

Personal Career Development Plan of Dr. Arnaud Chauvière

I am starting a PostDoc research fellowship at the University of Nottingham funded by the Marie Curie Research Training Network. I am originally from Paris, France, where I received my master's degree in physics with theoretical mechanics as my specialisation. After graduation I was awarded a PhD scholarship at the University *Pierre and Marie Curie* (Paris VI), France, where I obtained a PhD in fluid mechanics. After my PhD I was awarded a short time lecturer fellowship of two years in applied and theoretical mechanics in the University of Versailles, France. I spent the last two years in the Department of Mathematics of the *Politecnico* of Turin, Italy, as an Experienced Researcher within this Network. This actual PostDoc research fellowship is therefore my second one in the field of cancer modeling and it is a great opportunity for me to continue my academic career and accumulate great experience in this field.

Training needs

Through the Marie Curie Network I will be co-supervised by Prof. Helen Byrne, and Dr. Markus Owen in the form of weekly meetings. My supervisors and the Centre for Mathematical Medicine as a whole have great experience and international recognition in the field of cancer modeling paying special attention to interdisciplinary cooperation with hospitals and centres for experimental biology. This will greatly enhance my experience in the field. As I already developed good skills in mathematical modeling, numerical simulation and analytical methods, I will gain a broad knowledge of theoretical biology, and expertise in tumor modeling through the interaction with CMM members, participations to the seminar series and interdisciplinary collaborations. It is worth saying that the participation to the numerous workshops organized within the Network will be also a great opportunity to improve my knowledge in the domain.

Scientific objectives

The general aim of this project is to use mathematical techniques to gain deeper insight into the dynamics of solid tumor growth.

One of my previous works, related to biological systems, used the framework of the generalized kinetic theory. Mathematical methods of the kinetic theory are particularly well adapted to the description of the collective behavior starting from a description of microscopic interactions. This is a

major issue to be able to model the microscopic processes and provide continuum models which make explicit the appearance of spatio-temporal patterns and correlating phenomena at the macroscopic scale. This approach presents the advantage to provide a system of macroscopic conservation laws addressed to a specific biological phenomenon. It enables the development of mathematical analysis and does not relegate most of the discussion to a commentary on the numerical results. That was the aim of a recent work in which a continuum model of cell migration in a anisotropic fibrous environment has been obtained from very simple microscopic assumptions including *contact guidance*. The PDE over the migrating cell density has been obtained in a rigorous way by a moment closure method and an asymptotic limit as well. These procedures provide a very interesting, however extremely complicated, tool to model the terms appearing in macroscopic equations of evolution, starting from a microscopic description of biological and mechanical phenomena. I will certainly continue to develop this work including relevant features of cell migration as *adhesion* and *haptotaxis*.

A wide number of models applied to solid tumor growth has been developed these twenty last years. They involve either discrete (cellular automata, lattice networks) or continuum (reaction-diffusion equations) approaches and this for various cancer kinds. Because of my background, I aim to use the second approach and focus on the Glioblastoma Multiform tumor. This is a very severe kind of brain cancer with a very poor survival prognostic. GBM has the particularity to be very invasive and motility is a major issue to deal with when one is interested in GBM modeling. In the next months, as a member of the CMM of the Nottingham University, I aim to develop a GBM model which account for *chemotaxis* and *haptotaxis* within the tumor invasion. These processes are known to be the most relevant ones that lead to GBM invasion. The degradation of the surrounding tissue when the tumor core needs space to grow will be included as well. Starting again from a microscopic description of the interactions between the different populations involved (*e.g.* the resting cells in the core of the tumor, the invasive tumor cells, the surrounding tissue and the chemical substances that may lead to chemotaxis - as nutrients), we hope we will be able to address the problem, through the closure methods, and propose a macroscopic PDE model that would let us explain the phenotype change when tumor cells gain the invasiveness ability.

Mobility and network

The network brings together experts from across Europe, who share a common interest in understanding and, improving treatment for, solid tumor growth. The research team is highly multidisciplinary, comprising

mathematicians, experimentalists and clinicians whose areas of expertise include: mathematical modeling, numerical simulation, pattern formation, asymptotic analysis, biochemistry, medicine and drug design. Mobility of researchers between centres will inevitably lead to better knowledge transfer, training and integration of the network. I already developed strong interactions with some network partners and I am looking forward to continuing with other partners to facilitate communication between the different research teams. This should lead to the rapid dissemination of, and exploitation of new concepts and new skills.