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Majorana metals in spin-orbit entangled quantum matter

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The largely accidental balance of electronic correlations, spin-orbit entanglement, and crystal field effects of 5d transition metal oxides results in a remarkably broad variety of metallic and insulating states. In this talk, we will discuss the physics of spin-orbit entangled j=1/2 Mott insulators whose microscopic description gives rise to three-dimensional variants of the Kitaev model. The analytical tractability of this model allows to study the fractionalization of these moments into Majorana fermions (and a Z2 gauge field) and their emergent collective behavior. We show that the Majorana fermions generically form metallic states who precise character intimately depends on the underlying lattice structure. Examples range from the well known Dirac semimetal of the two-dimensional Kitaev honeycomb model to three-dimensional metals, in which the gapless modes either form a Fermi line or a Fermi surface akin to a conventional metal [1]. We further discuss our recent finding of a Weyl spin liquid – a state with topologically protected Weyl nodes in the bulk and associated Fermi arcs on the surface [2]. Finally, we comment on the thermodynamic and transport signatures of these various Majorana metals.

Joint work with M. Hermanns and K. O'Brien.

[1] M. Hermanns and S. Trebst, PRB 89, 235102 (2014).
[2] M. Hermanns, K. O'Brien, and S. Trebst, arXiv:1411.7379