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Chiral Anomaly, Topological Field Theory, and Novel States of Matter

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After a short review of the "gauge theory of states of matter" and of the chiral anomaly, I discuss the electrodynamics of 2D electron gases exhibiting the fractional quantum Hall effect (FQHE). The roles of anomalous chiral edge currents, of anomaly inflow from the bulk and of Chern-Simons topological field theory in the theory of the FQHE and of Chern insulators with spontaneously broken time-reversal invariance are highlighted. A sketch of the classification of abelian Hall fluids is presented.

Subsequently, the general theory of 2D time-reversal invariant topological insulators is sketched. Chiral edge spin currents are exhibited and the bulk response equations are derived. The nature of quasi-particles (two-component Dirac-type fermions) is discussed.

If time permits a lightening review of 3D time-reversal invariant topological insulators and of Halperin's 3D quantized Hall effect is presented.