69h Magnetically Driven Surface Flows in Ferrofluids

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The rotational flow induced on a ferrofluid free surface by a uniform planar rotating magnetic field has long captivated the imagination of scientists and engineers. This effect was long believed to be due to body couples and asymmetric stresses on the bulk of the fluid, arising from the polarizable nature of these structured continua and described by the ferrohydrodynamic equations. However, experiments have shown that the direction of rotation can be made to reverse upon change from a concave to a convex interface, making it evident that a surface phenomenon is responsible for the observed behavior. Still, recent experiments have demonstrated that bulk flow occurs in agreement with the ferrohydrodynamic equations. These observations and experiments will be presented, with a phenomenological explanation and rigorous derivation for the interfacial stress balance in a ferrofluid, and an analysis of the magnetically driven surface flow of a planar ferrofluid film subjected to a rotating magnetic field.