MAR15-2014-002144

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Geometry of Fractional Quantum Hall Fluids[1]

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Fractional quantum Hall (FQH) fluids of two-dimensional electron gases (2DEG) in large magnetic fields are fascinating topological states of matter. As such they are characterized by universal properties such as their fractional quantum Hall conductivity, fractionally charged anyonic excitations and a degeneracy of topological origin on surfaces with the topology of a torus. Quite surprisingly these topological fluids also couple to the geometry on which the 2DEG resides and have universal responses to adiabatic changes in the geometry. These responses are given by a Wen-Zee term (which describes the coupling of the currents to the spin connection of the geometry) and a gravitational Chern-Simons term which reflects the universal energy and momentum transport along the edges of the FQH state. We use a field theory of the FQH states to derive these universal responses [1,2]. To account for the coupling to the background geometry, we show that the concept of flux attachment needs to be modified and use it to derive the geometric responses from Chern-Simons theories. We show that the resulting composite particles minimally couple to the spin connection of the geometry[1]. Taking account of the framing anomaly of the quantum Chern-Simons theories[2], we derive a consistent theory of geometric responses from the Chern-Simons effective field theories and from parton constructions, and apply it to both abelian and non-abelian states.

[1] Cho, You, and Fradkin, Phys. Rev. B 90, 115139 (2014)
[2] Gromov, Cho, You, Abanov, and Fradkin, arxiv:1410.6812 (2014)

[1]This work was supported in part by the NSF grant DMR-1408713.