Radiation Detector Based on Magnetoresistance Induced by Superconducting Vortex Excitations

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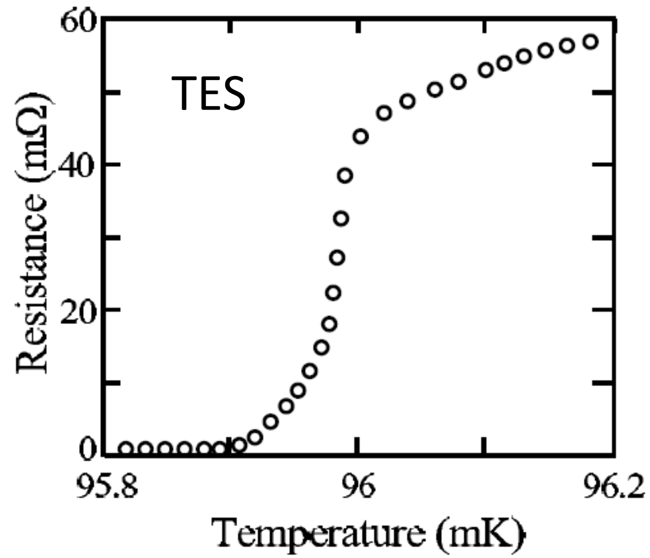
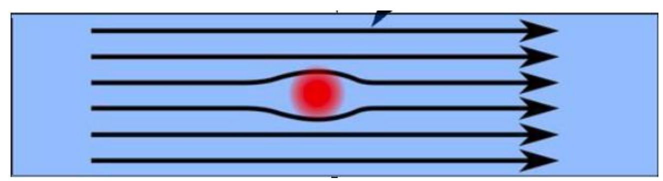
Superconducting Radiation Detector

Several superconducting devices used as radiation detector
→ High resolution and sensitivity
Many different devices:

- TES: radiation causes resistance increase
- MKIDs: radiation causes inductance variation
- Superconducting nanowire detectors: photon absorption causes resistance variation
- STJ
- JJ

and more.





SNPD

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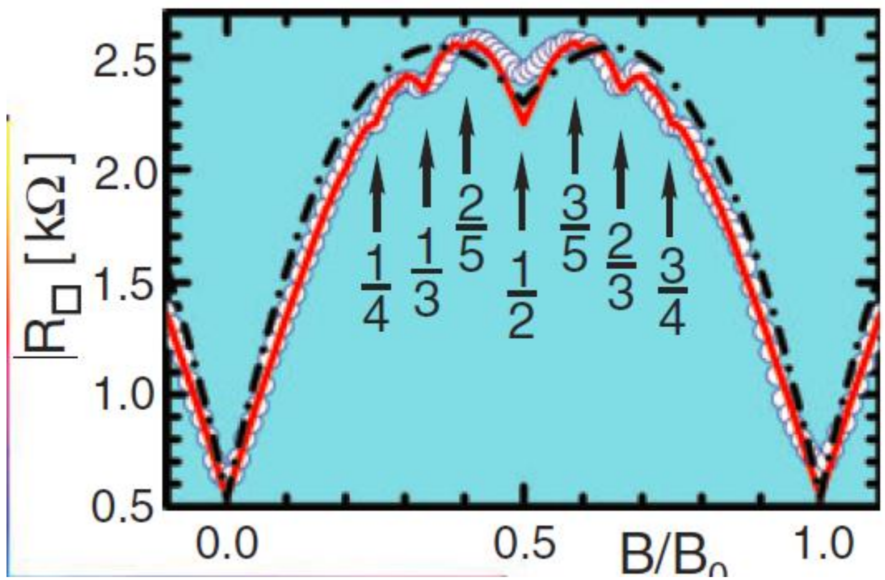
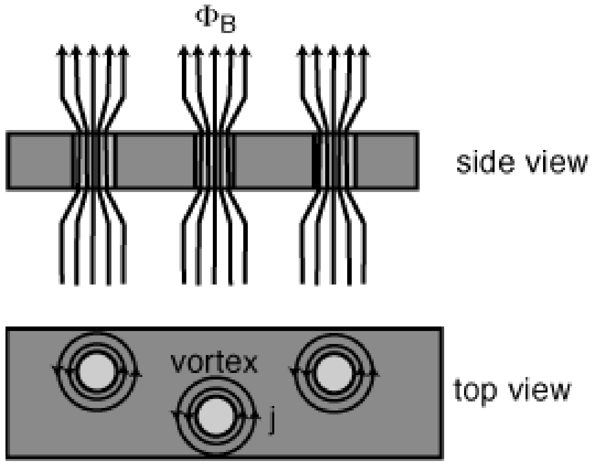
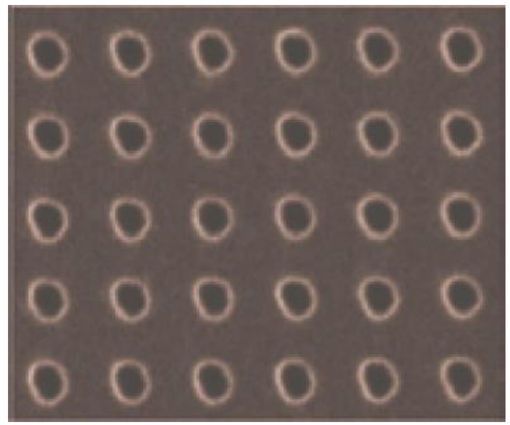
Controllable Resistance in Supercondacting Metamaterial

