Towards a systems-oriented mathematical model for cancer cell migration

Franziska Matthäus

University of Heidelberg, Germany
franziska.matthaeus@iwr.uni-heidelberg.de

Alistair Middleton, Damian Stichel

Session: 21. Mathematical models for biological invasion

In the talk we present a multi-level and systems-oriented mathematical model for collective cell migration. The model aims at describing lung cancer cells in an experimental setup that involves stimulation with growth hormones. The migratory behavior of these cells exhibits strong correlations between cell positions and velocities are observed that extend over multiple cell diameters which can be attributed to mechanical interactions such as cell-cell and cell-substrate adhesion. We present an individual-based model (IBM) that describes cell migration and adhesion, and captures the appearance of these correlations. The IBM approach allows us to simulate data, but is computationally expensive and difficult to analyze mathematically. We therefore derive a continuum approximation which is both accurate and amenable to fast computational solution. The experimental setup involves a scratch assay, where migratory behavior of lung cancer (H1975) cells is stimulated chemically using different growth hormones, and mechanically by insertion of a gap in the confluent cell layer. Data on the spatiotemporal dynamics following stimulation is then available as a sequence of images taken at equal time steps for 24 to 72 hours after stimulation. For data analysis we use particle image velocimetry (PIV), which provides us with quantitative measures of cell migration, in particular the spatiotemporal velocity distribution and or correlation lengths. By fitting the model to the PIV data we are trying to understand how the mechanical properties of individual cells are being affected by the treatments, which ultimately gives rise to the observed alterations in collective cell migration.