Avalanches of flux quanta in a ridge-like magnetic landscape

E. Altshuler[1,2], T.H. Johansen[3,2] , Y. Paltiel[4], Peng Jin[2],
K. E. Bassler[5], O.Ramos[1], G. F. Reiter[5], E. Zeldov[4] and C. W. Chu[2,6,7]

[1] Superconductivity Laboratory, IMRE – Physics Faculty, University of Havana, 10400 Havana, Cuba.
[2] Texas Center for Superconductivity, University of Houston, Houston, TX 77202-5002, U.S.A..
[3] Department of Physics, University of Oslo, POB Blindern, N-0316 Oslo, Norway.
[4] Condensed Matter Phyics Department, Weizmann Institute of Science, Rehovot 7610, Israel.
[5] Department of Physics, University of Houston, TX 77204-5005, U.S.A.
[6] Lawrence Berkeley National Laboratory, Berkeley, CA 94720, U.S.A.
[7] Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong.

In type II superconductors, magnetic flux penetrates as *vortices*, which consist in tiny whirpools of current typically 100 nanometers-diameter, each containing one flux quantum ($\sim 2 \times 10^{-15}$ Tm^2). Due to their mutual repulsion and their interaction with the *pinning centers* of the material, these nanometric magnetic entities enter discontinually, producing *avalanches*. There has been much discussion in the literature about the issue of the connection between Self Organized Criticality (SOC) and the dynamics of vortex avalanches. Power-law, robust avalanche size distributions are expected in the scenario of SOC. These characteristics are reasonably accepted to occur in the case of the Barkhausen effect, but not in the case of vortex avalanches. Here, we are able to measure vortex avalanches in a Nb foil with single flux quantum resolution using micro Hall probe arrangements (MHPA). The size-statistics of these local avalanches are measured at different locations of a "ridge-like" intrincate magnetic scenario which we can be visualize through Magnetooptical Imaging (MOI). The combinantion of MHPA and MOI provides a new dimension in the study of vortex avalanches, and suggests that SOC is a correct scenario to decribe their dynamics. Using different experimental arrangements, we are also able to estimate the size and "stiffness" of vortex bundles taking part in the avalanches.