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Exotic 3D Spin-Orbit Couplings BRANDON ANDERSON, JQI, NIST and the University of Maryland, GEDIMINAS JUZELIUNAS, Institute of Theoretical Physics and Astronomy and Vilnius University, IAN SPIELMAN, VICTOR GALITSKI, JQI, NIST and the University of Maryland — We describe a scheme for creating an isotropic three-dimensional spin-orbit coupling, dubbed Weyl spin-orbit coupling, in systems of ultracold atoms. This coupling is induced by Raman transitions that link four internal atomic states with a tetrahedral geometry. This spin-orbit coupling gives rise to a Dirac point that is robust against environmental perturbations. We then propose a general procedure for generating exotic three-dimensional spin-orbit couplings with degenerate ground states on more complex manifolds. The procedure is applied to produce a spin-orbit coupling with a toroidal ground state manifold. Finally, we discuss the many-body implications of the exotic spin-orbit couplings.

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