Transient behaviours of the Ising ferromagnetic thick cubic shell

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Abstract: We have investigated the nonequilibrium properties of an Ising ferromagnetic thick cubic shell through extensive Monte Carlo simulations. The study focuses on transient responses — specifically relaxation dynamics and metastable behaviour — and their dependence on shell thickness Δ . Exponential magnetic relaxation is observed for all values of shell-thicknesses, with the relaxation time τ_{relax} decreasing as the thickness Δ increases. The variation of the relaxation time τ_{relax} with shell-thickness exhibits three distinct regimes: (i) rapid fall region, (ii) plateau region, and (iii) linear region. The decay of the metastable state, another significant transient phenomenon, has also been analyzed in detail. The metastable lifetime τ_{meta} as a function of external magnetic field follows the predictions of Classical Nucleation Theory, exhibiting three characteristic regimes: (1) strong field regime, (2) coalescence regime, and (3) nucleation regime. Interestingly, when studied as a function of shell-thickness, the metastable lifetime displays a non-monotonic variation, with a specific thickness corresponding to the maximum metastable lifetime.

References

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