INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire d'Optique et Biosciences
CNRS identification code: UMR 7645
Internship director'surname: Michel Sliwa (70%) and Manuel Joffre (30%)
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Web page: https://portail.polytechnique.edu/lob/en/research/internal-dynamics-biomolecules
Internship location: Ecole Polytechnique, Palaiseau

Thesis possibility after internship: YES
Funding: NO (application to ED IP Paris) If YES, which type of funding:

Characterization of the multi-time scale Photodynamics of Diatom Phytochromes

For photosynthetic organisms, light is of major importance as it represents not only the main source of energy for metabolism, but also a very informative cue about their surroundings. While well studied and characterized in terrestrial organisms, light sensing capabilities and functions are still largely underexplored in marine environments. A recent study conducted by M. Jaubert (Sorbonne Univ.) has shown that diatoms, a prominent phytoplanktonic group of microalgae, use phytochrome (DPH) photoreceptors to acclimate their photosynthesis performance according to depth [1]. Phytochromes are among the most studied photoreceptors in plants, controlling major developmental stages [2]. They have the singularity to exist under two photoconvertible forms, one activating (Pr) and one inactivating signaling cascades (Pfr), upon red and far-red light exposure. Current knowledge about photoconversion mechanism of phytochromes has been acquired from plants and bacteria. Pr undergoes the picosecond isomerization of the linear tetrapyrrole chromophore triggering microsecond and millisecond deprotonation and reprotonation, generating three intermediate states before reaching the Pfr state.

PHY of marine microalga have never been studied at such a scale for their molecular photoreactions. Unravelling biophysical properties of photoswitching yield and photodynamics in DPH will provide novel information about the molecular basis of light sensing in phytochromes photoreceptor family and the specific adaptations of light-sensing mechanisms in marine organisms. The study of Diatom phytochrome is an ANR funded project, D-Phyto (Study of diatom phytochrome photoreceptors to explore light sensing mechanisms of phytoplankton in marine environments - PI M. Jaubert), that involves M. Sliwa and the group Internal dynamics of biomolecules at LOB -

The M2 internship will focus on the characterization of new DPHs. Different DPHs and variants were developed by M. Jaubert and within a collaboration with AC Stiel from TUM (Université technique de Munich) [2]. The internship will include being tutored on and gaining hands-on experience in multi-time scale transient absorption visible spectroscopy with the access to a new platform developed by the team [4], in data-analysis, and characterization of multiscale photodynamics. Depending on the candidate profile, the implementation of a new laser system may be considered.

[1] Duchêne. et al. Diatom phytochromes integrate the underwater light spectrum to sense depth. Nature (2025).
[2] Rodrigues & Stiel. It's a two-way street: Photoswitching and reversible changes of the protein matrix in photoswitchable fluorescent proteins and bacteriophytochromes. FEBS Letters (2023)
[3] A. Gharbi et al. Characterization of Thermal Recovery Activation in Fast Photochromic Flavoprotein Charge-Transfer Complexes, J. Phys. Chem. Lett. (2026).

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

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