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Nonlinear dynamics of vortices in nano-structured superconductors[1]

FRANCOIS PEETERS, Department of Physics, University of Antwerp, B-2020 Antwerpen, Belgium

Nonlinear flux dynamics in superconductors is a prototype for many nonlinear phenomena occurring in different areas of physics. It is well-known that vortices in nano-structured superconductors with dimensions comparable to characteristic length scales behave very different from those in bulk materials, e.g. multi-quanta giant vortices and symmetry-induced vortex-antivortex pairs can nucleate which are impossible in bulk. I will give a few examples of the surprising behavior of vortex matter in different type of nano-structured superconducting films. Our analysis is based on the time-dependent Ginzburg-Landau theory. Where possible comparison with experiments.will be made. For example large resistance oscillations are found, different from the usual Little-Parks effect, that are due to current-excited moving vortices. Unusal field-induced increase in the critical current may be observed as a consequence of the nonlinear distribution of the current in a sample. In type-I superconductors even in the intermediate state the smallest building block turns out to be a flux quantum and the current driven nucleation of flux domains is discretized to a single fluxoid. Domains of opposite flux, when driven towards each other, annihilate through a discretized sequence of single vortex-antivortex pairs.

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