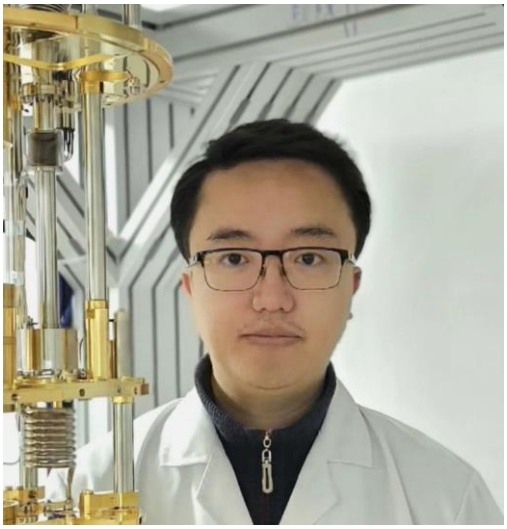
北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Chiral graviton modes in fractional quantum Hall liquids



Lingjie Du 杜灵杰

School of Physics, Nanjing University

Time: 3:00 pm, May. 10, 2024 (Friday)

时间：2024年5月10日 （周五）下午3:00

Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Recently, Haldane proposed a new geometrical description for the fractional quantum Hall (FQH) effect, suggesting the existence of a previously overlooked quantum metric. Novel collective excitations called chiral graviton modes (CGMs) are proposed as quanta of fluctuations of the metric. Such modes are condensed-matter analogues of gravitons that are hypothetical spin-2 bosons, and could be described by the corresponding Fierz-Pauli field equations in FQH liquids. CGMs are characterized by polarized states with chirality of +2 or -2, and energy gaps coinciding with fundamental neutral collective excitations (i.e., magnetorotons) in the long-wavelength limit. However, CGMs remain experimentally inaccessible. Here, we observe chiral graviton modes in FQH liquids using inelastic scattering of circularly-polarized light. The experiments are performed in a GaAs quantum well. At filling factor ν = 1/3, the long-wavelength magnetoroton emerges under a specific polarization scheme corresponding to angular momentum -2. Remarkably, the mode chirality remains -2 at ν = 2/5 but becomes the opposite at v = 2/3 and 3/5. The modes have characteristic energies and sharp peaks with marked temperature and filling-factor dependence, corroborating the assignment of the CGMs. These observations capture the essentials of the graviton modes and support the new FQH geometrical description. Our work offers access to quantum gravity physics in bench-top experiments.

About the speaker

Lingjie Du is a professor in school of physics at Nanjing University. Lingjie received his Bachelor's degree in physics from Nanjing University in 2008, and his Ph.D. in physics from Rice University in 2016. Then he worked as a postdoctoral scientist at Columbia University before joining the faculty at Nanjing University at 2019. Lingjie's research focuses on experimental studies of topological correlated states (such as fractional quantum Hall states and excitonic insulator) using techniques of low-temperature quantum transport and advanced optical spectroscopy.