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Spin orbit density wave: A non-magnetic phase of two-dimensional electron gas

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We propose and formulate an interaction induced staggered spin-orbit order as a new emergent phase of two-dimensional Fermi gases. We show that when some form of inherent spin splitting via Rashba-type spin-orbit coupling renders two helical Fermi surfaces to become significantly "nested," a Fermi surface instability arises. To lift this degeneracy, a spontaneous symmetry-breaking spin-orbit density wave develops, causing a surprisingly large quasiparticle gapping with chiral electronic states. Since the time-reversal invariant spin-orbit density wave is associated with a condensation energy, quantified by the gap value, destroying such spin-orbit interaction costs sufficiently large magnetic field or temperature or dephasing time. The $BiAg_2$ surface state is shown to be a representative system for realizing such novel spin-orbit interaction. We also apply this theory to LAO/STO interface, Iridates compunds, and in the enigmatic 'hidden-order' phase in URu_2Si_2 T. Das. Phys. Rev. Lett. **109**, 246406 (2012).