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Emergence of Helical Edge Conduction in Graphene in the $\nu = 0$ Quantum Hall State[1] HERBERT FERTIG, Indiana University, PAVEL TIKHONOV, EFRAT SHIMSHONI, Bar Ilan University, GANPATHY MURTHY, University of Kentucky — The conductance of graphene subject to a strong, tilted magnetic field exhibits a dramatic change with tilt-angle, interpreted as an evidence for the transition from a canted antiferromagnetic (CAF) to a ferromagnetic (FM) $\nu = 0$ quantum Hall state. We develop a theory for the electric transport in this system based on the spin-charge connection, whereby the evolution in the nature of collective spin excitations throughout this quantum phase transition is reflected in the charge-carrying modes. To this end we study quantum fluctuations of the spin-valley configuration in a system with an edge, and derive an effective theory describing collective charge edge excitations coupled to neutral bulk excitations. Focusing particularly on the FM phase, naively expected to exhibit perfect conductance due to the emergence helical edge modes, we analyze the mechanism whereby the coupling to bulk excitations assists in generating back-scattering. Finally, we calculate the conductance as a function of temperature and the Zeeman energy the parameter that tunes the transition between the two phases.

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