MIP: PARADIM at Cornell University, DMR-1539918

2017

Perturbing Valleytronic Materials to make them Relevant to Ground-State Quantum Computing

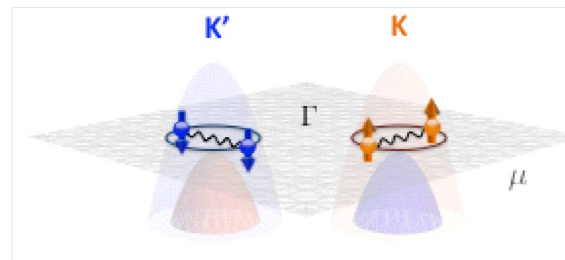
Eun-Ah Kim, Cornell University

PARADIM theorists have recognized that lightly hole-doped transition metal dichalcogenides (TMDs) are natural candidates for the long sought odd-parity topological superconductor vital for ground-state topological quantum computing. An interface materials strategy is considered that will cause a band of spin-polarized electrons to pair into an odd-parity superconductor.

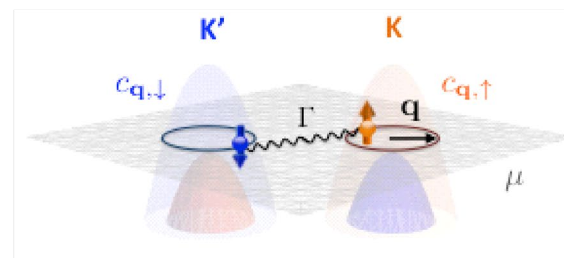
The strategy exploits the unique valley band structure of TMDs where valleys occur at *K* and *K'* just like graphene, but unlike graphene, TMDs have a special type of large spin-orbit coupling. These topological valley qubits are theorized to form in a hole-doped single-monolayer-thick TMD thin film synthesized on a strong ferromagnetic substrate. From theory the intra-valley pairing should have Chern number *C*=±1, whereas the inter-valley pairing should have *C*=2. The intra-valley pairing that can be promoted by a strong magnetic field coming from an underlying active substrate, will give rise to an odd-parity topological superconductor with protected Majorana zero modes.

Symmetry distinct pairing channels in a monolayer-thick, hole-doped transition metal dichalcogenide (TMD). The two oppositely spin-polarized Fermi surfaces centered at *K* and *K'* valleys (represented by the orange and blue circles) develop:

intra-valley pairing (desired for quantum computing)



inter-valley pairing



Y.-T. Hsu et al., *Nature Communications* **8** (2017) 14985.