# ULTRAFAST ENERGY TRANSFERS AT THE NANOSCALE

**LABORATORY :** Institut Lumière Matière

**LEVEL :** M2
**TEAM(S) :** FEMTO-NANO


**CONTACT(S) :** CRUT Aurélien
DEL FATTI Natalia
LASCOUX Noëlle

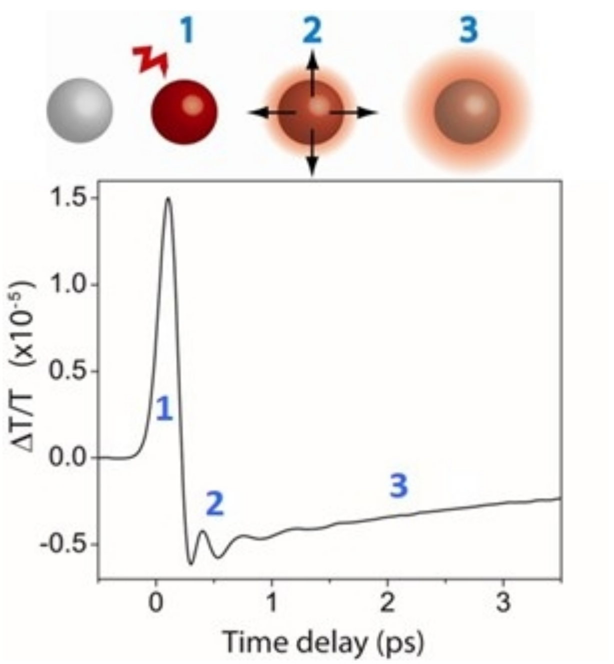
**CONTACT(S) DETAILS:** aurelien.crut[at]univ-lyon1.fr / Tel. 0472431135
natalia.del-fatti[at]univ-lyon1.fr /
noelle.lascoux[at]univ-lyon1.fr / Tel. 0472448315



**KEYWORD(S) :** Out-of-equilibrium physics / femtosecond nonlinear laser spectroscopy / single nanoparticules


## SCIENTIFIC CONTEXT :

The sudden absorption of electromagnetic energy by a nano-object triggers a series of relaxation processes—internal thermalization, acoustic vibrations, and cooling—occurring on femto- to picosecond timescales. Studying these processes provides insight into how macroscopic laws governing electronic interactions, elasticity, thermal conduction, and interfacial energy transfer are modified at the nanoscale.
The FemtoNanoOptics team possesses powerful experimental and theoretical tools to explore these phenomena, including quantitative linear and ultrafast optical measurements on individual nano-objects [1], morphological characterization by electron microscopy, and multiphysics numerical modeling of their ultrafast response [2].




*Monitoring the ultrafast dynamics of metallic nano-objects using pump-probe optical spectroscopy.*

## MISSIONS :

The first part of the internship will focus on continuing our current investigations into the vibrational dynamics of individual gold nanodisks [3], synthesized chemically in collaboration with CEA Saclay.
The main objective is to gain a deeper understanding of the vibrational damping mechanisms of these nanodisks in order to optimize their quality factors.

The second part of the internship will focus on the study of thermal energy transfer between distinct metallic nanoparticles separated by a nanometric dielectric layer. To this end, the different metallic components of individual nano-hybrids (synthesized in Bordeaux) will be selectively excited and probed to monitor the temporal evolution of their temperatures.

The experimental observations will be correlated with finite-element numerical simulations, allowing the interpretation of thermal coupling mechanisms and the quantification of energy transfer within these nanostructured systems.

## OUTLOOKS :

The internship may be extended into a PhD project.

## BIBLIOGRAPHY :

[1] Movie available on http://ilm.univ-lyon1.fr/femtonanooptics
[2] Crut et al., Chemical Society Reviews 43, 3921 (2014)
[3] Medeghini et al., Nano Letters 18, 5159 (2018); Rouxel et al., JPCC 28,15625 (2020); Rouxel et al., JPCC 125,23275 (2021); Crut, JAP 131, 244301 (2022); Panais et al., JPCL 14 ,5343 (2023)