Dynamics of Magnetic Flux Avalanches in Superconducting Films
PAUL LEIDERER, Department of Physics, University of Konstanz, Germany

Magnetic flux penetration into superconducting films can occur along two different scenarios: either in the form of homogeneously propagating flux fronts, or as a dendritic instability with branch-like flux avalanches propagating into the previously flux-free region of the superconductor. Since the relevant time scale for these processes in the case of thin films is in the nanosecond range, we have developed a fast pump-probe technique for magneto-optic imaging. The method is based on nucleating an event (e.g., the formation of a flux avalanche in a superconductor) by means of a femtosecond “pump” laser pulse, and taking a magneto-optic snapshot of the developing flux distribution by a delayed “probe” beam. The time resolution of this technique is given by the response time of the magneto-optic garnet films used, which in our experiment is about 100 ps. Using this technique, we have investigated the dendritic instability for various film materials (e.g., YBa$_2$Cu$_3$O$_{7-d}$ and MgB$_2$) and have constructed a “stability diagram” which separates regions with homogeneous flux penetration from unstable ones. In addition, we have studied systematically the influence of relevant parameters like film thickness and external magnetic field on the propagation characteristics of the flux dendrites. The experimental results are compared with a theoretical model for dendrite propagation, and good agreement is found.