MAR09-2008-004422

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Thermodynamics and Flow of the Vortex Matter at the Second-Order Glass Transition in $\mathbf{Bi_2Sr_2CaCu_2O_{8+\delta}}$[1]

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We study the low temperature phase diagram of the vortex matter in the high-T_c superconductor $Bi_2Sr_2CaCu_2O_8$. By employing vortex shaking the vortex system is relaxed towards the equilibrium state. We thus reveal a novel second-order glass transition, manifested by a sharp reversible kink in the measured local magnetization [2]. The glass line bisects the first-order melting line close to its extremum below which disorder is dominant. Consequently, the phase diagram consists of four thermodynamic phases: At high fields, above the melting line, we find amorphous vortex glass and liquid phases; Surprisingly, at low fields the glass transition separates between a low-temperature Bragg glass and a thermally depinned variant of it - possibly a perfect lattice. Studying the oxygen doping dependence of the vortex phase diagram we unexpectedly find that the novel low- temperature glass transition, along which quenched disorder should play a dominant role, has the same anisotropy dependence as that of the high-temperature melting line, where disorder is negligible [3]. Finally, we utilize an indirect measurement technique to reconstruct the low- temperature I-V characteristics in the region which is inaccessible by transport measurements [4]. At high temperatures the bulk resistance is of a thermally activated flux flow with linear I-V both in the liquid phase above the melting line as well as below it within the ordered phase. At lower temperatures, on approaching the glass transition, the temperature dependence of the bulk resistance becomes much sharper. This deviation from a simple Arrhenius behavior tracks the glass line, and may signify criticality.

[1]H. Beidenkopf is supported by the Adams Fellowship Program of the Israel Academy of Sciences and Humanities

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