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Ising lattice gauge theory at finite fermion density: Symmetry breaking, confinement, and emergent Dirac excitation SNIR GAZIT, Univ of California - Berkeley, MOHIT RANDERIA, The Ohio State University , ASHVIN VISHWANATH, Harvard University — Ising gauge theories represent the simplest form of topological order and have been invoked to describe spin liquids and correlated electronic systems. Due to the sign problem, gauge theories are notoriously hard to analyze in the presence of a finite density of fermions. Here we study the phase diagram of the Ising gauge theory in 2+1 dimensions in the presence of a conserved charge, which we show is free of the sign problem at arbitrary fermion density, with an even number of fermion flavors. At generic filling, we find that gauge fluctuations mediate pairing leading to a transition between a deconfined BCS state to a confined BEC. At half-filling, a π-flux phase is generated spontaneously with emergent Dirac fermions. The deconfined Dirac phase, with a vanishing Fermi surface volume is a non-trivial example of violation of Luttinger's theorem due to fractionalization. At strong coupling, we find a single continuous transition between the deconfined Dirac phase and the confined BEC, in contrast to the expected split transition.

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