Equilibrium Simulation of Longitudinal and Transverse Order of the Three-Dimensional Vortex Glass

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Abstract

Due to its enhaced effect of thermal fluctuations, the phase diagram of high-T_c superconductors under external fields is a highly nontrivial matter. It has been expected that the intrinsic pinning effect which inevitablly exists even in clean samples, combined with the frustration effect caused by applied magnetic fields, gives rise to a thermodynamically stable glassy state, vortex-glass phase. In this state, phase of the condensate is randomly frozen and the linear resistance vanishes. This claim found support in ome experiments and numerical simulations, although there exist several works which cast doubt to the existence of such vortex-glass state as a true equilibrium thermodynamic phase. For example, simulations based on the gauge-glass model suggested that the vortex-glass phase might be unstable against the screening effect. Meanwhile, the gauge-glass model is an extremely simplified and somewhat aritificial model, which is spatially isotropic without a uniform magnetic field threading the system. I wish to report here on my recent numerical simulation on a more realistic model, both with and without screening, where the effects of uniform external fields are taken into account. The simulation is performed based on a recetnly proposed version of extended ensamble methods (parallel tempering) and is fully equilibrated. By carefully examining the size-dependence of appropriate thermodynamic quantities, the possibility of the longitudinal (parallel to the field) and of the tranverse (perpendicular to

the field) vortex-glass ordering is examined.