Physics Colloquium

Magnetic Weyl and Dirac Kondo semimetal phases in heterostructures

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A key challenge of modern condensed matter physics is characterization of topologically non-trivial phases of matter - those phases of matter with signatures unaffected by sufficiently small perturbations - and their relationships to one another. An important branch of this work is characterization of correlated topological phases of matter, including study of topological Kondo phases of matter and the fractional quantum Hall effect among other phenomena. In this work, we extend the set of topologically non-trivial phases of matter and their relationships to one another by studying layered three-dimensional heterostructures in which two types of Kondo insulators are stacked alternatingly. One of them is the topological Kondo insulator SmB6, the other one an isostructural Kondo insulator AB6, where A is a rare-earth element, e.g., Eu, Yb, or Ce. We find that if the latter orders ferromagnetically, the heterostructure generically becomes a magnetic Weyl Kondo semimetal, while antiferromagnetic order can yield a magnetic Dirac Kondo semimetal. We detail both scenarios with general symmetry considerations as well as concrete tight-binding and ab-initio calculations and show that type-I as well as type-II magnetic Weyl/Dirac Kondo semimetal phases are possible in these heterostructures. Our results demonstrate that Kondo insulator heterostructures are a versatile platform for design of strongly correlated topological semimetals.

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