Master 2 “Photonics, Complex and Quantum Systems (PhoCQS)”: Research Training 2023-2024

Supervisor: Eric Louvergneaux

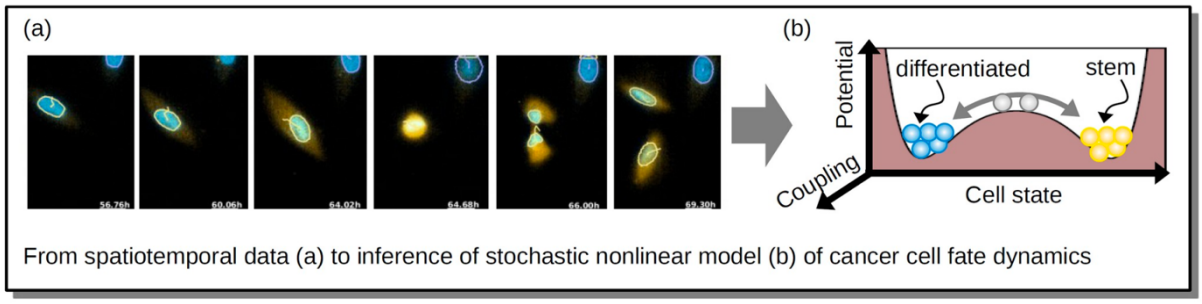
Topic: Dynamics of complex systems

Statistical modeling of the spatiotemporal dynamics of cancer cell populations

Biological organisms and tissues are constantly regenerated and evolving through complex spatiotemporal dynamics of interacting cells. Part of this complexity relies on the highly-heterogeneous nature of cell states and phenotypes, which is even more true in cancerous tumors. Understanding cancer cell heterogeneity requires to characterize how nonlinear, coupling and stochastic processes jointly contribute to complex population dynamics [1].

To address this issue, spatiotemporal data about stem- and differentiated-like phenotypes in cultured breast cancer cells will be analyzed using statistical inference methods [2] to build qualitative yet informative models of cancer cell fate decision. Besides methodological issues, a wider goal of this project is to challenge the cancer stem cell hypothesis [3] according to which a small reservoir of cells within the tumor are resistant to many standard therapies.

The candidate should have a solid background in physical or computational sciences, and some interest in biological/clinical issues.



From spatiotemporal data (a) to inference of stochastic nonlinear model (b) of cancer cell fate dynamics

References:
[1] Sisan DR, Halter M, Hubbard JB, Plant AL. Predicting rates of cell state change caused by stochastic fluctuations using a data-driven landscape model. PNAS. 2012;109:19262-7.
[2] Frishman A and Pierre Ronceray P. Learning force fields from stochastic trajectories, Phys. Rev. X 2020; 10: 021009
[3] Pardal R, Clarke MF, Morrison SJ. Applying the principles of stem-cell biology to cancer. Nat Rev Cancer. 2003;3:895-902.