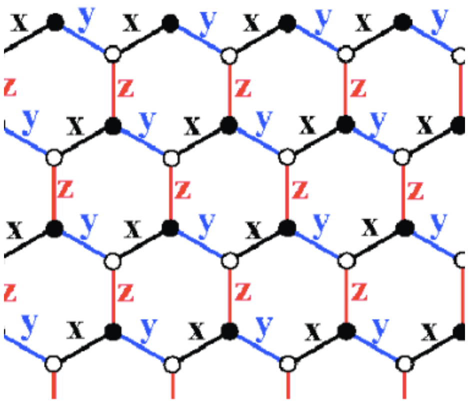
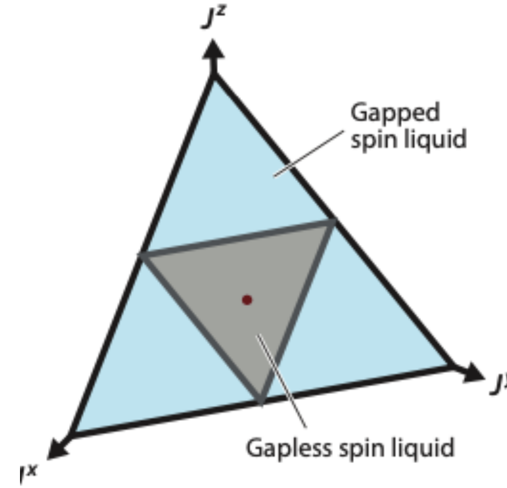
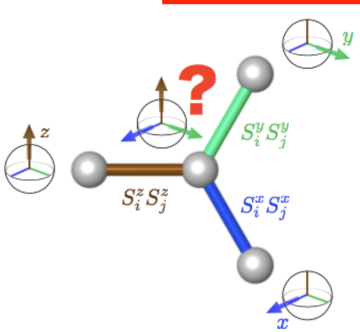
Kitaev Spin Liquids



