Free boundaries on the cell boundary: Understanding biologically relevant asymptotic limits of a model for receptor-ligand dynamics

Chandrasekhar Venkataraman

Receptor-ligand interactions, in which cell membrane resident receptors react with ligands in the extracellular medium to form receptor-ligand complexes, constitute a fundamental part of a number of phenomena in cell biology. Hence their mathematical modelling and computational simulation is an important task. In this talk we investigate a simple model for receptor-ligand dynamics which consists of coupled bulk-surface systems of parabolic partial differential equations. Nondimensionalisation of the model using biologically relevant values for the various characteristic scales leads one to consider a number of biologically relevant asymptotic limits of the model. In this talk we develop a mathematical theory for the treatment of the original model together with a rigorous proof of convergence to a number of simplified limiting problems in the aforementioned limits. The theoretical results are supported by computations of the original and reduced problems on realistic geometries. One upshot of our analysis is that, in a suitable parameter regime, the original system converges to a simplified model which is considerably cheaper to approximate numerically leading to orders of magnitude speed up in computational time.