Simulations of Diffusion on the surface of the Endoplasmic Reticulum: CSE Lab

Master Thesis

INSTITUTE OF COMPUTATIONAL SCIENCE

Protein Diffusion in Cell Membranes

Simulation and analysis of diffusion of membrane-bound proteins in live cells.

Comnputation is becoming an increasingly important tool in cell biology. Advanced experimental methods require computational data analysis and simulations of physical processes in realistic biological geometries.

This project focuses on the simulation of diffusion of proteins in the membrane of the Endoplasmic Reticulum (ER), the main protein factory of every cell. The ER has a complex shape, which complicates the analysis of experimental results. In a standard experiment, fluorescent protein is expressed in the ER. A certain part of the ER is then bleached using Laser light and the influx of non-bleached protein into the bleached region is monitored. Comparing such an observed recovery to a computer simulation allows to measure the diffusion constant of the protein in the living cell.

In this project, a particle code will be used to simulate diffusion on the membrane/ surface of the ER. We will validate the simulations, optimize the simulation code, and compare it to real experiments, thus measuring diffusion constants in living cells.

The project offers a great opportunity for interdisciplinary work and insight to methods of work and reasoning in the life sciences. The project is in collaboration with the Institute of Biochemistry in ETHZ.

PREREQUISITES

Programming experience (F90)
Experience in using Linux/UNIX
Interest in biological applications
Independent worker

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CSE LAB

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In the CSE Lab we combine computational methods, computer science tools, and domain specific knowledge to solve scientific and Engineering Problems in areas such as Fluid Mechanics, Nanotechnology and Life Sciences. The core computational competences of our group are in particle methods and in stochastic optimization techniques. Motivated by challenges in application fields, we focus on identifying the common elements among computational techniques and on formulating common methodological, algorithmic and software structures that facilitate their further development.