

# Perovskite Multiple Quantum Wells: Ultralow-Dimensional Heterostructures for Advanced Optoelectronic Devices

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## Project Background and Motivation

Metal–halide perovskites have rapidly evolved from bulk thin films to **engineered low-dimensional heterostructures**, enabling unprecedented control over electronic structure, excitonic effects, and light–matter interaction. Among these architectures, **multiple quantum wells (MQWs)**—consisting of alternating layers of perovskite wells and barrier materials with nanometer-scale thickness control—represent a powerful platform for tailoring carrier confinement, exciton binding energy, and radiative recombination dynamics.

Perovskite MQWs combine several unique advantages:

- Strong quantum confinement achievable at room temperature
- Large exciton binding energies and enhanced oscillator strength
- Tunable emission and absorption via layer thickness and composition
- Compatibility with low-temperature and vacuum-based fabrication routes

These properties make perovskite MQWs highly attractive for next-generation optoelectronic devices, including light-emitting diodes, lasers, photodetectors, and quantum photonic components. However, a systematic understanding of **growth methodologies, interface quality, and structure–property relationships** in perovskite MQWs remains limited, particularly for scalable fabrication approaches.

This thesis project focuses on the design, fabrication, and characterization of **perovskite multiple quantum well structures**, with emphasis on controlled growth, quantum confinement effects, and optoelectronic functionality.

## Objectives

The main objectives of this Master’s thesis are:

1. To understand the fundamental physics of quantum confinement in perovskite materials.
2. To design and fabricate perovskite multiple quantum well heterostructures with nanometer precision.
3. To investigate how well and barrier thickness influences optical and electronic properties.
4. To study excitonic and carrier recombination dynamics in perovskite MQWs.

5. To assess the potential of perovskite MQWs for optoelectronic device applications.