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The superconducting transition in TES: possible role of vortex pair unbinding

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The R(T,I,H) shape of the superconducting transition of Transition Edge Sensors (TESs) is crucial for their operation and performances. Its sharpness as a function of temperature and current influences the devices noise. Also, the behaviour of the resistance as a function of these three parameters can provide understanding of the physical phenomena governing the transition, which in turn can be essential to define optimization routes.

Estimates of fundamental lengths of TESs suggest that they behave as dirty type II superconductors, likely two-dimensional (2D). The onset of dissipation in 2D superconductors at H=0 is most often related to the so-called Berezinskii-Kosterlitz-Thouless transition, that is, the thermal unbinding of vortex-antivortex pairs: this may cause the motion of free vortices through the film under any applied electrical current, which would result in a voltage drop, and thus the appearance of a finite resistance at a temperature below the superconducting mean field critical temperature (that is, without Cooper pair breaking). This flux motion is considered a possible source of excess noise in TESs.

We have performed a study of the resistive transition of Mo/Au-based TESs with diverse sizes and critical temperatures, under different applied electrical currents and magnetic fields. We have found a distinct analytic expression for R(T,I) at zero magnetic field, which holds for all the devices analysed at low biases, from the appearance of resistance up to quite high R/Rn values in some cases. We argue that this expression might be indicative of a current assisted vortex pair unbinding mechanism, and discuss the possible impact of such an effect on TES parameters and performances.

Less than 5 years of experience since completion of Ph.D

N

Student (Ph.D., M.Sc. or B.Sc.)

N

Primary authors: FABREGA, Lourdes (ICMAB-CSIC); Dr CAMÓN, Agustín (ICMA-CSIC)

Co-authors: POBES ARANDA, Carlos (ICMA-CSIC and ICMAB-CSIC); Dr STRICHOVANEC, Pavel (ICMAB-CSIC and ICMA-CSIC); Mrs JÁUDENES, Rosa María (ICMAB-CSIC and ICMA-CSIC)

Presenter: FABREGA, Lourdes (ICMAB-CSIC)

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