

Optical Response of Fractional Chern Insulator and the Contribution of Chiral Graviton Mode

Keito Yamamoto¹ and Naoto Tsuji^{1,2}

¹*Department of Physics, The University of Tokyo*

²*RIKEN Center for Emergent Matter Science (CEMS)*

Recent progress in controlling band dispersion, topology, and interactions in moiré systems and multilayer graphene has enabled the observation of fractional quantum Hall-like states without Landau levels formed under strong magnetic fields [1, 2]. These states, known as fractional Chern insulators (FCIs), arise from strong electron correlations in partially filled Chern bands and exhibit fractional quantum Hall-like topological order [3,4]. While the quantized DC Hall conductivity provides a hallmark of the topological phase, understanding the properties of the associated quantum Hall liquid also requires investigating its low-energy collective excitations.

In this work, we consider the checkerboard model, a lattice model that hosts an FCI phase [4], and calculate its finite-frequency response functions. We analyze the resulting optical spectra in terms of collective excitations. In particular, we investigate the possible contribution of a chiral graviton mode by comparing the optical spectra with the spectral functions of operators designed to probe collective excitations in the FCI [5].

[1] J. Cai *et al.*, *Signatures of fractional quantum anomalous Hall states in twisted MoTe₂*, Nature **622**, 63 (2023).

[2] Z. Lu *et al.*, *Fractional quantum anomalous Hall effect in multilayer graphene*, Nature **626**, 759 (2024).

[3] T. Neupert *et al.*, *Fractional quantum Hall states at zero magnetic field*, Phys. Rev. Lett. **106**, 236804 (2011).

[4] N. Regnault and B. A. Bernevig, *Fractional Chern insulator*, Phys. Rev. X **1**, 021014 (2011).

[5] M. Long *et al.*, *Chiral graviton modes in fermionic fractional Chern insulators*, Rep. Prog. Phys. **89**, 078001 (2026).