Anisotropic vortex lattice melting of the untwinned $YBa_2Cu_3O_{7-\delta}$ crystals

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Abstract

The nature of vortex lattice melting still has some on-going controversial affairs. We would like to focus on the anisotropic properties of the vortex lattice melting in Y123 crystals. Vortex lattice melting transition of a large untwinned $YBa_2Cu_3O_7$ crystal ($T_c = 91.6$ K) in case of $H \parallel c$ axis appears as a jump in dc magnetization M_{dc} at a melting transition T_m and an abrupt transition in the ac susceptibility χ_{ac} above T_m. Similarly, M_{dc} shows a jump at T_m in the $H \parallel b$ and $H \parallel a$ configurations, indicating that the first-order-melting transition occurs in a highly compressed vortex lattice. This is reinforced by a lattice softening in χ_{ac} below T_m and a sharp transition above T_m. The intrinsic pinning is not so effectual in the vortex liquid. The melting lines fitted by $H = H_0(1 - T/T_c)^{1.5}$ give the relations $H_0^{\|a}/H_0^{\|c} = 7.24 \pm 0.09$, $H_0^{\|b}/H_0^{\|c} = 8.93 \pm 0.12$, and $H_0^{\|b}/H_0^{\|a} = 1.23 \pm 0.01$. These are in excellent agreement with the anisotropy parameters $\gamma_{ca} = \sqrt{m_c/m_a} = 7.44 \pm 0.25$, $\gamma_{cb} = \sqrt{m_c/m_b} = 8.79 \pm 0.21$, and $\gamma_{ab} = \sqrt{m_a/m_b} = 1.18 \pm 0.05$. The presentation will be published in Phys. Rev. B**58** (1998) by T. Ishida *et al.*