

# Internship proposal at Ecole polytechnique

## Internship proposal

Date of the proposal: October 15<sup>th</sup> 2020

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Code: LOB	Organism: Ecole Polytechnique, CNRS, INSERM		
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Internship place: LOB, Ecole Polytechnique, Palaiseau			

<b>Internship title:</b> Study of the dynamics of membrane permeability in the terahertz domain.
<p>The cell membrane consists of a selective hydrophobic lipid bilayer that separates the cell from its environment. It regulates exchanges between the inside and outside of the cell and therefore has a selective permeability that controls the passage of ions and other molecules such as peptides or proteins, depending on their size, charge or chemical function. Numerous membrane mechanisms (diffusion, transmembrane proteins, endocytosis, etc.) allow passive or active transport, thus ensuring the proper functioning of the cell.</p> <p>The selective control of membrane permeabilization is a major issue in medicine, for example to specifically deliver drugs to target cells, for anti-cancer treatments or gene therapy. At the Laboratory for Optics and Biosciences of the Ecole Polytechnique, we study the dynamics of membrane permeability using new tools in the terahertz spectral domain, on projects involving permeation triggered by chemistry (detergent), electric field (electroporation), or optical beams (photodynamic therapy) [1]. These last two techniques are, for example, commonly used in anti-cancer treatments.</p> <p>Terahertz radiation is in the electromagnetic range between far infrared and microwaves, corresponding to frequencies between 0.1 and 10 THz. This spectral range is currently largely under-exploited, but its application to the study of biological objects has already shown great potential in the detection of skin cancer, ion flow monitoring or biosensors. In the laboratory, we have developed new terahertz biological measurement tools that have enabled us to study, for example, ion and aqueous flows through the neuronal membrane or cardiac muscle [2] using near-field techniques [3], or membrane dynamics induced by saponin [4].</p> <p>Recently, we have developed a terahertz device based on attenuated total reflection (ATR) [4-5] which has a remarkable accuracy allowing stable measurements on model cell layers. The proposed internship will study the action of photo-sensitizing vectors on the permeabilization of the optically triggered plasma membrane, using our terahertz ATR setup. Membrane dynamics measurements will be compared to biophysical models that we are developing to extract fundamental membrane parameters.</p> <p>The proposed project is therefore deeply interdisciplinary as the student will work with a state-of-the-art physics setup, while basing his or her interpretations on tools already established in cell biology. The LOB terahertz team has the skills in these two fields, and has the necessary technical facilities in cell culture. The ideal profile is a student who is curious about interface topics and who is able to take ownership of an original physics setup.</p>
[1] App. Phys. Lett. <b>107</b> , 103702 (2015); Scientific Reports 10, 10471 (2020)
[2] PNAS <b>103</b> , 4808 (2006) ; Appl. Phys. Lett. 89, 153904 (2006)
[3] Opt. Exp. <b>14</b> , 11566 (2006) ; Appl. Opt. <b>47</b> , 3254 (2008); Opt. Lett. <b>35</b> , 901 (2010) ; Opt. Exp. <b>19</b> , 14099 (2011)
[4] Biophys. J. 119, 7498 (2020)
[5] Opt. Lett. <b>38</b> , 112 (2013); App. Phys. Lett. <b>107</b> , 103702 (2015); J. Phys. Chem. B, <b>121</b> , 9508 (2017)

Possibility of a PhD ? : <b>YES</b>
<b>If yes, financial support for the PhD: Ecole doctorale, Bourses Monge (Polytechnique), Région Ile-de-France</b>