COST ACTION TD1409 "Mathematics in Industry Network"

Short-Term Scientific Mission: REPORT

Name of Applicant: Dr. Katerina Kaouri (Cyprus University of Technology, Cyprus)

Host: Mathematical Institute, University of Oxford (Prof. Philip K. Maini)

Dates: 1-31/08/16

The STSM was very fruitful. For most of my visit, I continued my research on calcium signaling with Prof. Philip Maini (Director of the Wolfson Centre for Mathematical Biology, Mathematical Institute) and Prof. Jon Chapman (Director of the Oxford Centre for Industrial and Applied Mathematics). Calcium signaling is an important and interesting research area for mathematicians, medical researchers, and pharmaceutical companies since calcium is ubiquitous in living organisms, and plays a key role in many crucial processes in, for example, embryogenesis, cardiac function, and brain function. There are many interesting open problems, and calcium modeling it is a very active area of mathematical modelling. We are currently preparing the final draft of a publication on calcium signaling.

Furthermore, I spent some time revising a second article we had submitted to EJAM last year. Finally, I have obtained more valuable guidance on how to run a Study Group in Cyprus and further develop the area of industrial and applied mathematics.

Research activities during the STSM

A) Mathematical modeling of calcium signaling

Most of the calcium in the body is stored in the bones. The rest is stored elsewhere, and calcium signalling is one of the most important mechanisms of information propagation in the body. Yet, many questions are still open and mathematical modelling can help answer them.

Several models of calcium signalling have been proposed up to now. In our work, motivated by experimental evidence that cells release calcium when mechanically stimulated and that, in turn, calcium release affects the mechanical behaviour of tissue, we propose a 3D nonlinear ODE system, which is an extension of the well-established 2D Atri model for calcium dynamics. The third variable models the dilatation of tissue, and we also introduce a mechanical stimulus that induces calcium release. We have two bifurcation parameters, and we study in detail the bifurcation structure of the system. We investigate in detail the interplay of the mechanical and the chemical effects and we find that as the strength of the mechanical stimulus increases oscillations eventually vanish at a critical value of the mechanical stimulus. Furthermore, we exploit a separation of timescales and we study the system asymptotically.

B) Revision of an article submitted to EJAM in September 2015.

In this work, we quantified the **probability of correct resolution** of the Left-Right Ambiguity Resolution in Towed Array Sonar. The work is co-authored by Dr David Allwright (Senior Mathematician at the Smith Institute for Industrial Mathematics and Systems Engineering, UK). We received the reviewers' reports while I was in Oxford - we have now submitted the revised version.

C) Study Group with Industry in Cyprus and other industrial mathematics initiatives

I have received valuable guidance from Dr Hilary Ockendon, Prof. John Ockendon, and Dr David Allwright on how to run a Study Group with Industry in Cyprus (which is taking place 5-9 December 2016).

Outcomes and next steps:

1) Worked on the revision of an article on an industrial problem which we subsequently re-submitted to EJAM
2) Worked on the final draft of a research article to be sent to a high-impact journal **- to be submitted in November 2016**
3) Received training on running a Study Group with Industry in Cyprus

Overall, this STSM provided me with much needed financial support that enabled me to develop my research in collaboration with world-leading researchers, and to receive valuable guidance on how to contribute to the growth of industrial and applied mathematics in Cyprus, currently an under-represented discipline in the country.