# Modelling coupled surface-bulk viscous flows in animal cells with unfitted finite elements

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**Abstract**

The shape of animal cells is governed by the surface mechanics of its actomyosin cortex: a network of cross-linked polymer filaments stirred by active motors and lying beneath the plasma membrane (1). In large animal cells, cortical actomyosin flows can drag cytoplasmic flows in the cell bulk, and vice versa (2). These surface-bulk hydrodynamic couplings contribute to a myriad of biological functions, such as the establishment of PAR-polarity in the C. Elegans zygote, the even distribution of syncytial nuclei in Drosophila embryos or the asymmetric positioning of the spindle in mouse oocytes. However, they have been so far little investigated, as appropriate numerical tools are very scarce.

In this talk, we will describe our efforts to shed light onto this matter with mathematical modelling and numerical simulations with unfitted Finite Element (FE) methods (3). The mathematical model considers the dynamics of surface-bulk viscous flows on general and smooth closed surfaces with an active term on the surface, representing active tensions generated by the activity of myosin motors. For the numerical discretisation, we have considered a first-of-its-kind approach, coupling trace FE formulations for the surface physics with aggregated FE formulations for the bulk physics. We will provide details on our coupled formulation and its numerical behaviour, performance aspects of the computer implementation, and some numerical examples, including qualitative experimental validation.

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