IEEE CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), June 2023

Diodic Order in Graphene Multilayers -- A Study of the Nonreciprocal Superconducting and Normal State

Jiang-Xiazi Lin[1], Phum Siriviboon[1], Harley D. Scammell[2], Mathias S. Scheurer[3], Naiyuan J. Zhang[1], Song Liu[4], Daniel Rhodes[5], James C. Hone[4], Takashi Taniguchi[6], Kenji Watanabe[6], and J.I.A. Li[1]

[1]Brown University, Rhode Island, USA
[2]University of New South Wales, Australia
[3]University of Innsbruck, Austria
[4]Columbia University, New York, USA
[5]University of Wisconsin–Madison, USA
[6]National Institute for Materials Science, Japan

Email: jiangxiazi_lin@brown.edu

***Abstract* – We report a zero-field superconducting diode effect in twisted trilayer graphene, evidenced by the highly nonreciprocal I-V curve and directional dependence in the critical supercurrent. This phenomenon points towards an electronic order in graphene moiré systems that breaks both spacial inversion and time-reversal symmetry. This symmetry-breaking order naturally arises from an imbalance of the fermi surfaces in two valleys, thus breaking the valley symmetry. In the second part of this talk, I will introduce a method of angle-resolved nonreciprocal transport measurement to identify the valley imbalance. We first demonstrate the viability of this method in a Bernal bilayer graphene, showing a Coulomb-driven momentum polarization effect. Then we go back to twisted trilayer graphene, where we established the relation between the normal state nonreciprocity with valley imbalance, and further set out to probe the diodic order in the transition into the superconducting state.**

***Keywords (Index Terms)* – Superconducting diode effect, nonreciprocal transport, valley degree of freedom, twisted trilayer graphene**

IEEE-CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), June 2023. Presentation given at American Physical Society's March Meeting, Las Vegas, NV, USA, March 10, 2023.