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Ferrofluid Meniscus Shape in an Applied Uniform Horizontal or Vertical Magnetic Field

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The classic analysis of the shape of a meniscus due to fluid wetting a vertical wall, including the influence of fluid weight and interfacial surface tension, is extended to ferrofluids stressed to magnetic saturation by a horizontal or vertical uniform magnetic field. This analysis is the first step in a larger analysis to calculate the magnetic surface force due to ferrofluid surface shapes altered by magnetic fields and forces that cause surface driven flows in rotating magnetic fields. Bernoulli's equation, including "magnetic pressure" together with the interfacial force balance due to pressure, surface tension and jump in Maxwell stress, leads to a second-order non-linear differential equation for the solution of interfacial displacement. Solutions show that a horizontal magnetic field raises, while a vertical magnetic field lowers, the meniscus height. Preliminary optical experiments are presented which measure meniscus height and shape using narrow light beam reflections from the meniscus as a function of horizontal magnetic field.

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