Josephson glass and decoupling of flux lattices in layered superconductors

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Abstract

Phase transitions of a flux lattice in layered superconductors with magnetic field B perpendicular to the layers and in the presence of disorder are studied [Horovitz and Goldin, Phys. Rev. Lett. **80**, 1734 (1998)] . We consider first the decoupling transition [Daemen *et al.*, Phys. Rev. Lett. **70**, 1167 (1993)] in which the Josephson coupling between layers vanishes above a temperature T_d while the lattice can be maintained by the electro-magnetic coupling between layers. We reinterpret this transition in terms of a renormalized Josephson coupling which vanishes at temperatures $T > T_d$ only on *long scales*, while locally the Josephson coupling can yield a finite plasma resonance.

We consider next effects of disorder by employing replica symmetry breaking methods. We find a glass phase transition T_g such that for $T < T_g$ strong pinning is expected. This is due to to point disorder which generates a random Josephson coupling and a "Josephson glass" order parameter. At $T > T_g$ only the much weaker Bragg glass type pinning survives. The lines T_d and T_g cross and lead to four distinct phases which meet at a multi-critical point in the $B - T$ phase diagram. The phase diagram accounts for unusual data on $Bi_2Sr_2CaCu_2O_8$ such as the "second peak" transition and the recently observed depinning transitions [Fuchs *et al.*, Nature (London) (to be published)].