JOINT SEMINAR

Center for Integrated Bio and Nano Systems
Texas Center for Superconductivity at the Univ. of Houston
Materials Engineering Program

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10:00 a.m. – 11:00 a.m.
Houston Science Center (HSC), 102

Gate tunable spin transport in a two-dimensional semiconductor

ABSTRACT: Exploitation of the intrinsic spin of an electron, spintronics, facilitates the development of multifunctional and novel devices that could play an important role in the Beyond-CMOS era. Two-dimensional (2D) crystals and their van der Waals heterostructures are particularly promising for spintronics device applications due to their unique properties, including strong responses to field effect gating and proximity interactions, which may enable new functionalities that are impossible with conventional bulk materials [1].

Black phosphorus is a particularly promising 2D semiconducting material for spintronics research due to its high charge mobilities, low atomic mass, and puckered crystalline structure. It is expected to lead to anisotropic spin transport with nanosecond spin-lifetimes. I will introduce ultra-thin BP as a unique platform for studying rich spin-dependent physics in this seminar. Firstly, I will show that BP supports all electrical spin injection, transport, precession, and detection up to room temperature [2]. Then, I will present our recent findings on the impact of the unique crystal structure of BP on its spin dynamics, revealing strong anisotropic spin transport along three orthogonal axes [3]. Finally, I will discuss the influence of the carrier type and concentration on spin transport. The exceptional spin transport, its strong gate-tunability, and the strong spin-lifetime anisotropy we observe in BP add to the growing body of evidence for the potential of 2D materials in functional spin-based device applications.

References

[1] A. Avsar et al., Rev. Mod. Phys. 92, 021003 (2020); [2] A. Avsar et al., Nat. Phys. 13, 888-894 (2017); [3] L. Cording et al., Nat. Mater. (2024), https://doi.org/10.1038/s41563-023-01779-8.

BIO: Dr. Avsar has been an Assistant Professor and NRF Fellow in the Department of Material Science and Engineering at the National University of Singapore (NUS) since September 2022. Before joining NUS, Dr. Ahmet was an Assistant Professor of Physics at Newcastle University (UK) and worked as an EPFL Fellow (co-funded by the European Marie Curie COFUND program) at the Swiss Federal Institute of Technology Lausanne (EPFL, Switzerland) between 2016 and 2020 after completing his PhD in Physics at NUS. He is interested in exploiting the multiple quantum degrees of freedom (spin, pseudospin, and valley) available to novel materials in the ultimate atomically thin limit for applications in energy-efficient information technologies. He fabricates mesoscopic devices based on two-dimensional heterostructures and characterizes their electronic, magnetic, and optical properties (mostly) at low temperatures. His NRF-supported research program utilizes electrons, magnons, and superconducting quasiparticles to transport and process spin information for efficient and environmentally sustainable green computing.

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