Nanotechnologies allow the construction of metamaterials with specific properties that can be both controlled and modified. Superconducting systems, for instance, may be turned into an insulator in **nanoperforated TiN films** [T.I. Baturina et al., EPL 93 (2011) 47002].





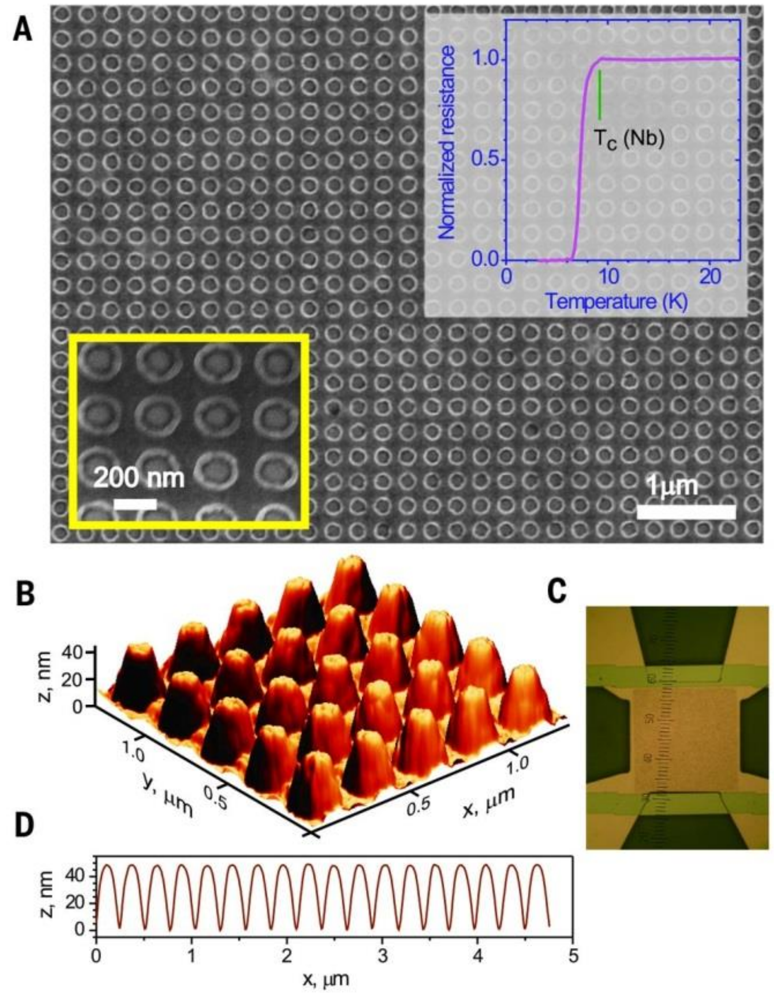


Nanoperforated TiN films

Proximity Superconducting Array

N. Poccia, et al., Science, 349 (2015) 1202

