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Fulde-Ferrell-Larkin-Ovchinnikov States and Topological Bogoliubov Fermi Surfaces in Altermagnets: an Analytical Study

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We present an analytical study of the ground-state phase digram of dilute two-dimensional spin-1/2 Fermi gases exhibiting *d*-wave altermagnetic spin splitting under *s*-wave pairing. Within the Bogoliubov-de Gennes mean-field framework, four distinct phases are identified: a Bardeen-Scheriffer-Cooper-type superfluidity, a normal metallic phase, a nodal superfluidity with topological Bogoliubov Fermi surfaces (TBFSs), and Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) states with finite center-of-mass momentum. Notably, the FFLO states and TBFSs represent two unconventional forms of superconductivity. Considering the simplicity of this model, with only one band, zero net magnetization, and nodeless s-wave paring, the emergence of both unconventional phases underscores the pivotal role of altermagnetic spin splitting in enabling exotic pairing phenomena. This analytical study not only offers a valuable benchmark for future numerical simulations, but also provides a concrete experimental roadmap for realizing FFLO states and TBFSs in altermagnets.

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