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Title :
Disorder induced power-law behavior of individual superconducting vortices on a twin boundary : using magnetic force microscopy to study directed polymers in random media

Abstract :
We use a low temperature magnetic force microscope (MFM) to both image and manipulate individual vortices trapped on a twin boundary, a common planar defect, in optimally doped YBCO. This allows us to test an extensive body of theoretical work on directed polymers in random media. This theoretical framework is important for diverse systems including polymers, magnetic domain walls, strongly driven fluids, friction, spin-glasses, vortices in superconductors and more. Our approach is facilitated by the twin boundaries which only allow trapped vortices to move in along a plane. We find that when we drag a vortex with the magnetic MFM tip the vortex moves in a series of jumps. As theory suggests, the distribution of the sizes of these jumps does not depend on the force that we apply. Even more significantly, we find that the jump sizes are power-law distributed - the disorder in the sample enhances the wandering of the vortex off the field axis. The power-law that we measure provides an estimate for the wandering exponent, a universal number which is notoriously hard to measure.