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Mirror symmetry and the half-filled Landau level MICHAEL MULLIGAN, SHAMIT KACHRU, Stanford University, GONZALO TORROBA, Centro Atomico Bariloche and CONICET, HUAJIA WANG, University of Illinois at Champaign-Urbana — We study the dynamics of the half-filled zeroth Landau level of Dirac fermions using mirror symmetry, a supersymmetric duality between certain pairs of 2 + 1-dimensional theories. We show that the half-filled zeroth Landau level of a pair of Dirac fermions is dual to a pair of Fermi surfaces of electrically-neutral composite fermions, coupled to an emergent gauge field. Thus, we use supersymmetry to provide a derivation of flux attachment and the emergent Fermi liquid-like state for the lowest Landau level of Dirac fermions. We find that in the dual theory the Coulomb interaction induces a dynamical exponent z = 2 for the emergent gauge field, making the interactions classically marginal. This enables us to map the problem of 2+1-dimensional Dirac fermions in a finite transverse magnetic field, interacting via a strong Coulomb interaction, into a perturbatively controlled model. We analyze the resulting low-energy theory using the renormalization group and determine the nature of the BCS interaction in the emergent composite Fermi liquid.

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