Institute of SCIENCE TOKYO

Advanced Research Center for ***Quantum Physics and Nanoscience***

量子物理学・ナノサイエンス第 406 回特別セミナー

Quantum geometry on material properties

講師　：　呉 昌根 氏（Mr. Oh Changgeun）

東京大学 工学系研究科

日程　：　3 月 7 日（金）13:30 –

場所　：　本館 2 階 227B 物理学系輪講室

概　要

Quantum geometry, which describes the geometric structure of Bloch wave functions in momentum space, has emerged as a key research topic in condensed matter physics. While the Berry curvature has been extensively studied for its role in determining topological properties, the influence of the quantum metric or quantum distance on material properties has only recently gained significant attention. This presentation explores the impact of quantum geometry on various material properties, focusing on the following aspects:

- **Universal optical conductivity** in quadratic band touching (QBT) semimetals: In isotropic QBT semimetals, the optical conductivity is universally given by $\sigma = e^2/(8\hbar)d^2_{max}$, independent of the detailed band structure. Here, d^2_{max} denotes the maximum value of Hilbert-Schmidt quantum distance near the band-touching point.

- **Quantum geometry in transport properties**: The scattering rate is often treated as a pheno-menological parameter. However, it is intrinsically influenced by the geometric structure of wave functions, which affects electrical conductivity and the thermoelectric power factor. Controlling wave function geometry thus provides a novel strategy for optimizing thermoelectric performance.

- **Bulk-interface correspondence in singular flat band systems**: Bulk-edge correspondence is a fundamental concept in topological physics. While previous studies have focused on the topological properties of wave functions in relation to boundary modes, we demonstrate that another geometric quantity—the quantum distance—can also establish a bulk-interface correspondence in singular flat band systems.

- **Magnetic phase transitions driven by quantum geometry**: We show that spin susceptibility can be decomposed into a trivial component, which depends solely on the band dispersion, and a geometric component. By examining a class of QBT semimetals, we reveal that a phase transition between ferromagnetic and antiferromagnetic ordering can occur even without changes in the band structure, solely due to the influence of quantum geometry.

連絡教員　　村上　修一（内線 2747）