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Reviewer's report on the PhD thesis
"Critical state response in hard type II superconductors (comparison of transverse and longitudinal geometries)" presented by Ahmed Youssef

1. General

Use of magnetic measurements in the contactless characterization of superconductors requires quantitative models that take into account real sample shapes. Therefore the study of this problem on three different materials is of practical importance and scientific interest.

2. Content

The presented thesis, after general introduction to superconductivity, contains the summary of critical state model based analytical predictions for magnetization curves. Author used the distributions of current density published in literature for various geometries in order to calculate the hysteresis magnetization loops and derive AC susceptibilities: real and imaginary parts of the fundamental, 3rd and 5th harmonics, respectively. He developed the procedure for extracting the temperature-dependent critical current density from measured susceptibilities.
Sensitive home-made SQUID magnetometer has been used to collect the experimental data. For each of the studied materials (Nb and YBCO strips and a (Nd,Eu,Gd)-123 puck, respectively) only one experimental sample is mentioned.
Experimental results are clearly presented and data analysed utilising the original procedure developed by the candidate.

3. Judgement and criticism

The work contains interesting original data on AC susceptibility. However, the conclusion about the applicability of the critical state model is not enough clear in my opinion. In particular, I would like the candidate during the defence to address the following points:

a) To which temperature is referred the quantity J_{c0} presented in Table 4 and Table 5? In the case it is the prefactor attributed to T = 0 as indicated on Page 62 then the discrepancy between values obtained analysing the data taken at different amplitudes is too big and the candidate should comment on

this. In the case this is the quantity determined for certain temperature (e.g. that of the imaginary peak) I would be interested to see the temperature dependence of J_{c0} .

b) Reduction of the imaginary peak at weakest AC field amplitude observed in Nb sample could be explained by various mechanisms different from flux pinning. The most plausible explanation can be found by comparing the results obtained at different frequencies. Did the candidate try this, if yes what was the result?
c) The critical state model disregards the existence of flux vortices. Could the candidate explain which intervortex distance he expects in Nb or YBCO film at the imaginary peak when the AC field amplitude is 1 μT and compare it with the sample dimensions?

In spite of these questions the candidate has proven the ability to conduct autonomously a systematic research activity and interpret the obtained results. I recommend that he could defend his PhD thesis.

Bratislava, October 2011