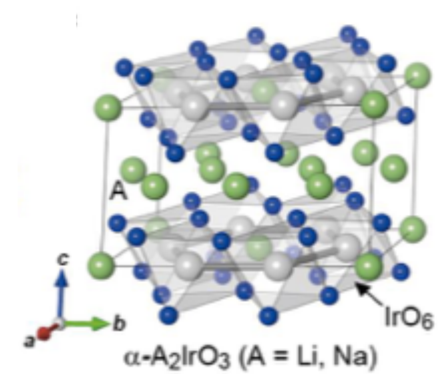
Context
The Model



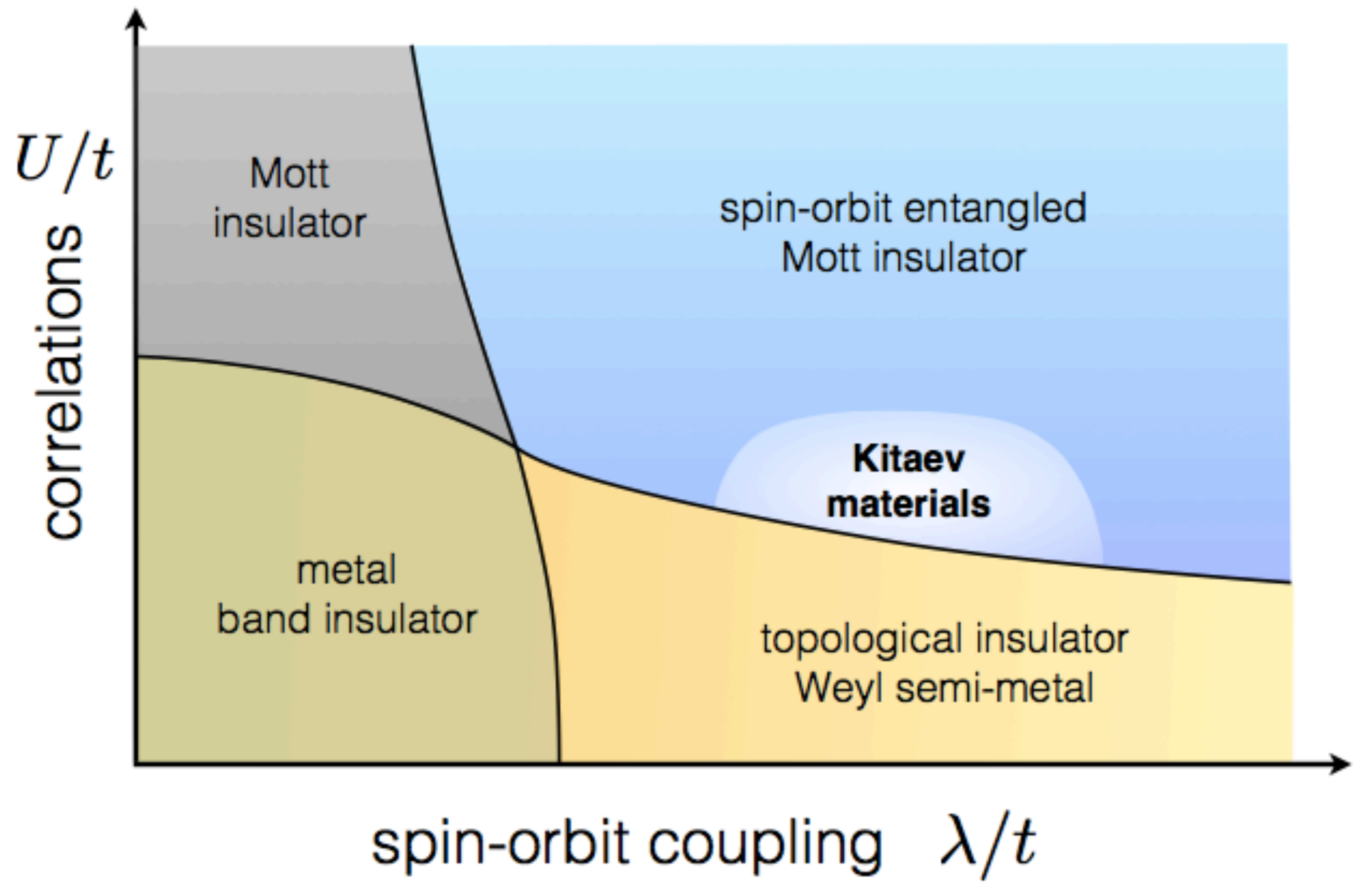
Gus "Lithium Ion Batteries"
Cory "Measuring Spin Waves with Neutrons"
Kevin "The Aharonov-Bohm Effect"



