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## Scanning Nano-SQUID for Nanoscale Thermal Imaging of Dissipation in Quantum System

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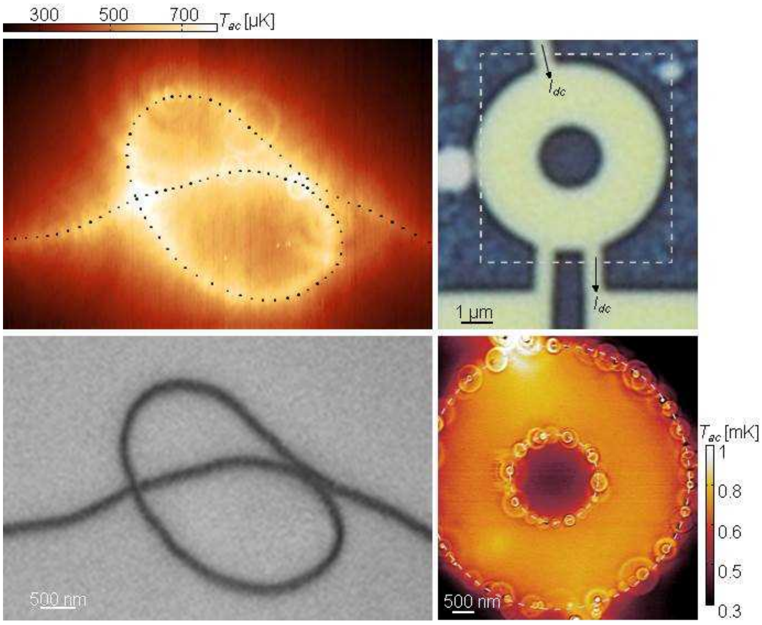
Energy dissipation is a fundamental process governing the dynamics of physical systems. In condensed matter physics, in particular, scattering mechanisms, loss of quantum information, or breakdown of topological protection are deeply rooted in the intricate details of how and where the dissipation occurs. More specifically, conversion of electric current into heat involves microscopic processes that operate on nanometer length scales and release minute amounts of power. While central to our understanding of the electrical properties of materials, individual mediators of energy dissipation have so far eluded direct examination.

We recently developed a superconducting quantum interference nano-thermometer device with sub 50 nm diameter that resides at the apex of a sharp pipette and provides scanning cryogenic thermal sensing with four orders of magnitude improved thermal sensitivity of below 1 uK/sqrtHz at 4.2 K [1]. We applied this novel thermal imaging technique to study dissipation processes in hBN encapsulated graphene heterostructures. We reveal local heat released through resonant inelastic electron scattering from individual defects along the edges of graphene that form localized states near the Dirac point. The defects act as switchable phonon emitters providing energy sinks for electrons when brought into resonance with defects' energy levels.

[1] D. Halbertal, J. Cuppens, M. Ben Shalom, L. Embon, N. Shadmi, Y. Anahory, H. R. Naren, J. Sarkar, A. Uri, Y. Ronen, Y. Myasoedov, L. S. Levitov, E. Joselevich, A. K. Geim & E. Zeldov, Nature 539, 407–410 (2016), http://dx.doi.org/10.1038/nature19843

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