We have considered a proximity superconducting array manufactured on a silicon/silicon oxide substrate where a metallic gold template with four contacts has been grown. The size of the array is 80 µm x 80 µm. On this 'template' an array of 300x300=90000 Nb superconducting islands was realized. The device has a period of a=270 nm, the island diameter is 220 nm, thickness of 45 nm and separation of 47 nm.

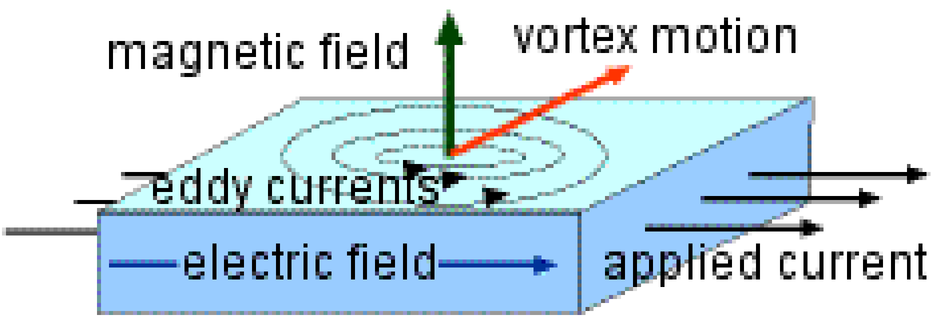


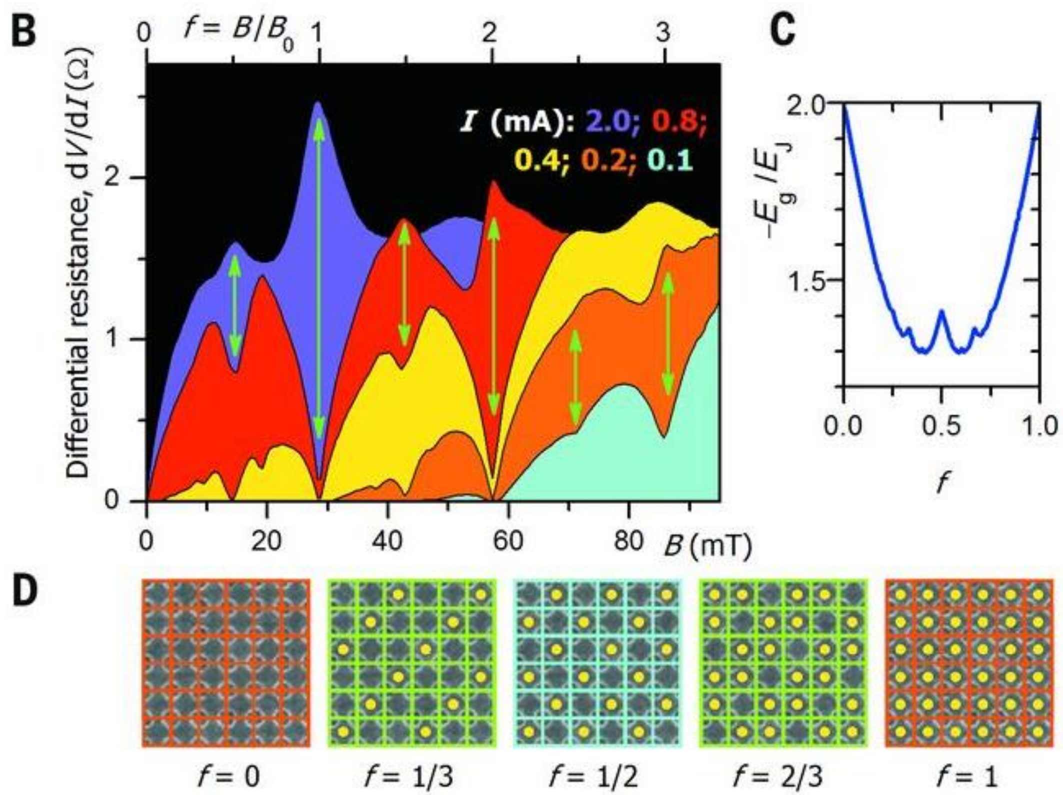
SEM image of a square array of Nb islands.

