INTERNSHIP PROPOSAL

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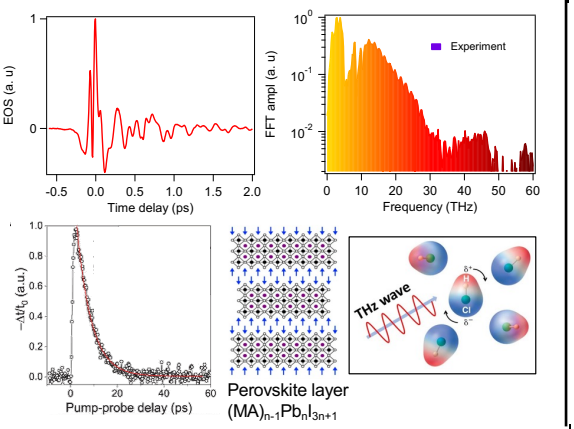
Internship location: LPENS, 24 rue Lomond 75005 Paris

Thesis possibility after internship: YES
Funding: YES Type of funding: Doctoral school or Research grant

Probing Hot Carrier Dynamics and THz Gain in Emerging Quantum Materials and Polar Molecules

Many elementary processes in matter, such as interactions between electrons, spins, and phonons, involve low energies (on the order of a few meV) as well as dynamics on a (sub)-picosecond timescale. Unlike visible light, whose photon energy is high, terahertz (THz) radiation provides a direct way to probe and excite these low-energy processes, since THz photon energies fall in the same range (1 THz corresponds to 4 meV). Moreover, the vibrational and rotational modes of many molecules have resonance frequencies that lie within the THz spectral range. As a result, THz spectroscopy and optical pump–THz probe experiments are powerful techniques for exploring a wide range of low-energy physical phenomena and their ultrafast dynamics.

The aim of the internship is to explore many-body interactions in 2D perovskites using optical pump-THz probe experiment [1]. The candidate will study exciton and free carrier dynamics to assess their respective contributions to the photoexcited population, a crucial information for advancing 2D perovskite optoelectronics. The project will also involve studying gain dynamics in ammonia molecules using a MIR pump-THz probe experiment to provide key insights for the development of a THz pulsed gas laser. The candidate will combine experimental data with microscopic modeling to uncover and understand the main underlying physical mechanisms.



Up: THz waveforms and its amplitude spectrum. Bottom: Dynamics of hot carriers (left), 2D perovskites (center) and scheme of molecular gas (right).

This internship may be pursued by a thesis. Further developments of the doctoral project include the exploration of topological insulators, 3D Dirac materials, and quantum dots [2]. It will also involve studying the dynamics of elementary processes when these materials are integrated into THz cavities [3]. Different light–matter coupling regimes will be explored.

[1] N. Nilforoushan et al. Appl. Phys. Lett. 123, 241107 (2023), [2] Y. Todorov et al. Nanophot. 13, 1681 (2024) [3] S. Messelot et al. Phot. Res. 11, 1203 (2023)

Condensed Matter Physics: YES
Soft Matter and Biological Physics: NO
Quantum Physics: YES
Theoretical Physics: NO