The influence of the external magnetic field on the flux jumps dynamics in the flux flow model

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At certain conditions critical state of superconducting sample may become unstable leading to a thermomagnetic avalanche called flux jump. The dynamics of thermomagnetic avalanches remains poorly understood. In present work we study dynamics of the flux jumps assuming the conductivity of the sample during the jump to be described by the flux flow conductivity, $\sigma_{ff}=\sigma_n B_{c2}/B$, where σ_n is the normal state conductivity, B_{c2} – induction of the second critical field and B – induction of the local magnetic field. This problem we have solved numerically for an infinite slab sample with thickness $2d$.

We have solved the equation of magnetic diffusion $\frac{\partial B}{\partial t}=\frac{1}{\mu_0\sigma_n B_{c2}}\frac{\partial}{\partial x}\left(B\frac{\partial B}{\partial x}\right)$ with appropriate initial and boundary conditions. We assumed that at the beginning superconducting sample is fully penetrated by the magnetic flux and that the local induction of the magnetic field, in the whole sample, is equal to B_0. The external magnetic field is then increased by a value of ΔB_a and in the external magnetic field of $B_0+\Delta B_a$ flux jumps occurs. Hence in order to calculate the dynamics of the flux jump, we assumed the initial condition $B(x,0)=B_0+\left[\Delta B_a-\mu_0 J_c(d-|x|)\right]\theta\left(\Delta B_a-\mu_0 J_c(d-|x|)\right)$, where J_c is the critical current density and θ – Heaviside step function, and the boundary conditions $B(\pm d,t)=B_0+\Delta B_a$.

In our simulations we used the parameters characteristic for a conventional NbTi superconductor at 4.2 K. In particular we study the influence of the parameter B_0 on the flux jumps dynamics. We have found that this parameter strongly influence initial stage of the flux jump. With increasing B_0 decreases time during which flux front of the avalanche reaches the center of the sample. Temporal changes of the magnetic field distribution in the sample during the avalanche will be presented.