Experimental Realizations



Kitaev Materials



S. Trebst, arXiv 1701.0705

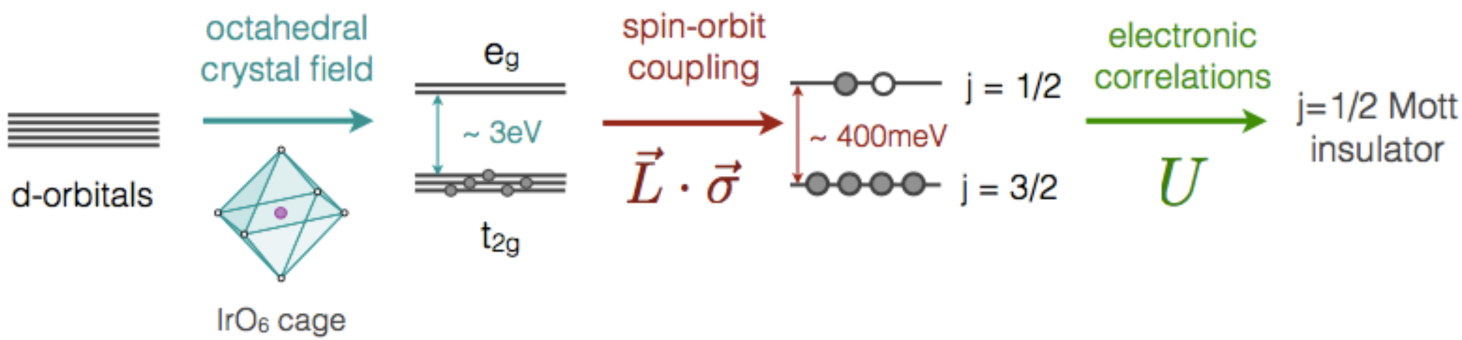


Fig. 2: *Formation of spin-orbit entangled $j = 1/2$ moments for ions in a d^5 electronic configuration such as for the typical iridium valence Ir^{4+} or the ruthenium valence Ru^{3+}.*

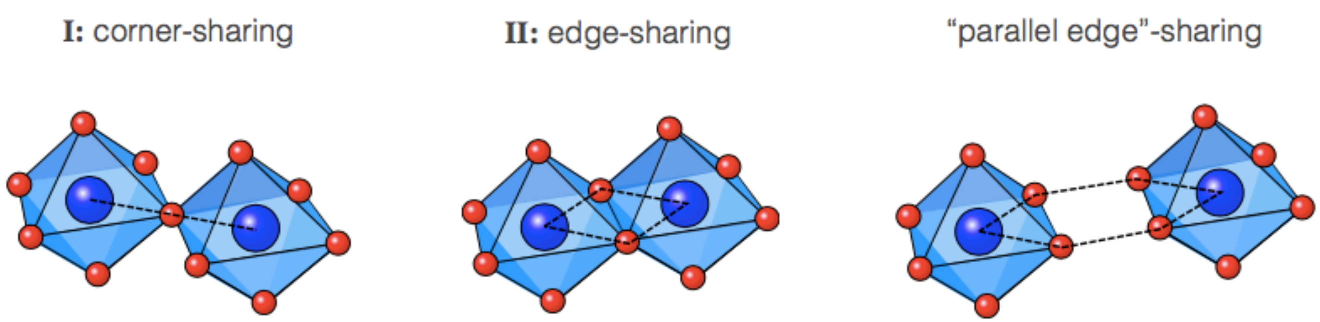
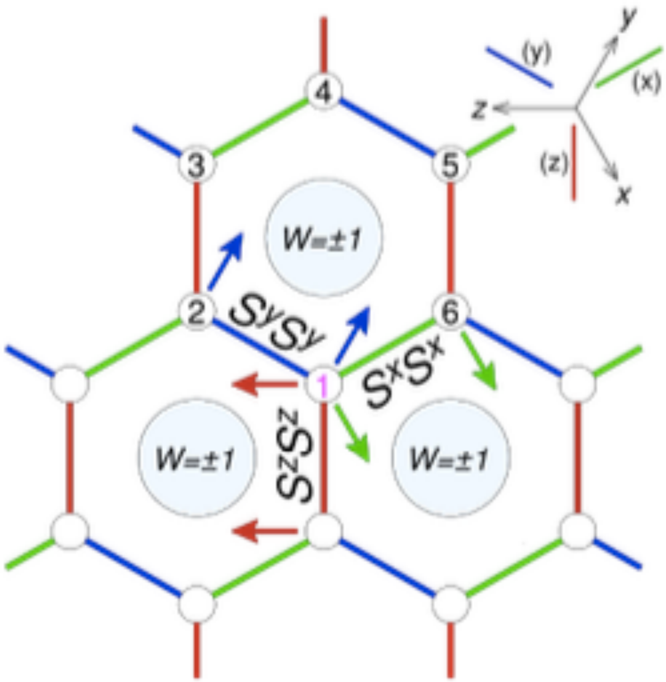


Fig. 3: *Illustration of possible geometric orientations of neighboring IrO_6 octahedra that give rise to different types of (dominant) exchange interactions between the magnetic moments located on the iridium ion at the center of these octahedra. For the corner-sharing geometry (I) one finds a dominant symmetric Heisenberg exchange, while for the edge-sharing geometries (II) one finds a dominant bond-directional, Kitaev-type exchange.*

