Time Resolved Infrared Spectroscopy: monitoring molecular reactions and transformations

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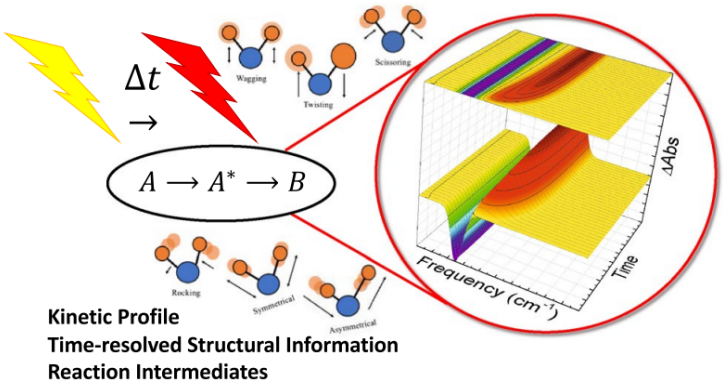
Time-resolved infrared (IR) spectroscopy is a key tool for exploring photoinduced reactions because it provides direct, bond-specific insight into transient molecular structures and reaction mechanisms. By following vibrational signatures in real time, these methods allow us to observe short-lived intermediates and track how molecular systems evolve after photoexcitation. Since their introduction in the 1980s, time-resolved IR techniques have been applied in many areas, including photochemistry, photobiology, materials science, and catalysis. [1]

This lecture is designed for a broad audience and aims to provide an intuitive and coherent introduction to the main concepts of time-resolved IR spectroscopy,[2] with particular emphasis on ultrafast IR, two-dimensional IR (2D-IR), and nonlinear spectroscopic methods. We first review the fundamental principles and experimental strategies behind these techniques, highlighting what type of structural and dynamical information they can deliver. We then illustrate their capabilities through five representative case studies drawn from photobiology, photochemistry, semiconductors, and metal–carbonyl complexes.



Our goal is to show how time-resolved and ultrafast nonlinear IR methods can provide unique insights into molecular structure, energy flow, and reaction pathways, and to encourage their broader use across disciplines.

[1] *Mezzetti, et al.,* Photochemical & Photobiological Sciences

[2] Ashbury et al., *J. Mater. Chem. C*, (2019),7, 5889-5909