Seminar

Geometric Bloch oscillations and transverse displacement in flat band systems

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Time: 3:00 pm, Dec.15, 2025 (Monday)

时间：2025年12月15日（周一）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

We investigate transport phenomena and dynamical effects in flat bands where the band dispersion plays no role. We show that wavepackets in geometrically non-trivial flat bands can display dynamics when inhomogeneous electric fields are present. This dynamics is revealed both for the wavepacket trajectory and for its variance, for which we derive semiclassical equations extended to the non-Abelian case. Our findings are tested in flat band models in one- and two-dimensional lattices where the dynamics is solely determined by geometric effects, in the absence of band dispersion. In particular, in the one-dimensional case, we show the existence of Bloch oscillations for the wavepacket position and for the wavepacket variance, whereas in the two-dimensional case we observe a transverse displacement of the wavepacket in the absence of Berry curvature. This work paves the way for understanding quantum-geometry-induced dynamical effects in flat band materials and also opens the possibility for their observation with synthetic matter platforms.

References:

[1] M. F. Lapa and T. L. Hughes, Semiclassical wave packet dynamics in nonuniform electric fields. *Phys. Rev. B* **99**, 121111(R) (2019).

[2] M. Di Liberto, N. Goldman, and G. Palumbo, Non-Abelian Bloch oscillations in higher-order topological insulators, *Nature communications* **11**, 5942 (2020).

[3] V. Kozii, A. Avdoshkin, S. Zhong, and J. E. Moore, Intrinsic Anomalous Hall Conductivity in a Nonuniform Electric Field, *Phys. Rev. Lett.* **126**, 156602 (2021).

About the speaker

Born on January 29, 1998, in Hebei Province, Liu is now a PhD student in the Department of Physics at Nanjing University. He joined Prof. Shi-Liang Zhu's group in 2020 and visited Prof. Marco Di Liberto's group in Padova in 2024. His research interests focus on quantum geometry and quantum simulation in ultracold atomic systems.