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Physics & Astronomy

PHYSICS DEPARTMENT'S SPECIAL DISTINGUISHED SEMINAR

Stuart S.P. Parkin
Max Planck Institute of Microstructure Physics, Halle (Saale), Germany

2D van der Waals materials for spintronics

2D van der Waals (vdw) materials allow for highly interesting spintronic phenomena and potential devices. In particular, vdw layers allow for novel ultrathin tunnel barriers for both magnetic tunnel junctions (MTJs) and Josephson junctions (JJs). Recently, we have demonstrated an all-antiferromagnetic tunnel junction that is formed from two bilayers of the van der Waals antiferromagnet CrSBr that are twisted at a non-zero angle. These junctions exhibit two (or more) non-volatile states in zero magnetic field with very large tunneling magnetoresistance values exceeding 1,000 %[1]. On the other hand, Josephson junctions that are formed with weak links derived from certain vdw materials exhibit a novel intrinsic Josephson Diode effect[2-4]. The superconducting critical current density shows large asymmetries for current flowing in opposite directions of up to 80%. Such an effect could have important applications (beyond superconducting logic) as a novel magnetic field detector at cryogenic temperatures, for example, to “read” magnetic domain walls in a cryogenic racetrack memory[5*] . Finally, we discuss the highly interesting role of defects that appear to be intrinsic to many vdw materials. For example, vacancies in specific Wyckoff sites within the vdw layers in Fe_3GeTe_2 result, in a non-centrosymmetric crystal structure that, thereby, allows for the presence of Neel-like skyrmions[6]. Perhaps, even more interestingly the presence of Fe atoms randomly distributed withing the vdw gaps in Fe_3GeTe_2 behave as the first 2D spin glass[7].

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