Tunable Magnetoresistance

N. Poccia, et al., Science, 349 (2015) 1202

With the application of a magnetic field, Josephson vortices are induced and localized among superconducting islands. These vortices generate different patterns as a function of $f=B/B_0$, with B the applied magnetic field and $B_0 = \Phi_0/a^2 = 28.6$ mT. The system will show minima of the differential electrical resistance, dV/dI, for different stable vortex lattices. **Reversal of these minima into maxima is induced by increasing the bias AC current**.



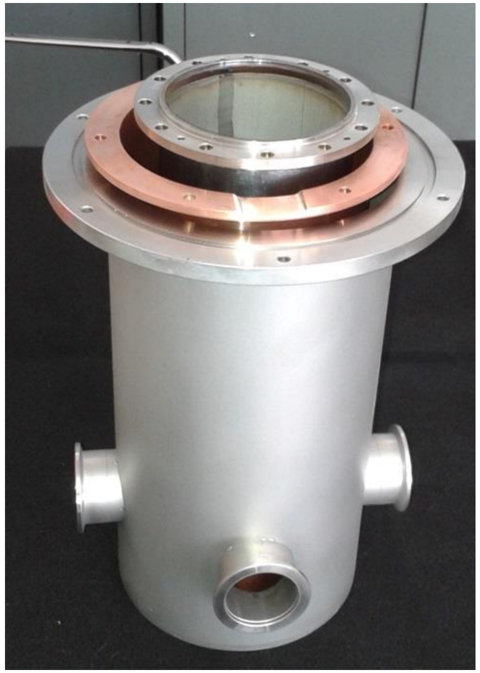


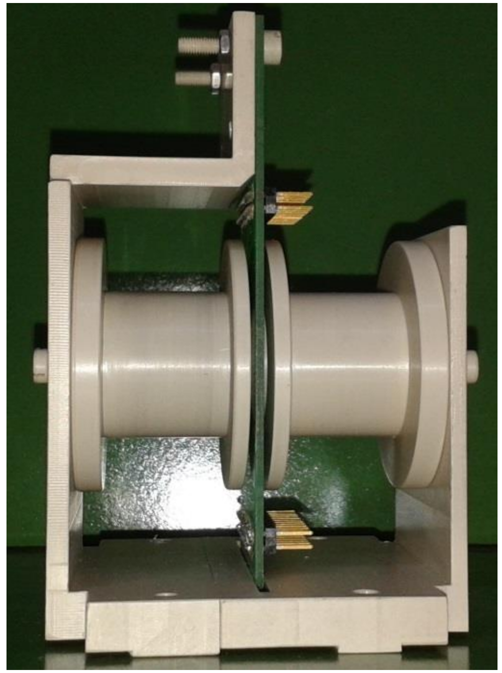
dV/dI and vortex configurations versus B.

Main Goal

Investigate the excitation of vortex-array configurations with incident radiation and the resulting resistance variation showing up in a V-I signal.

At LNF we designed and constructed a cryostat to host the device with a tunable sc-magnet. A thin window will allow tests with minimum ionizing particles. Optical fiber will be inserted for UV-IR illumination.





Cryostat and sample holder

Potential Impact

Applications in CMB measurements, X-ray astronomy, Axion and WIMP dark-matter searches.