# Deformation of ferrofluid droplets: the interplay between shear flow and magnetic field

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**Abstract**

The dynamics of a ferrofluid droplet embedded into another immiscible and non-magnetizable phase are investigated assuming shear (creeping) flow conditions and a magnetic force acting on the droplet in a direction perpendicular to the velocity field. Such problem is addressed numerically via solution of the relevant mass and momentum partial differential equations properly coupled with the Maxwell equations. The deformation of the boundary separating the droplet from the external matrix is properly tracked by means of a hybrid Level set-VOF technique relying on a finite-volume approach and a non-staggered collocation of the fluid-dynamic variables on the underlying grid. We use such a framework to identify the cause-and-effect relationships driving the droplet dynamics and the related dependences displayed by its deformation on the problem characteristic numbers (namely, the Capillary number and the non-dimensional intensity of the applied magnetic field). Both the shape and orientation of the main axis of symmetry of the droplet depend significantly on such parameters. Sudden removal of the applied magnetic field causes a relaxation process which can fairly be approximated in some ranges of the Capillary number and magnetic field intensity with the evolution of a simple damped harmonic oscillator.