Gauge invariance, correlated fermions, and Meissner effect in 2+1 dimensions

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We present a 2+1 dimensional quantum gauge theory model with correlated fermions that is exactly solvable by bosonization. This model gives an effective description of partially gapped fermions on a square lattice that have density-density interactions and are coupled to photons. We show that the photons in this model are massive due to gauge-invariant normal-ordering, similarly as in the Schwinger model. Moreover, the exact excitation spectrum of the model has two gapped and one gapless mode. We also compute the magnetic field induced by an external current and show that there is a Meissner effect. We find that the transverse photons have significant effects on the low-energy properties of the model even if the fermion-photon coupling is small.

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