Understanding and controlling supercurrents for novel physics and devices

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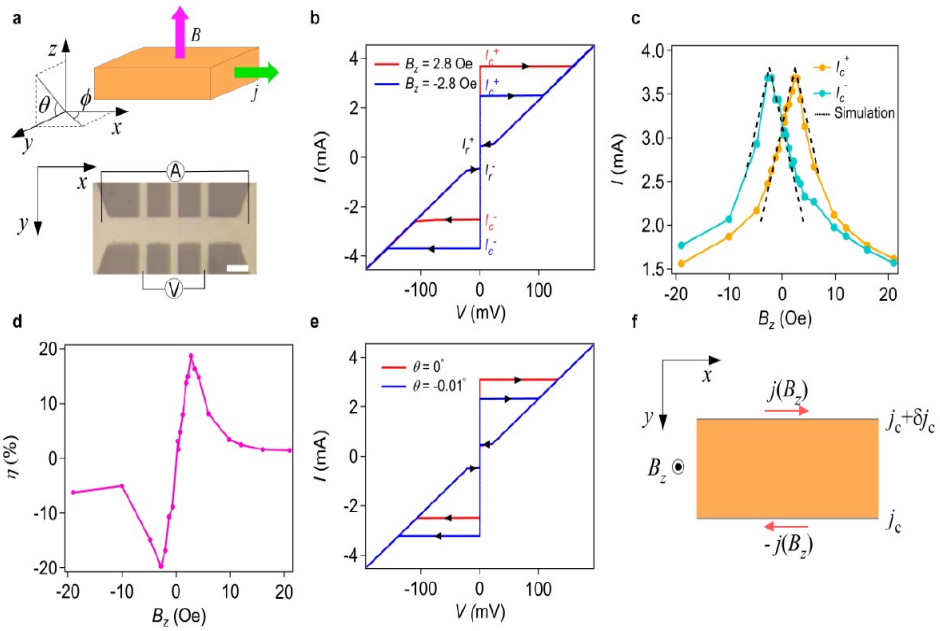
This theoretical project aims to investigate the maximum possible supercurrent that can flow through a superconductor.

A superconductor supports dissipationless charge current called supercurrent. This unique feature is enabled by the superconductor being composed of Cooper pairs' condensate forming a macroscopic quantum coherent state. As a result, superconductors form the basic building block in a wide range of quantum technologies currently being developed in labs.

Recent experiments conducted by collaborators at MIT and IBM Zurich find a record large difference between the maximum supercurrent that can flow in the forward and backward directions. This has caused great excitement in the scientific community as the mechanism for this phenomenon remains unclear. It further raises fresh possibilities for employing this effect, dubbed the superconducting diode effect, in probing "strange" properties of the superconductor as well as for engineering low-dissipation rectifiers.

The exact problem to be investigated will be decided in consultation with the student as per his/her aptitude and interests. For an example of recent research coming out of our group, please see the figure below. The language of communication will be English. Please contact the supervisor for a discussion if you are interested.



Experimental demonstration and a schematic depiction of the underlying mechanism of the recently observed superconducting diode effect in thin film superconductors. Figure from article: Y. Hou et al. Ubiquitous Superconducting Diode Effect in Superconductor Thin Films. Phys. Rev. Lett. 131, 027001 (2023).