Quasi-static analysis of a ferrofluid blob in a capillary tube

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Ferrofluids are stable dispersions of coated single domain ferro- or ferri-magnetic nanoparticles dispersed in a carrier liquid. Ferrofluids have promising application potentials for biological, medical, subsurface, and many other industrial purposes. In their subsurface applications, the nano-size particles are capable of flowing through micron-size pores without blocking them, and with minimal retention in the rock. To bring the potentials to reality, it is of utmost importance to characterize the behavior of ferrofluids under different conditions, especially in the presence of more than one phase. In this study, the quasi-static behavior of a non-wetting ferrofluid blob, surrounded by a wetting fluid confined in a capillary tube, is investigated when a magnetic field is applied. The effect of geometrical, hydrodynamic, and magnetic properties of the blob on its deformations when subject to a magnetic field is explained.

Finally, in order to relax the simple confining geometry assumption, we show preliminary simulations using the level set method in complex solid geometries. The method was previously developed for capillarity and used for realistic rock geometries, and now accounts for magnetic pressures, as well.