Biological Soft Matter Theory

Physics Department TUM

"Soft-Matter Seminar"

Modeling red blood cells and blood flow in health and disease

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Abstract:

Healthy red blood cells (RBCs) are simulated using a coarse-grained RBC model having realistic mechanical properties, rheology, and dynamics. The modeled membrane is represented by a triangular mesh which incorporates shear in-plane energy, bending energy, and area and volume conservation constraints. The macroscopic membrane elastic properties are imposed through a linear semi-analytic analysis and are matched with those obtained in optical tweezers stretching experiments. Rheological measurements characterized by a time-dependent complex modulus are extracted from the membrane thermal fluctuations and from magnetic twisting cytometry results. Dynamics of RBCs in shear flow will be presented and the results of pressure-driven blood flow show the Fahraeus-Lindqvist effect as well as a cell-free layer consistent with experimental data.

The main characteristics of malaria-infected RBCs are progressing changes in their mechanical properties and geometry and their adhesion to the vascular endothelium. Malaria-infected RBCs become considerably stiff compared to healthy ones and may bind to the vascular endothelium of arterioles and venules. This leads to a significant reduction of blood flow, and eventual vessel obstruction. Blood flow in cerebral malaria is simulated using the developed coarse-grained RBC model in combination with RBC adhesion based on the stochastic bond formation/breakage model.

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