Visualization of critical current oscillations in a doubly connected superconducting structure without Josephson junctions

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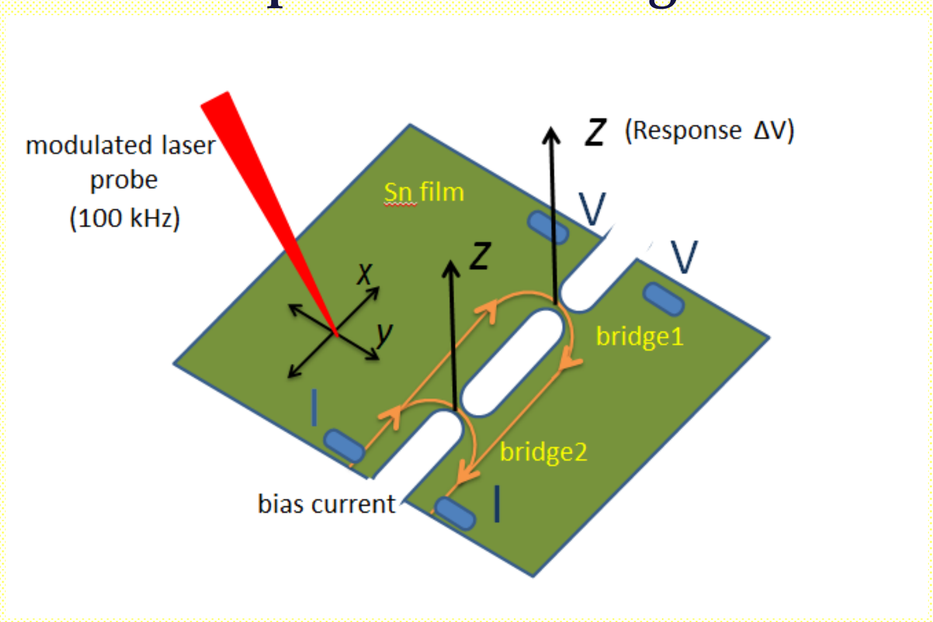
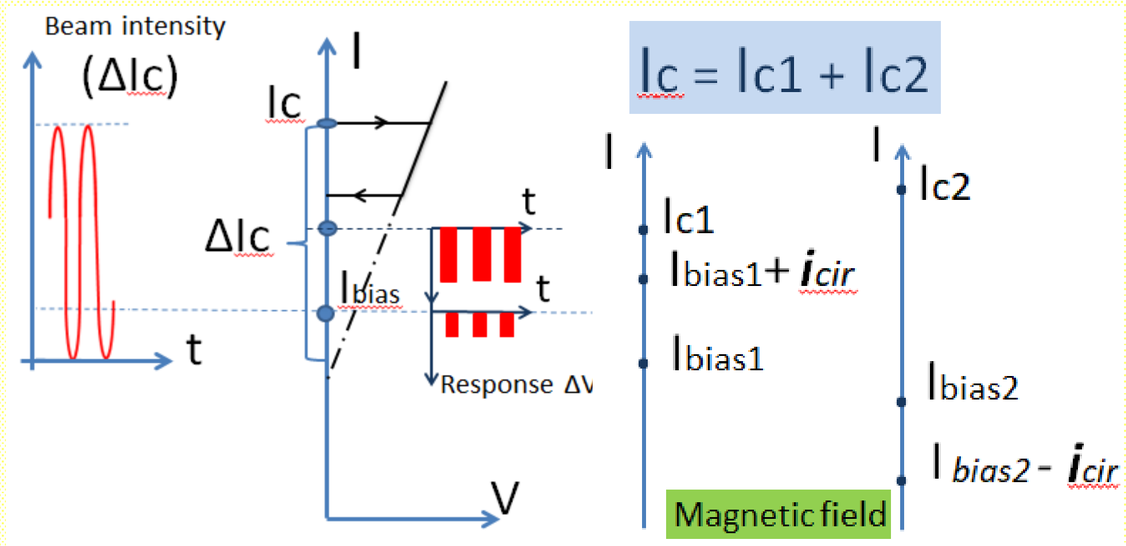
1. Introduction

Experiments on wide tin films with a rectangular macroscopic hole have convincingly demonstrated [1] that the “microscopic nature” ofa doubly connected superconducting system is not a necessary condition for observing oscillations of the critical transport current. . In this case, the oscillation effect is associated with the addition of the transport current to the circulating current, the magnitude of which is determined by the magnetic field and the inductance of the structure. Since the oscillation effect does not follow from the direct algebraic addition of the critical current of the circuit with the circulating current in the magnetic field (the circulating current is added in one arm and subtracted in the other), additional considerations are needed to explain the effect. In order to determine how the critical state is reached in individual arms of the “interferometer”, we used the technique of low-temperature scanning laser microscopy (LTLSM) [2].

