Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

The dynamics and pinning of single vortices in type-II superconductors investigated using a scanning SQUID-on-tip microscope LIOR EMBON, YONATHAN ANAHORY, ALEX SUHOV, DORRI HALBERTAL, JO CUPPENS, ANTON YAKOVENKO, AVIRAM URI, YURI MYASOEDOV, MICHAEL RAPPAPORT, Weizmann Institute of Science, MARTIN HUBER, University of Colorado Denver, ALEX GUREVICH, Old Dominion University, ELI ZELDOV, Weizmann Institute of Science — The electromagnetic properties of superconductors, particularly their ability to carry non-dissipative currents, are governed by the dynamics of quantized magnetic vortices and their pinning due to material defects. Despite recent advances in the understanding of the complex physics of vortex matter, the behavior of vortices driven by current through a potential created in an actual material is still not well understood, mostly due to the scarcity of adequate experimental tools. Using a novel scanning SQUID-on-tip microscope we have investigated the controlled dynamics of vortices in Pb films with sub-Angstrom sensitivity to vortex displacement. Using the ability to trace vortex trajectories on nanometer scales, we measured, for the first time, the fundamental dependence of the elementary pinning force of multiple defects on the vortex displacement, revealing a far more complex behavior than has previously been recognized. Our results indicate the importance of thermal fluctuations even at 4.2 K, and of the vital role of small and seemingly un-important ripples in the pinning potential. These give new insights into the mechanisms of magnetic relaxation and electromagnetic response of superconductors.

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Date submitted: 04 Nov 2015 Electronic form version 1.4