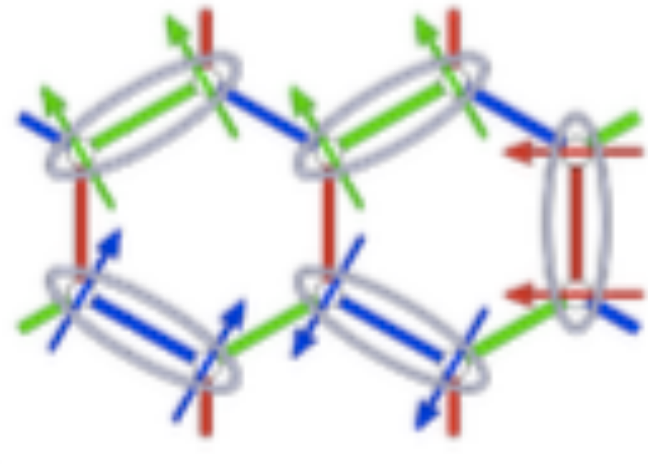
The Kitaev Model on the Honeycomb Lattice



$$H = -\sum_{<ij>_\gamma} K_\gamma S_i^\gamma S_j^\gamma$$

Ising Spins with Bond Anisotropies

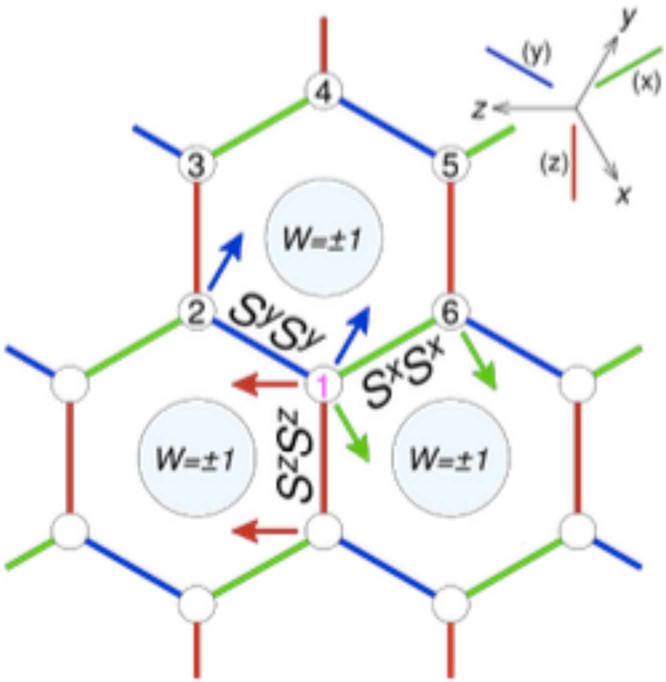
Classical Model



Two “happy” bonds/plaquette

Classical Model has Extensive Ground State Degeneracy

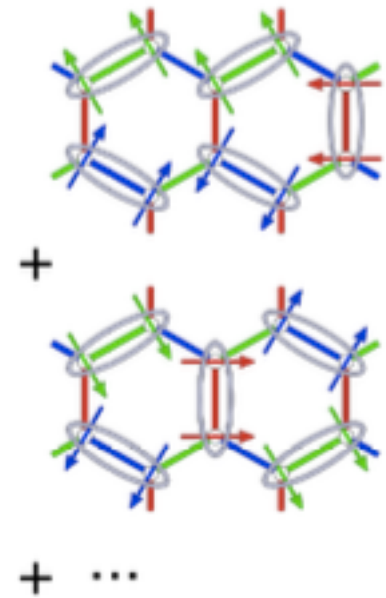
The Kitaev Model on the Honeycomb Lattice



