ELECTRON SPECTROSCOPY AND MACHINE-LEARNING ANALYSIS OF PLASMONIC NANOPARTICLES

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Institut Lumière Matière (iLM)

LEVEL : M1 / M2
TEAM(S) : AGNANO

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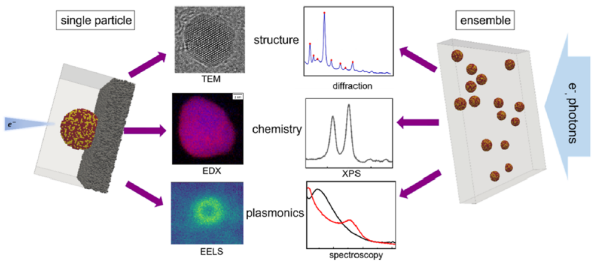
KEYWORD(S) :

SCIENTIFIC CONTEXT :



Plasmonic nanoparticles (NPs) exhibit optical properties that strongly depend on their size, composition, structure and environment. NPs of noble or trivalent metals display strong resonances in the near UV–visible–IR spectral range, known as localized surface plasmon resonances (LSPRs), which are a sensitive fingerprint of their electronic structure. Our group combines complementary Transmission Electron Microscopy (TEM) and spectroscopy techniques to investigate how the structural and optical properties of well-defined plasmonic nanoparticles and nanoalloys, including Ag, Au–In and Ag–In systems [1], depend on their composition, chemical order and environment. These experiments generate multidimensional datasets, in which advanced statistical, machine-learning and artificial intelligence methods can help extract physical information more effectively.

MISSIONS :

The student will start with Ag nanoparticles [2,3] and analyze experimental electron-spectroscopy datasets using Python-based tools. The work will focus mainly on Scanning-TEM EELS (Electron Energy Loss Spectroscopy) data processing, visualization and interpretation, including statistical and machine-learning approaches such as Principal Component Analysis (PCA) and Non-negative Matrix Factorization (NMF), to map the LSPRs of small nanoparticles (diameter < 10 nm). The approach will then be extended to bimetallic NPs, with the aim of relating nanoparticle structure and composition to their optical response. Through this internship, the student will learn how to work within a research group and will acquire skills related to optical properties of nanomaterials, electron–matter interactions and to numerical and statistical approaches for data processing.

OUTLOOKS :

Physics. Previous experience with Python or machine learning is welcome but not required.

BIBLIOGRAPHY :

1 - M. Moreira et al., ACS Nano (2026), DOI: 10.1021/acsnano.6c08377.

2 - A. Campos et al., Nature Physics 15, 275–280 (2019).

3 - M. H. Moreira et al., J. Phys. Chem. C 127, 17828–17835 (2023).

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