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Research and Application of Micromagnetic Simulation Based on Landau-Lifshitz-Gilbert Equation

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Research Methods



Landau-Lifshitz-Gilbert Equation

Landau-Lifshitz-Gilbert (LLG) equation describes the microkinetics of magnetization in ferromagnetic materials. It combines the Landau-Lifshitz (LL) equation and the Gilbert damping term α , which is used to simulate and understand the micro-magnetic dynamics phenomena such as the motion of magnetic domain walls and magnetization reversal.

$$\frac{d\mathbf{m}}{dt} = -\gamma \mathbf{m} \times \mathbf{H}_{\text{eff}} - \alpha \mathbf{m} \times \frac{d\mathbf{m}}{dt} \quad (1.1)$$

To process the term $\alpha \mathbf{m} \times d\mathbf{m}/dt$, we left multiply the LLG equation by \mathbf{m} and use the identity $\mathbf{m} \cdot d\mathbf{m}/dt = 0$ to generate LL equation.

$$\frac{d\mathbf{m}}{dt} = -\frac{\gamma}{1 + \alpha^2} \mathbf{m} \times \mathbf{H} - \frac{\gamma\alpha}{1 + \alpha^2} \mathbf{m} \times \mathbf{m} \times \mathbf{H} \quad (1.2)$$

The LLG equation is more convenient for numerical calculation, while the LL equation can introduce the dissipation term more physically.