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Mixture model for biomagnetic separation in microfluidic systems

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Abstract: In this paper, we show that mixture model, with algebraic slip velocity relating to the magnetophoresis, provides a continuum-based, and cost-effective tool to simulate biomagnetic separations in microfluidics. The model is most effective to simulate magnetic separation protocols in which magnetic or magnetically labeled biological targets are within a naturally dilute or diluted samples. The transport of these samples is characterized as mixtures in which the dispersed magnetic microparticles establish their magnetophoretic mobility quickly in response to the acting forces. Our simulations demonstrate the coupled particle-fluid transport and the High Gradient Magnetic Capture (HGMC) of magnetic beads flowing through a microchannel. Also, we show that the mixture model and accordingly the modeling of the slip velocity model, unlike with the case with dense and/or macro-scale systems, can be further simplified by ignoring the gravitational and granular parameters. Furthermore, we show, by conducting comparative simulations, that the developed model provides an easier and viable alternative to the commonly used Lagrangian-Eulerian (particle-based) models.