Persistence of magnetism in atomically thin $MnPS_3$ crystals

Hugo Henck
Gen Long, Marco Gibertini, Dumitru Dumcenco, Zhe Wang, Takashi Taniguchi, Kenji Watanabe, Enrico Giannini, Alberto F. Morpurgo
Department of Quantum Matter Physics, University of Geneva, 24 Quai Ernest Ansermet, CH-1211 Geneva, Switzerland
hugo.henck@unige.ch

The magnetic state of atomically thin semiconducting layered antiferromagnets such as CrI_3 and $CrCl_3$ can be probed by forming tunnel barriers and measuring their resistance as a function of magnetic field (*H*) and temperature (*T*) [1-3]. This is possible because the spins within each individual layer are ferromagnetically aligned and the tunneling magnetoresistance depends on the relative orientation of the magnetization in adjacent layers. The situation is different for systems that are antiferromagnetic within the layers, in which case it is unclear whether magnetoresistance measurements can provide information about the magnetic state. Here, we address this issue by investigating tunnel transport through atomically thin crystals of $MnPS_3$, a van der Waals semiconductor that in the bulk exhibits easy-axis antiferromagnetic order within the layers. For thick multilayers below $T \sim 78$ K, a *T*-dependent magnetoresistance sets-in at $\mu_0 H \sim 5$ T, and is found to track the boundary between the antiferromagnetic and the spin-flop phases known from bulk measurements (Figure 1(a)). We show that the magnetoresistance persists as thickness is reduced with nearly unchanged characteristic temperature and magnetic field scales (Fig 1(c)), albeit with a different dependence on *H*, indicating the persistence of magnetism in the ultimate limit of individual monolayers.

References

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Figures

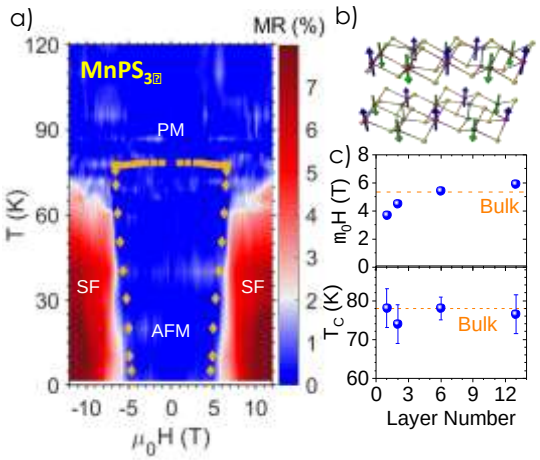

Figure 1: (a) Color plot of the tunneling magnetoresistance of 6-layer $MnPS_3$, as a function of applied perpendicular magnetic field and temperature. (b) $MnPS_3$ crystal structure, illustrating the antiferromagnetically aligned spins on the Mn atoms. Panel (c) bottom and up show the characteristic magnetic fields and the temperature at which magnetoresistance vanishes for all devices, as a function of layer number.