Moving glass theory of driven lattices with disorder

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Abstract

We review the theory of the Bragg glass. We examine the current status (theory, experiments, simulations) of the prediction made in [Phys. Rev. B **52** (1995)], that the phase diagram of all type II superconductors consists of a topologically ordered Bragg glass phase at low fields undergoing a transition at higher fields into a vortex glass or a liquid. We find that the proposed phenomenology is compatible with 96-97 experiments on superconductors, as described in [TG, PLD, Phys. Rev. B 55 6577 (1997)] as well as 97-98 experiments. We review our theoretical estimation of the position of the phase boundary. The stability of the Bragg glass phase is demonstrated in a layered geometry with a weakly first order transition towards an amorphous glass [D. Carpentier, PLD, T.G.,Euro.Phys.Lett. 35 (1996), p. 379]. We

present a detailed study of elastic 2D solids with substrate disorder using new renormalisation group calculations [D. Carpentier, PLD, cond-mat/9712227], which extend the conventional KTNHY theory. We find that the pure melting transition is replaced by a sharp crossover between a high temperature liquid with thermally induced dislocations and a low temperature glassy regime with disorder induced dislocations at scale larger than $\xi_d >> R_c$ which we compute both near T_m and at low T. We discuss experimental consequences of this cross-over, reminiscent of the pure melting transition, such as size effects in vortex flux flow and AC response in thin films. In the low T regime, a 2D quasi-Bragg glass exists and is studied in detail [D. Carpentier, PLD, Phys.Rev.B 55 (1997), p.12128]. Finally a recent study is presented of a new type of transition in 2D between a quasi ordered XY phase and a disordered phase [D. Carpentier, PLD, cond-mat/9802083]. It is driven by frozen topological defects and broad fugacity distributions. It is treated using a novel RG approach to 2D random XY models which includes fusion of environments. Via the Kolmogorov non linear equation (KPP) which appears as a RG flow equation for the fugacity distributions of the defects, it is shown that the problem has precise connections to Derrida's random energy models, and recent studies of 2D random Dirac operators.