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Kitaev physics in three dimensional honeycomb iridates[1]

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It has been realized that Mott insulators with strong spin-orbit coupling may allow strongly bond-dependent exchange interactions between local moments. Such interactions may lead to magnetic frustration and possible quantum spin liquid phases. This is in contrast to usual frustrated magnets, where the magnetic frustration comes from the geometry of the underlying lattice structure. Hence, it offers a new avenue to generate exotic phases of matter. Recently, both two-dimensional (α-Li_2IrO_3) and three-dimensional honeycomb iridates (β-Li_2IrO_3 and γ-Li_2IrO_3) have been discovered and it has been suggested that the magnetic exchange interactions contain the so-called Kitaev interaction, which depends on bond directions. In particular, the local moments of Ir ions in β-Li_2IrO_3 and γ-Li_2IrO_3 reside on the three-dimensional hyper-honeycomb and stripy-honeycomb lattices. The Kitaev model is exactly solvable on these lattices as well as the two-dimensional honeycomb lattice and the ground state is a quantum spin liquid with gapless excitations. We discuss recent progress in theoretical understanding of magnetic exchange interactions, possible presence of quantum spin liquid phases, and unusual magnetic order in β-Li_2IrO_3 and γ-Li_2IrO_3. These theoretical results are used to make connections to recent experimental data.

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