

# 凝縮系物理学ゼミナール

## Condensed Matter Seminar

(※ seminar is held online via zoom)

Date: **13:30-15:00**, Wednesday, 15th July 2020

“Thermodynamic Approach to Electric Quadrupole Moments”

Speaker:

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Abstract:

Electric quadrupole moments (EQMs) are among the most fundamental quantities describing electric properties of materials. In contrast to their simple definitions in classical electromagnetism, quantum-mechanical formulation of EQMs has not been completed, due to the difficulty of treating position operator in periodic crystals. It has been revealed only recently that EQMs can be obtained as a topological invariant in the presence of those crystalline symmetries which force EQMs to classically vanish (e.g. fourfold rotation) [1]. Extension to systems without such symmetries are discussed [2-3], but some subtleties are pointed out [2,4]. Further effort is needed to establish the formulation of EQMs in crystal.

In this work, we discuss the thermodynamic aspect of EQMs, following recent studies of orbital magnetization [9] and magnetic quadrupole moments [10-13]. Thermodynamic EQMs are defined via the change of free energy density in response to electric field gradient, and are expressed by using Bloch functions. Thermodynamic relation between thermodynamic EQMs and electric susceptibility is obtained, in the same way as previous studies for magnetic multipole moments [10-13]. We apply the obtained formulas to a model of the electron nematic state, and discuss the relationship with previous studies of topological EQMs.

References:

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