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Three-component Fulde-Ferrell superfluids in a two-dimensional Fermi gas with spin-orbit coupling FANG QIN, FAN WU, Key Laboratory of Quantum Information, University of Science and Technology of China, WEI ZHANG, Department of Physics, Renmin University of China, WEI YI, GUANG-CAN GUO, Key Laboratory of Quantum Information, University of Science and Technology of China, WEI YI'S TEAM TEAM, WEI ZHANG'S TEAM COLLABORATION — We investigate the pairing physics of a three-component spin-orbit coupled (SOC) Fermi gas in two spatial dimensions. The three atomic hyperfine states of the system are coupled by the recently realized synthetic SOC, which mixes different hyperfine states into helicity branches in a momentum-dependent manner. As a consequence, the interplay of SOC and the hyperfine-state dependent interactions leads to the emergence of Fulde-Ferrell (FF) pairing states with finite center-of-mass (COM) momenta even in the absence of the Fermi-surface asymmetry that is usually mandatory to stabilize an SOC-induced FF state. We show that, for different combinations of spin-dependent interactions, the ground state of the system can either be the conventional BCS pairing state with zero COM momentum or be the FF pairing states. Of particular interest here is the existence of a three-component FF pairing state in which every two out of the three components form FF pairing. We map out the phase diagram of the system and characterize the properties of the three-component FF state, such as the order parameters, the gapless contours and the momentum distributions. Based on these results, we discuss possible experimental detection schemes for the interesting pairing states in the system.

Fan Wu
Key Laboratory of Quantum Information, University of Science and Technology of China

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