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Time evolution of shear-induced particle margination and migration in a cellular suspension QIN M. QI, ERIC S.G. SHAQFEH, Stanford University — The inhomogeneous center-of-mass distributions of red blood cells and platelets normal to the flow direction in small vessels play a significant role in hemostasis and drug delivery. Under pressure-driven flow in channels, the migration of deformable red blood cells at steady state is characterized by a cell-free or Fahraeus-Lindqvist layer near the vessel wall. Rigid particles such as platelets, however, marginate and thus develop a near-wall excess concentration. In order to evaluate the role of branching and design suitable microfluidic devices, it is important to investigate the time evolution of particle margination and migration from a non-equilibrium state and determine the corresponding entrance lengths.
From a mechanistic point of view, deformability-induced hydrodynamic lift and shear-induced diffusion are essential mechanisms for the cross-flow migration and margination. In this talk, we determine the concentration distribution of red blood cells and platelets by solving coupled Boltzmann advection-diffusion equations for both species and explore their time evolution. We verify our model by comparing with large-scale, multi-cell simulations and experiments. Our Boltzmann collision theory serves as a fast alternative to large-scale simulations.

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