Study introduces the intrinsic superconducting diode effect
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The superconducting diode effect is a phenomenon that produces a unique and special type of diode. The characterizing feature of this diode is that, inside it, electric resistance vanishes in one direction and remains finite in the other. This feature is referred to as the 'nonreciprocity of the critical current.'

"We suggest that a possible mechanism that could cause the superconducting diode effect is the intrinsic superconducting diode effect, where the breaking of Cooper pairs plays an important role," Daido explained. "Our work builds a foundation of the theoretical understanding of the superconducting diode effect."

In their paper, Daido and his colleagues clarified the temperature dependence of the nonreciprocal de-pairing current near the critical temperature in superconducting diodes. They also highlight the significant enhancement of this effect at low temperatures and show that the sign of the nonreciprocal critical current can be reversed when greater magnetic fields are applied to a material.

The researchers finally explore the idea that the intrinsic superconducting diode effect underpins the rich phase diagram and functionalities of noncentrosymmetric superconductors. Ultimately, their study could thus improve the physical understanding of some types of superconducting materials.

"Our work revealed that the superconducting diode effect captures a signature of the exotic superconducting phases and can be used as the promising probe for their detection," Daido said. "This means that the superconducting diode effect is an interesting phenomenon not only from an engineering standpoint, but also from the viewpoint of fundamental physics."
In the future, the recent paper by Daido and his colleagues could inspire other teams to investigate the intrinsic mechanism they proposed. This could ultimately shed more light on the physical underpinnings of the unique effect observed by Prof. Ono and his colleagues.

In their next studies, the researchers plan to examine the effect proposed in their paper further, to further delineate its physics and dynamics. In addition, they would like to try to identify other mechanisms that could underlie the superconducting diode effect.


Fuyuki Ando et al, Observation of superconducting diode effect, Nature (2020). DOI: 10.1038/s41586-020-2590-4