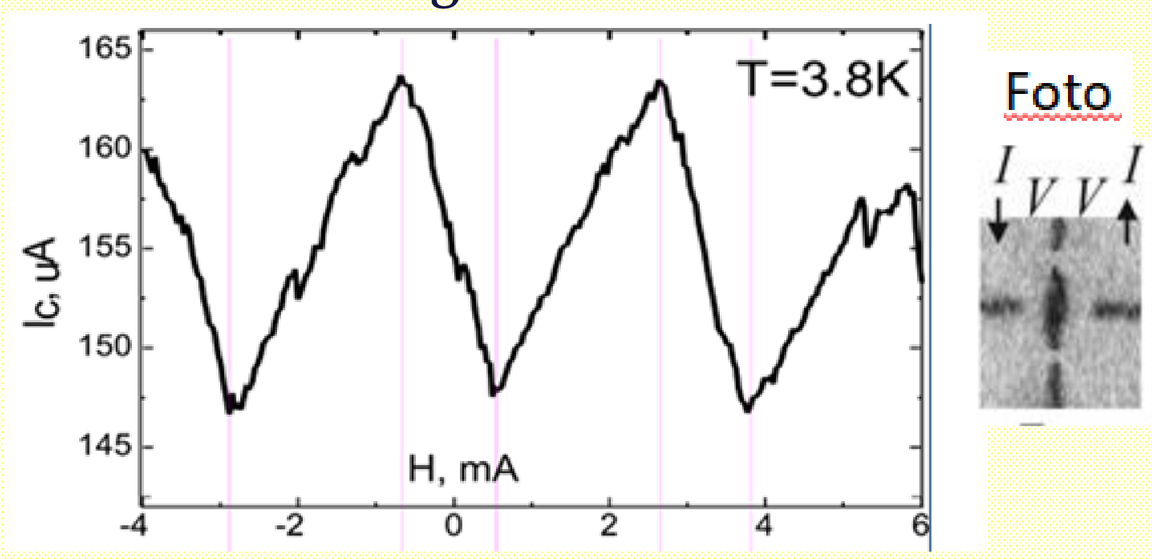
2. Experimental design



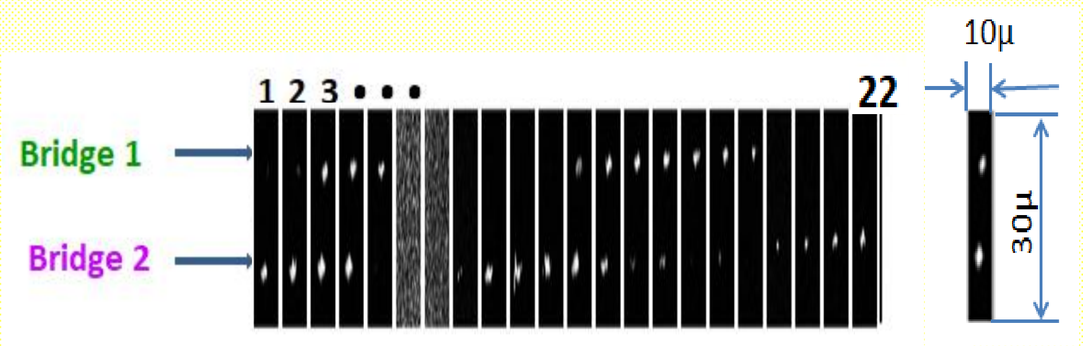
3. Response mechanism



4. Oscillations of critical current in SC circuit with two film bridges

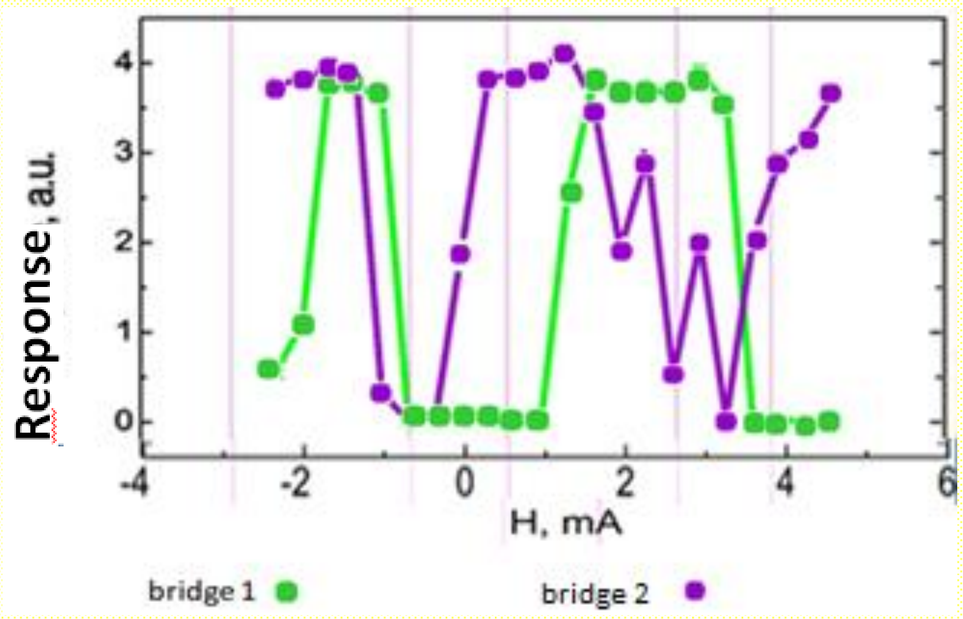


5. SLM maps of the voltage response of doubly connected bridges for different external magnetic fields



Bias current -- 84μA, frequency – 100 kHz,
light areas correspond to greater response amplitude

6. Dependence of the SLM responses of individual bridges on magnetic field



Conclusion

The critical current of the entire structure achieves alternately in one or another bridge when the transport current coincides with the direction of the circulating current in it.

[1] A. G. Sivakov, A. S. Pokhila, A. M. Glukhov, S. V. Kuplevakhsky, A. N. Omelyanchouk. Low Temp. Phys. 40, 408 (2014). https://doi.org/10.1063/1.4876229.

[2] A. P. Zhuravel, A. G. Sivakov, O. G. Turutanov, A. N. Omelyanchouk, S. M. Anlage etc. Low Temp. Phys. 32, 592 (2006)). https://doi.org/10.1063/1.2215376