Versão UK

Scientific Work Proposal for Mathematics Phd Thesis

Scientific Domain

Mathematics

Main Area

Mathematics of Fluid Mechanics and its Applications, Analysis Mathematics, Numerical Simulation and Mathematical Modeling with Experimentations

Thesis title (Provisory)

Modeling the fluid dynamics of the eye

Keywords

Fluid-structure Interaction Problems, Ocular fluids, Newtonian Fluids, Non-Newtonian Fluids, Partial Differential Equations, Ordinary Differential Equations, Laboratory Experimentation.

Host Institution

University of Évora and CIMA-UE, Portugal

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Scientific Work Proposal:

The flow dynamics of the human ocular tear film is a complex problem involving the flow of a complex fluid in a complex domain. While a considerable amount of attention has been paid to understanding various complex physical mechanisms of the eye, some fundamental questions regarding the flow of the tear film and its interactions with embedded foreign bodies in the eye remain open. One of these questions pertains to the role of mucus which lines the cornea in the eye and is assumed to provide lubrication and protection to the eye. The literature remains vague about the meaning of the term 'protection' in general. In the context of the eye, it is attributed to the fluidity and high viscosity of mucus. However, in some recent papers, we have hypothesized that the answer is more complex than currently suggested and in fact, could well depend upon various aspects including, mucin distribution, forces of attraction in the system, blinking rate and other material properties of the tear film. Using some preliminary hypothesis about the non-Newtonian nature of the tear film, our theoretical and computational analysis of a fluid-structure problem has implicated lift-forces produced by asymmetric material properties and normal stresses as being responsible for maintaining a healthy tear film.

These studies need to be advanced by collecting experimental data, considering more appropriate models for the tear film and considering pathologies of the eye that go beyond the question of lubrication, which has been previously addressed. The project will involve mathematical tools from Partial Differential Equations, Dynamical Systems and Numerical Analysis techniques and promises not only to advance the theoretical aspects of the problem but also will be of value to ophthalmologists and physicians.

Some General References about Ocular Fluid Dynamics:

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