POLITECNICO DI TORINO

DISMA Dipartimento di Scienze Matematiche G. L. Lagrange

ECCELLENZA 2018 • 2022

Tuesday the 12 March 2019 at 10:30

Politecnico di Torino, DISMA, Aula Buzano (third floor)

Mariia DVORIASHYNA

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Mathematical Models of Fluid Flows in the Human Eye

Prof. Davide Carlo Ambrosi introduces the seminar

Abstract

Fluids in the eye have many important functions, such as regulating the intraocular pressure, delivering nutrients to the avascular intraocular tissue of the cornea and the lens and contributing to adhesion forces between the sensory retina and the retinal pigment epithelium. Failure of these functions may lead to a number of pathological conditions. Therefore, studying fluid flows in the eye, mainly form the mechanical point of view, is relevant to improve our understanding of the physiology of the organ and to prevent or treat certain eye diseases.

In this seminar, Dr Dvoriashyna will cover two topics related to different parts of the eye. The first topic concerns the motion of a transparent fluid, the aqueous humor, which is located in the anterior segment of the eye and has properties similar to those of water. Making use of mathematical models, she will address problems of clinical relevance related to the motion of this fluid. Dr Dvoriashyna will present the application of an approximation technique, lubrication theory, which is valid for the flows in thin domains and is used to simplify the Navier-Stokes equations in order to obtain semi-analytical solutions.

The second topic will concern fluid flow across the retinal pigment epithelium (RPE). The RPE is the outermost cell layer of the retina, and it is responsible for pumping of fluid from the sub-retinal space to the choroid. Failure of this pump results in fluid accumulation and leads to some eye diseases. To understand the mechanisms that drive fluid across the RPE, it is possible to develop a spatially resolved mathematical model that couples fluid and ion transport in the epithelial layer. Fluid transport is modelled with Stokes equations, and the problem of ion transport is governed by Poisson-Nernst-Planck equations, resulting in a set of coupled nonlinear PDEs. This system is simplified to a system of ODEs, taking advantage of the small thickness of the space between the adjacent cells, which allows the use of asymptotic expansions.

Biography

Mariia Dvoriashyna is a final year PhD student in Fluid Mechanics and Environmental Engineering programme at the University of Genoa. Her research project is related to mathematical models of fluid flows in the human eye, and it has been developed under the supervision of Prof. Rodolfo Repetto. She completed her undergraduate degree in the department of Mechanics and Mathematics at National Taras Shevchenko University of Kyiv (Ukraine) in 2013. She then was enrolled into the MathMods Erasmus Mundus MSc programme in Mathematical Modelling in Engineering and obtained a joint master's degree between the University of L'Aquila and University of Hamburg (Germany) in 2015. During her studies, Mariia developed an interest in problems related to mathematical biology and biomechanics, which she pursued during her PhD. As a part of her PhD training, she had a pleasure to spend two terms in Mathematical Institute at the University of Oxford (UK), visiting Prof. Eamonn Gaffney. In the last four years, she has attended many problem-solving workshops and study groups of Mathematics in Industry, one of which she initiated and contributed to organising (ESGI 136th, L'Aquila, Italy, May 2018). On free from solving equations time, she likes travelling, singing, surfing and dancing Lindy Hop.

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