November 12-13 2024
RamanFest
Paris | FRANCE

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Ultrafast dynamics of quantum materials by time resolved Raman scattering

Controlling materials properties with light pulses is an emerging field in condensed matter research. Quantum materials with their delicate interplay of magnetic, electronic, orbital and lattice degrees of freedom offer an attractive playground to demonstrate optically induced novel phases out-of-equilibrium with unique properties.

To achieve this, spectroscopic techniques capable of probing electronic, magnetic and lattice degrees of freedom on the ultrafast timescales (picosecond or femtosecond), both table-top and in large scale facilities, are currently being developed. In this talk, I will discuss the extension of Raman scattering to the ultrafast time scale as a symmetry resolved probe of non-equilibrium lattice and electronic properties of quantum materials. Quite remarkably this well-established technique to probe quantum materials in equilibrium has remained relatively underused on the ultrafast time scale. After a brief introduction to the technique, I will illustrate its use to the candidate excitonic insulator material Ta_2NiSe_5. I will show that a metastable phase with unique lattice and electronic properties can be induced in this material by a sub-picosecond near infrared pulse. If time allows, I will also discuss more recent results on the out-of-equilibrium dynamics of superconducting cuprates.

References

[1] K. Katsumi et al. Phys. Rev. Lett. 130, 106904 (2023)

Figures

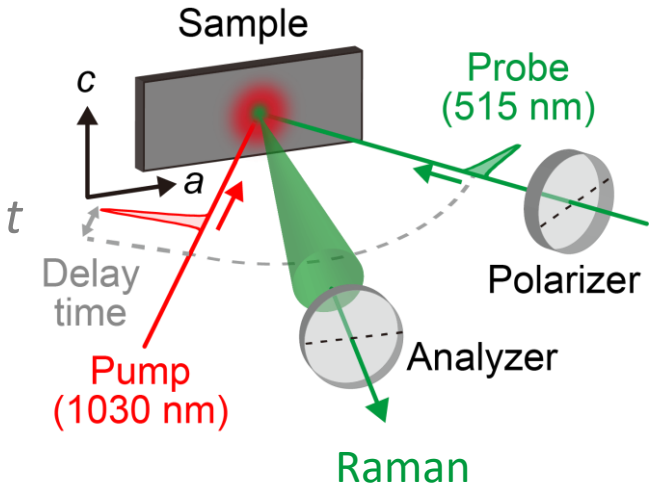

Figure 1: Ultrafast two-colour pump-probe Raman scattering