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Topological semimetal: a probable new state of quantum optical lattice gases protected by D_4 symmetry[1] KAI SUN, JQI and CMTC, University Of Maryland, W. VINCENT LIU, University of Pittsburgh and KITP UCSB, S. DAS SARMA, JQI and CMTC, University of Maryland — We demonstrate that a novel topological semimetal emerges as a parity-protected critical theory for fermionic atoms loaded in the p and d orbital bands of a two-dimensional optical lattice. The new quantum state is characterized by a parabolic band-degeneracy point with Berry flux 2π, in sharp contrast to the π flux of Dirac points as in graphene. We prove that this topological liquid is a universal property for all lattices of D_4 point group symmetry and the band degeneracy is protected by odd parity. Turning on interparticle repulsive interaction, the system undergoes a phase transition to a topological insulator, whose experimental signature includes chiral gapless domain-wall modes, reminiscent of quantum Hall edge states.

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