Photonics, 9, 2385-2397, (2022)
5. A. Manoli et al., Adv. Opt. Mater., 2500792, (2025)