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Current distribution in field-cooled $YBa_2Cu_3O_7$ and MgB_2 disks as deduced from levitation force and trapped field measurements carried out in a large temperature range

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A classical method used for determining J_c, the critical current density in superconducting cylinders consists in measuring the magnetic field along the superconductor axis after field cooling the sample. Supposing that the current generating the trapped field flows in the whole sample, the trapped field is proportional to J_c and the obtained curve can be reproduced with the Chen et al. expression [Chen et al. Journal of Applied Physics ***72***, 1013 (1992)], using J_c as a fitting parameter. However, confirming some numerical simulations, a combination of trapped field and levitation force measurements carried out at 77K has shown that the current flows in a restricted region of the cylinder with thickness ***t***, that does not depend on the magnetization process of the superconductor [P.Bernstein et al. Supercond. Sci. Technol **29** 075007 (2016)]. Here, we report levitation force and trapped field measurements carried out on both a MgB_2 and a $YBa_2Cu_3O_7$ cylinder in a large temperature range in order to investigate the dependence of ***t*** on temperature. The results show that ***t*** decreases as the temperature decreases. A consequence is that the trapped field can no longer be considered as proportional to J_c. This behaviour is due to the magnetic energy stored in the superconductor, that does not depend on its temperature. As a result, ***t*** behaves as $J_c^{-2/3}$, while the trapped field along the axis of the cylinder behaves as $J_c^{1/3}$. These claims are substantiated by the experimental results obtained with both samples.

Authors: BERNSTEIN, Pierre (Université de Caen-Normandie); Mr COLSON, Louis (Université de Caen-Normandie); Mr DUPONT , Louis (Université de Caen-Normandie); Prof. NOUDEM, Jacques (Université de Caen-Normandie)

Presenter: BERNSTEIN, Pierre (Université de Caen-Normandie)

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