Robust Larkin-Ovchinikov superfluidity in laser-assisted bilayer Fermi gases

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Recently, a scheme that uses layer degree of freedom has been successfully addressed to experimentally implement the spin-orbit coupling (SOC) for ultracold atomic bosons[1] , where the layer states play a role of (pseudo)spin states. In [2] we show that extension of this scheme to atomic fermions provides a possibility of formation of exotic superfluid phases in laser-assisted bilayer Fermi gases. We demonstrate that an interplay between an attractive intralayer interaction and laser-assisted interlayer tunneling can induce a bound molecular state containing two degenerate minima at finite momenta. This drives the many-body ground state into a Larkin-Ovchinnikov (LO) [3] type superfluidity state which breaks the translational symmetry and exhibits supersolid properties. This is in a sharp contrast to the SOC for real spins where the Fulde-Ferrell (FF) [4] superfluid carrying a single momentum component is formed by pairing particles in mismatched Fermi-surfaces. Our findings provide solid evidence that the long-sought LO superfluidity can be observed experimentally for ultracold atomic fermions using laser assisted bilayer structures.

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