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Transport of magnetic nanobeads in a small blood vessel

JONATHAN FREUND, University of Illinois at Urbana-Champaign — Numerical simulations are used to study the transport of sub-micron spherical magnetic beads in a model microvessel, particularly how transport is affected by physiologically realistic concentrations of flowing red cells. (Such beads are candidate vehicles for targeted drug delivery.) A previously validated high-fidelity boundary integral algorithm is used to solve the flow equations in the viscous limit in a $\sim 15\mu$m vessel. As expected, the red cells suppress transport toward the vessel wall when a magnetic field is applied normal to the flow direction. A more subtle mechanism is important when a magnetic field has a component parallel to the vessel. A homogeneous fluid model would be insensitive to forces applied in this direction, but tendency of blood cells to tilt away from the wall on their upstream side breaks the streamwise symmetry. These tilted cells act as viscous-flow variants of turning vanes, guiding magnets toward the wall if they are slowed by the magnetic field and toward the vessel center if they are accelerated by the magnetic field. This affects dispersion in the vessel and can also alter wall-ward magnetic field driven transport.

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