Open PhD position: Electro-mechano-biology and microfluidics engineering of cell permeabilization

A three-year funded PhD position is open for interdisciplinary research in numerical studies of electro-mechano-biology (EMB) and microfluidics engineering of cell permeabilization. Looking at the boundary of physics, mechanics and biology, the problem of cell membrane permeabilization presents an excellent opportunity for cross-disciplinary science and engineering and a context in which fundamental physics is called for to answer complex questions. Hence, many topics in biology comprise a growing area of inter-disciplinary science and provide significant opportunities for the application of the first-principles of physics. Additionally, due to the large separation of length scales between the membrane thickness and the size of the cytoplasm, it is challenging to understand quantitatively the electromechanical couplings in these systems. With developing advanced multiphysics and multiscale numerical analysis we expect to learn many cross-properties of biological materials which involve multiple spatial or temporal scales. Since EMB involves a broad range of length scales (from nm (membrane thickness) through μm (cell size) up to cm (tissue sample)) and timescales (from ns to h), understanding its first-principles features requires a multiscale modeling approach, ranging from molecular simulations to large-scale continuum models of cells and tissues.

Location: Brest, France

Start: October 2022

The successful candidate should have a **Master Degree in physics, biophysics, or mechanical engineering, with a strong background in computational analysis** relevant to the research program. Experience with quantitative electromagnetic simulation tools (finite-element, Comsol Multiphysics) is mandatory.

Gross salary: 2000€/month

Qualified applicants are invited to send curriculum vitae, publication list, and contact information for two references via e-mail, or fax to : Prof. Christian Brosseau, Lab-STICC, Université de Brest, 6 avenue Le Gorgeu, CS 93837, 29285 Brest Cedex 3, France ; Tel. : 33-298016105, FAX: 33-298016131, e-mail : brosseau@univ-brest.fr

The PhD student will be assigned to my group for this project. He or she will spend several months in European or American groups via the PhD mobility program of UBO. Apart from the regular contact with local partners, meetings are planned on a regular basis where experimental and numerical results will be discussed. Plans for further development of the project will be outlined and adjustment of the project deadlines will be performed during these meetings. Deliverables of this project will consist of a set of publications in high impact factor peer-reviewed journals, communications in major international conferences and possibly a patent dealing with microfluidics. Due to its multidisciplinary character, the public engagement of the research concepts and results will be achieved through public talks and open lab days such as Fête de la Science.

Publications from my last three PhDs:

T. MUROVEC (2013-2017), Slovenian

T. MUROVEC, C. BROSSEAU, "Electrostatics of two charged conducting ellipsoids", *Appl. Phys. Lett.*, 102, 2013, 084105(1)-084105(5).

T. MUROVEC, C. BROSSEAU, "Anisotropy of the crossover between electrostatic attraction and repulsion of biological cells", *Appl. Phys. Lett.*, 103, 2013, 193702(1)-193702(4).

T. MUROVEC, C. BROSSEAU, "Numerical simulation of the sign switching of the electrostatic force between charged conducting particles from repulsive to attractive", *J. Appl. Phys.*, 116, 2014, 214902(1)-214902(10).

T. MUROVEC, C. BROSSEAU, "Does like attract like?", *Appl. Phys.Lett.*, 105, 2014, 054101(1)-054101(5).
T. MUROVEC, C. BROSSEAU, "Spectral fingerprint of electrostatic forces between biological cells", *Phys. Rev.* E, 92, 2015, 042717(1)-042717(9).
T. MUROVEC, D. SWEENEY, E. LATOUCHE, R. V. DAVALOS, C. BROSSEAU, "Spatiotemporal modeling of transmembrane potential in realistic multicellular structures during irreversible electroporation", *Biophys. J*., 111, 2016, 2286-2295.

D. SHAMOON (2016-2019), Indian
D. SHAMOON, S. LASQUELLEC, C. BROSSEAU, "Low-order statistics of the effective permittivity and electric field fluctuations in two-phase heterostructures", *J. Appl. Phys.*, 122, 2017, 044106(1)-044106(7).
D. SHAMOON, S. LASQUELLEC, C. BROSSEAU, "Perspective: Towards understanding the multiscale description of cells and tissue by electromechanobiology", *J. Appl. Phys.*, 123, 2018, 240902(1)-240902(18).
D. SHAMOON, J. DERMOL-CERNE, L. REMS, M. REBERSEK, T. KOTNIK, S. LASQUELLEC, C. BROSSEAU, D. MIKLAVCIC, " Assessing the electro-deformation and electro-permeabilization of biological cells using a three dimensional finite element model", *Appl. Phys. Lett.*, 114, 2019, 063701(1)-063701(5).
D. SHAMOON, S. LASQUELLEC, C. BROSSEAU, "A multiphysics analysis of the strain energy in multicellular environments", *App. Phys. Lett.*, 115, 2019, 043701(1)-043701(5).

E. SABRI (2019-2022), French
E. SABRI, S. LASQUELLEC, C. BROSSEAU, "Electromechanical modeling of the transmembrane potential-dependent cell membrane capacitance", *Appl. Phys. Lett*., 117, 2020, 043701(1)-043701(5).
C. BROSSEAU, E. SABRI, "Resistor-capacitor modelling of the cell membrane: a multiphysics analysis", *J. Appl. Phys.*, 129, 2021, 011101(1)-011101(22).
E. SABRI, C. BROSSEAU, ""Proximity-induced electrodeformation and membrane capacitance coupling between cells", *Eur. Biophys. J.*, 50, 2021, 713-720.
E. SABRI, C. BROSSEAU, "Modelling cell membrane electrodeformation by alternating electric fields", *Phys. Rev.* E, 104, 2021, 034413(1)-034413 (7).
E. SABRI, C. BROSSEAU, "Thin-layer approximation for the multi-physics and multiscale simulation of cell membrane electrodeformation", *Bioelectrochemistry*, 145, 2022, 108055(1)-108055(11).