Nonlinear Dynamics of a Flux Line Lattice

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Abstract

We report on remarkable nonlinearities in the response of the flux lattice (FLL) in NbSe2. These effects are observed in the region of the H-T phase diagram where the DC critical current, $< I_c$, increases with H and T (the lower part of the "peak effect" region). In this regime the FLL can be set in motion with currents that are lower than $< I_c$ by periodically reversing the direction of the current. When driven by a train of symmetric square wave pulses, the amplitude of the response increases with each pulse until it reaches a steady state value. The onset of the finite response to the AC currents defines a critical current, I_{ac} which in this regime can be much lower than I_c , but elsewhere in the phase diagram the two are almost identical. If the current switching is stopped and the drive returned to DC the response slowly decays to zero. The decay is logarithmic in time and is similar to that observed in compaction of granular materials. The decay depends strongly on the frequency of the drive before it was turned back to DC. In other words the system remembers the driving frequency long after the AC drive was turned off. When the current is switched to zero the flux motion stops

instantaneously. But when it is turned back on their motion resumes exactly where it stopped, even after very long times, indicating that in the absence of current the FLL does not move and can remian trapped in a metastable state indefinitely. This shows that thermal fluctuations are negligible and that the current is the agent that allows the system to explore its phase space. We will introduce a model which qualitatively accounts for these phenomena.

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