$$H = -\sum_{<ij>_\gamma} K_\gamma S_i^\gamma S_j^\gamma$$

Ising Spins with Bond Anisotropies

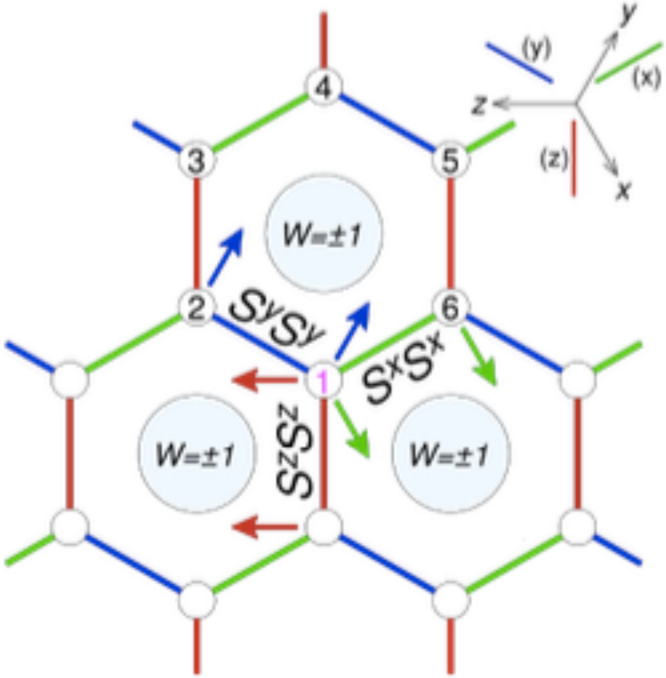
Quantum Model



Superposition of Classical Configurations (similar to RVB)

Highly Entangled Quantum Spin Liquid State

The Kitaev Model on the Honeycomb Lattice



$$H = -\sum_{<ij>_\gamma} K_\gamma S_i^\gamma S_j^\gamma$$

Ising Spins with Bond Anisotropies

$$W_p = 2^6 S_1^z S_2^x S_3^y S_4^z S_5^x S_6^y$$

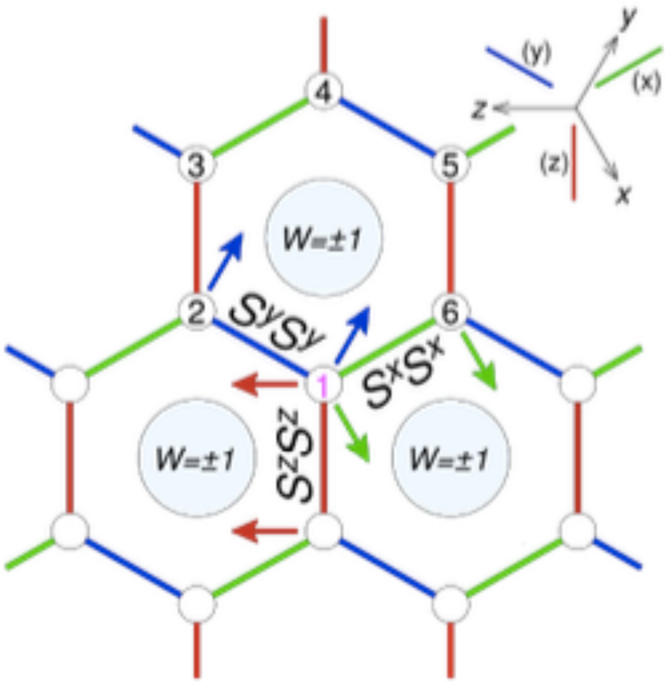
$$[W_p, H] = 0$$

Infinitely Many Conserved Quantities

$$W = \pm 1$$

Each many-body eigenstate can be labelled by conserved flux quanta through each hexagon

The Kitaev Model on the Honeycomb Lattice



$$H = -\sum_{<ij>_\gamma} K_\gamma S_i^\gamma S_j^\gamma$$

Ising Spins with Bond Anisotropies