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3D Kitaev spin liquids

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The Kitaev honeycomb model has become one of the archetypal spin models exhibiting topological phases of matter, where the magnetic moments fractionalize into Majorana fermions interacting with a Z_2 gauge field. In this talk, we discuss generalizations of this model to three-dimensional lattice structures. Our main focus is the metallic state that the emergent Majorana fermions form. In particular, we discuss the relation of the nature of this Majorana metal to the details of the underlying lattice structure. Besides (almost) conventional metals with a Majorana Fermi surface[1], one also finds various realizations of Dirac semi-metals, where the gapless modes form Fermi lines or even Weyl nodes[2]. We introduce a general classification of these gapless quantum spin liquids using projective symmetry analysis. Furthermore, we briefly outline why these Majorana metals in 3D Kitaev systems provide an even richer variety of Dirac and Weyl phases than possible for electronic matter and comment on possible experimental signatures.
Work done in collaboration with Kevin O'Brien and Simon Trebst.

[1]M. Hermanns and S. Trebst, PRB **89**, 235102 (2014).
[2]M. Hermanns, K. O'Brien, and S. Trebst, PRL **114**, 157202 (2015).