

## 量子物理学・ナノサイエンス第 447 回セミナー

## Quantum geometry on material properties

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### 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:

1. Mass-Invariant universal optical conductivity: In isotropic quadratic band touching semimetals, the optical conductivity is universally given by a geometric quantity independent of the detailed band structure.
2. 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.
3. Third harmonic generation of Higgs mode in superconductor: Collective modes in superconductors, such as the Higgs mode, offer deep insights into the nature of condensates. Third-harmonic generation is a primary tool for probing the Higgs mode, but its signal competes with that of quasiparticle excitations depending on impurity scattering rates.

In particular, in the clean regime the standard BCS theory generally predicts the dominance of quasiparticle contributions. Here, we propose and demonstrate that the quantum geometry of electronic bands can be a key mechanism governing this competition.

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