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Fermi Superfluids with Engineered Dispersion: A Consistent Treatment of Fluctuation Effects BRANDON ANDERSON, CHIEN-TE WU, RUFUS BOYACK, KATHYRN LEVIN, James Franck Institute, University of Chicago — Recent experimental advances in cold atoms allows for the possibility of engineered dispersion that give rise to novel physics. For example, in systems with either spin-orbit coupling (SOC) or shaken optical lattices, momentum fluctuations can have energy cost that is quartic instead of quadratic at small momenta. The resulting density of states (DOS) will then more accurately resemble a system with lower dimension, leading to, e.g., enhanced depletion of Bose condensates or enhanced binding energy of Fermions. We consider the effects of the reduced DOS on the stability of fermionic superfluids in the presence of SOC or optical lattice shaking. We establish and characterize fluctuations associated with the standard mean field equations of the superfluid instability. This introduces bosonic degrees of freedom at a level beyond Gaussian fluctuations. Moreover, these bosons must necessarily condense in order for the fermionic superfluid to be stable. This is a non-trivial constraint for fermions, as seen from the observation that, e.g., Rashba SOC destroys a condensate of non-interacting (true) bosons. On this basis we present a phase diagram establishing the regions of fluctuation-stable fermionic superfluidity as a function of scattering length and temperature.

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