

Department of Physics, National Central University



# Colloquium

# **Nonlinear optical responses**

# and quantum geometry

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### Date: 2023/12/19 (Tue) Venue: S4-625 Time: 14:00-16:00

#### Abstract

Nonlinear optical (NLO) responses of materials, e.g., second-harmonic generation and bulk photovoltaic effect (BPVE), have received renewed interests recently due to their promising applications in next generation optoelectronics, photovoltaic solar cells and sensitive THz radiation detection. In the meantime, understanding of responses of materials to static electromagnetic fields, e.g., quantum Hall effect, in terms of geometry of quantum states has become a powerful approach, resulting in such important discoveries as quantum anomalous Hall (Chern) insulator. However, it has been challenging to relate quantum geometry with optical responses. In this talk, I will present some findings of our recent endeavor along this direction. In particular, we discovered that in BPVE, injection photocurrent is controlled by quantum metric and Berry curvature while shift photocurrent is governed by Christoffel symbols. Further, by identifying transition dipole moment matrix elements as tangent vectors, we constructed a Riemannian geometry theory for NLO processes, and showed that optical responses are dominated by the manifestations of Riemannian geometry of quantum states. We also demonstrated that third-order photovoltaic Hall effect in topological materials are caused mainly by Riemannian curvature tensor.