CRITICAL DYNAMICS IN NANOSCALE

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Critical dynamics, formally defined in terms of metastability and ergodicity breaking, is a topic of advanced research and novel applications. Problems in theory basically emerge from the violation of conventional statistics with application to behavior of higher-level object as determined from the lower – level background. Developments, reported in this work, are addressed to (i) nanoscale behavior of ferroelectric polarization and (ii) magnetization in a dot of spins as illustrative examples. In classic limit the setting includes Langevin equations for interacting subsystems (blocks) and the corresponding multivariate probability density introduced by the nonlinear Fokker-Planck equation. Critical behavior is initiated by attractive mean-field interaction between adjacent blocks and the impact of thermal fluctuations. The mathematical technique comprises Wentzel-Kramers-Brilluin ansatz and subsequent symplectic integration which yields polarization and electroelastic response at arbitrary driving, finite size, and essential boundary conditions [1, 2]. However, minimum size of blocks is limited by applicability of the Boltzmann statistics. Going down the lenght scale the open quantum system approach becomes actual. We demonstrate nonstationary solutions for phase transition in dot of Ising spins with the spin (1/2) – dot coupling as a source of ergodicity breaking, and dot – phonon bath coupling as a source of relaxation inspired from Fokker-Planck type relations derived in [3]. Unlike classic models, in this open quantum approach the kinetic and diffusion coefficients emerge from microscopic entities as a substantial advancement and a clue to temperature dependent ab initio approach for more realistic systems.

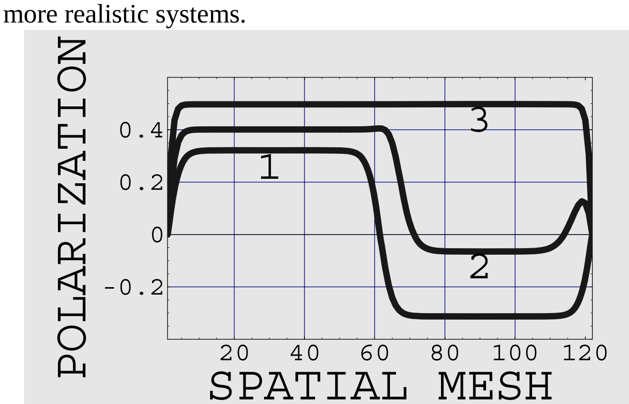

Fig.1 Nanoscale behavior of ferroelectric polarization Two 180^0 domains in stationary state (1) at zero source field. Time development toward monodomain state (3) is evidenced as combined effect of the motion of domain boundary and the birth and growth an opposite domain (2). Estimate for spatial increment 10^{-8} m.

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