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Theory and Simulation of the Pyromagnetic Coefficient of a Ferrofluid

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The pyromagnetic coefficient is the temperature derivative of the magnetisation under a constant applied field. It is a central quantity in several applications ranging from temperature sensing to thermomagnetic cooling[1]. In this work, the pyromagnetic coefficient of a ferrofluid is computed using modified mean field theory [2], and in particle-based Langevin dynamics simulations using a fluctuation formula. The roles of thermal expansion of the carrier fluid and the intrinsic magnetic properties of the suspended particles are outlined. For systems with physically realistic parameters, the theoretical predictions are shown to be in good agreement with simulation results, with discrepancies only appearing when chain formation begins. It is indicated how particle-size polydispersity can be used to maximise the pyromagnetic coefficient over broad ranges of applied field, which could be important for applications.

References

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