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Chiral sp-orbital paired superfluid of fermionic atoms in a 2D spin-dependent optical lattice[1] BO LIU, Univ of Pittsburgh, XIAOPENG LI, Univ of Pittsburgh & Univ of Maryland, BIAO WU, Peking University & Collaborative Innovation Center of Quantum Matter, W. VINCENT LIU, Univ of Pittsburgh — Recent progress in realizing synthetic quantum orbital materials in chequerboard and hexagonal optical lattices opens an avenue towards exploiting unconventional quantum states, advancing our understanding of correlated quantum matter. Here, we unveil a chiral *sp*-orbital paired superfluid state for an interacting two-component Fermi gas in a 2D spin-dependent optical lattice. Surprisingly, this novel state is found to exist in a wide regime of experimentally tunable interaction strengths. The coexistence of this chiral superfluid and the ferro-orbital order is reminiscent of that of magnetism and superconductivity which is a long-standing issue in condensed matter physics. The topological properties are demonstrated by the existence of gapless chiral fermions in the presence of domain wall defects, reminiscent of quantum Hall edge states. Such properties can be measured by radio frequency spectroscopy in cold atomic experiments.

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