

NSYSU

# physics 書報討論 Weekly Seminar

## Non-adiabaticity as a source of coherence and decoherence in quantum matter

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Adiabatic dynamics is a cornerstone of quantum physics, describing regimes where slowly varying parameters allow quantum states to evolve smoothly. This framework underlies geometric effects in quantum materials and the Born–Oppenheimer approximation, which not only enables practical electronic-structure theory but also shapes how we interpret ultrafast phenomena such as coherent phonons.

Yet many frontiers of current research—from controlling quantum matter with light to understanding decoherence in complex systems—lie beyond this adiabatic limit. In such non-adiabatic regimes, quantum dynamics can display qualitatively new behaviour, shaping both the emergence of coherence and the onset of decoherence.

In this talk, I will illustrate these ideas with two examples. First, I will discuss how ultrafast laser driving in solids, beyond the adiabatic regime, can lead to new electronic responses connected to the geometric structure of the bands. Second, I will show that non-adiabatic electron–nuclear coupling can provide a direct route to electronic decoherence, even without the need to average over many different nuclear configurations.

Viewed alongside the familiar adiabatic perspective, these examples reveal how non-adiabatic effects enrich our understanding of quantum matter and the dynamics it can exhibit.



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