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Topological phase transitions in ultra-cold Fermi superfluids: the evolution from BCS to BEC under artificial spin-orbit fields LI HAN, KANGJUN SEO, CARLOS A.R. SA DE MELO, School of Physics, Georgia Institute of Technology — We discuss topological phase transitions in ultra-cold Fermi superfluids induced by interactions and artificial spin orbit fields. We construct the phase diagram for population imbalanced systems at zero and finite temperatures, and analyze spectroscopic and thermodynamic properties to characterize various phase transitions. For balanced systems, the evolution from BCS to BEC superfluids in the presence of spin-orbit effects is only a crossover as the system remains fully gapped, even though a triplet component of the order parameter emerges. However, for imbalanced populations, spin-orbit fields induce a triplet component in the order parameter that produces nodes in the quasi-particle excitation spectrum leading to bulk topological phase transitions of the Lifshitz type. Additionally a fully gapped phase exists, where a crossover from indirect to direct gap occurs, but a topological transition to a gapped phase possessing Majorana fermions edge states does not occur.

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