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Vortex Motion Study on Disordered 8nm Thin Superconducting NbRe Microstrips

Xingchen Chen[1*], Carla Cirillo[2], Mikkel Ejrnaes[2], Loredana Parlato[3], Giovanni Piero Pepe[3], Carmine Attanasio[4], Michiel De Dood[1], Sense Jan Van der Molen[1]

[1]*Leiden University, The Netherlands*

[2]*CNR-SPIN, Italy*

[3]*Università degli Studi di Napoli Federico II, Italy*

[4]*Università degli Studi di Salerno, Italy*

It is well established that magnetic flux quanta that flow across a superconducting film cause dissipation of energy even if the film is well below the Cooper-pairs-depairing state. This reflects in experiments as a non-linear section of the current-voltage curve before a final jump from the instability points to the high resistance state. The characterization of the flux motion at the instability point provides a platform for understanding nonequilibrium correlated states, and is important for the application of superconducting wires as single photon detection. Here, we look closely at the vortex flow behaviour on a disordered noncentrosymmetric 8 nm thin superconducting NbRe film with very weak volume pinning, the material has recently been demonstrated to be a good candidate for superconducting nanowire single photon counter[1][2][4]. Our study provides insight into the heat dissipation mechanism of a hot spot. We observe the mean vortex instability velocities to be around 500 m/s at low magnetic fields ($B < 0.1T$). Due to the nonuniform pinning of the vortices, the mean velocities oscillate with increasing magnetic fields but roughly follow the theoretically predicted (1/B0.5) dependency (Larkin–Ovchinnikov instability). Our device typically exhibits an inelastic relaxation time of 60 ps, which agrees well with what had been reported[3]. Furthermore, we report an anomalous negative resistance measured below the superconducting transition in a standard four probes device geometry. This anomaly can be “corrected” with either magnetic field strength or temperature. The physical origin of this intriguing effect is yet to be found.

References

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*Corresponding author Xingchen Chen

Affiliation Leiden University

E-mail address chen@physics.leidenuniv.nl