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BCS-BEC Crossover and Topological Phase Transition in 3D Spin-Orbit Coupled Degenerate Fermi Gases MING GONG, Department of Physics and Astronomy, Washington State University, Pullman, Washington, 99164, USA, SUMANTA TEWARI, Department of Physics and Astronomy, Clemson University, Clemson, South Carolina 29634, USA, CHUANWEI ZHANG, Department of Physics and Astronomy, Washington State University, Pullman, Washington, 99164, USA, CHUANWEI ZHANG TEAM, SUMANTA TEWARI COLLABORATION — We investigate the BCS-BEC crossover in three-dimensional degenerate Fermi gases in the presence of spin-orbit coupling (SOC) and Zeeman field. We show that the superfluid order parameter destroyed by a large Zeeman field can be restored by the SOC. With increasing strengths of the Zeeman field, there is a series of topological quantum phase transitions from a nontopological superfluid state with fully gapped fermionic spectrum to a topological superfluid state with four topologically protected Fermi points (i.e., nodes in the quasiparticle excitation gap) and then to a second topological superfluid state with only two Fermi points. The quasiparticle excitations near the Fermi points realize the long-sought low-temperature analog of Weyl fermions of particle physics. We show that the topological phase transitions can be probed using the experimentally realized momentum-resolved photoemission spectroscopy. Phys. Rev. Lett. 107, 195303 (2011).

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