

## PhD Position: empirical modeling of polaronic excitons in halide perovskite quantum dots

3-years PhD position offered at the Foton Institute-OHM - INSA Rennes (France) funded by ANR project PEXPEQ. The PhD position is expected to start between October and December 2026.

### Supervisors:

**Pr. Simon Thébaud**

**Pr. Laurent Pedesseau**

**Keywords:** theoretical physics, effective mass and k.p models, exciton-phonon interactions, semiconductor heterostructures, quantum dots, quantum technology

### Project description

Halide perovskite quantum dots are emergent platforms for optoelectronics and quantum light emission. While they have already demonstrated impressive capabilities, progress is hindered by the fact that the polaronic interactions between electron-hole pairs (excitons) and lattice vibrations (phonons) in such systems are still not understood, including the nature of the dominant interaction mechanism and the magnitude of key optical observables. Revolving these open questions require reliable **theoretical predictions of the fundamental properties and optical signatures of polaronic excitons in perovskite quantum dots**.

This PhD thesis aims at establishing such a theory based on **empirical k.p and effective mass models** of exciton states in semiconductor heterostructures coupled to phonons via **Fröhlich or optical deformation potential models**. The rich physics of perovskite quantum dots will be described by configuration-interaction and variational methods accounting for the complex interplay of quantum confinement of electron and holes, Coulomb interactions between them and their polaronic coupling to phonons.

The PhD candidate will carry out analytical pen-and-paper calculations and will program parallel-running codes in Matlab or Fortran to numerically evaluate excitonic properties. The PhD funding is part of ANR project PEXPEQ, which also includes funding for traveling to conferences and collaborations, and a teaching discharge for Prof. Simon Thebaud to help and supervise the PhD candidate. The candidate will benefit from the group's world-renowned expertise in the field of halide perovskite, its extensive experience with empirical modeling of semiconductor heterostructures and its ongoing collaboration with leading experimentalists (Rice University, University of Bordeaux, ETH Zürich...). Depending on the candidate's inclination, he/she may additionally take part in experiments or carry out *ab initio* calculations used to parametrize the empirical models.

### **Profile of the candidate**

The ideal candidate holds a Master's degree in Physics, Materials Science, Condensed Matter Physics or Photonics, with a strong foundation in semiconductor physics and nanoscale heterostructures. He/she has experience programming in Matlab or Fortran, is familiar with the field of halide perovskites, and has a track record interacting with experimentalists. Experience with halide perovskites, interacting with experimentalists. Autonomy, problem-solving skills, and the capacity to thrive in an interdisciplinary research environment are highly valued. **Fluency in English** (written and oral) is mandatory for effective communication and collaboration.

### **Foton Institute - INSA Rennes (CNRS, UMR6082)**

The Foton institute is a research laboratory managed by the National Center for Scientific Research (CNRS), Rennes University and INSA Rennes. The specificity of Foton is to gather around common research programs three groups and three facilities spanning multiple fields from photonics to green energy generation and conversion, including photovoltaics and hydrogen production which are European, national and regional priorities. The PhD candidate will mainly work within the Rennes perovskite theory group located at Foton and at ISCR.

### **High Performance Computing**

Access to National (CINES, TGCC) supercomputing facilities will be provided under the GENCI proposal. The candidate will also have access to local facilities.

### **Ressources online**

FOTON Institute - OHM department: <https://www.institut-foton.eu/en/dpts/ohm/>

### **Applying**

To apply and for any further information, please contact Ass. Pr. Simon Thébaud ([simon.thebaud@insa-rennes.fr](mailto:simon.thebaud@insa-rennes.fr)).

A successful application must contain the following elements:

- Cover letter (detailing motivation and research interests)
- Detailed CV (post-Master experience, list of Publications if available)
- Educational grades and marks (at university level)
- References of people to contact for recommendation

All qualified candidates are invited to apply.