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Finite temperature theory of spin-orbit coupled fermions in three dimensions in the presence of external Zeeman fields and tunable s-wave interactions PHILIP POWELL, Lawrence Livermore National Laboratory, GORDON BAYM, University of Illinois at Urbana-Champaign, CARLOS SA DE MELO, Georgia Institute of Technology, Joint Quantum Institute — We develop a finite temperature theory of ultracold three-dimensional Fermi gases in the presence of artificial spin-orbit coupling, Zeeman fields, and tunable s-wave interactions. With the inclusion of quadratic fluctuations, we compute both the critical temperature for superfluidity and the population of bound and unbound fermions throughout the evolution from the Bardeen-Cooper-Schrieffer (BCS) to Bose-Einstein condensate (BEC) regimes. In particular, we show that in the BEC regime, spin-orbit coupling is capable of increasing the critical temperature relative to the no-field case, by inducing a triplet component to the superfluid order parameter, while decreasing the many-body effective mass. We also derive the time-dependent Ginzburg-Landau equation to sixth-order in the superfluid order parameter, and obtain explicit expressions for the coefficients of the effective theory valid across the entire evolution from BCS to BEC superfluidity.

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