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M. Timmermans, T. Samuely, B. Raes, J. Van de Vondel, V.V. Moshchalkov

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M. Timmermans[a], T. Samuely[a,b], B. Raes[a,c], J. Van de Vondel[a], V. V. Moshchalkov[a]

[a] *INPAC Institute for Nanoscale Physics and Chemistry, KU Leuven, Celestijnenlaan 200D, B3001 Leuven, Belgium.*
[b] *Centre of Low Temperature Physics, Institute of Physics, P.J. Šafárik University, Park Angelinum 9, 04001 Košice, Slovakia*
[c] *Physics and Engineering of Nano Electronic Devices Group, Catalan Institute of Nanotechnology, Campus Universidad Autónoma de Barcelona, E-08193 Bellaterra, Spain.*

Abstract

The resistive state of a superconductor in magnetic field has been thoroughly investigated both by experiments and by theoretical simulations. However, a local study of vortex dynamics inducing dissipation was performed only recently by means of scanning Hall probe microscopy (SHPM). In this work we extend this idea and we visualize the oscillatory motion of vortices in $NbSe_2$ using scanning tunneling microscopy (STM). In contrast to previous experiments, sensitive to magnetic fields, the STM probes the local density of states and the local topography. Its ability to resolve vortices is limited by the coherence length as opposed to the penetration depth in magnetic measurements. In the case of type-II superconductors ($\lambda > \xi$) this technique resolves vortex motion beyond the detection limit of the SHPM. In addition, we prove the enhanced sensitivity by observing vortex motion in a very dense vortex lattice (H=600 mT).

Keywords: STM, vortex, dynamics, superconductivity, scanning tunneling microscope

1. Introduction

Vortex dynamics has been studied for many years. Most experiments consisted of measuring the global electrical resistance across a wire or strip [1, 2]. This global resistance due to the motion of vortices [3, 4] is detrimental for applications, where the zero resistance of the superconductor is intended. Therefore different methods of vortex pinning were devised. These methods in general increase the upper critical field and the critical current of the superconductor [5, 6, 7]. Additionally, these methods give rise to interesting features like matching effects [8, 9]. Researches rely mostly on two types of phenomenological models in order to explain the obtained experimental results. The first is based on molecular dynamics simulations [5, 6] which treats the vortex as a hard interacting object moving in a potential landscape. The second model is