USING LINEAR AND NON-LINEAR OPTICS TO PROBE THE SURFACE OF NANOPARTICLES

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : iMust Labex

LEVEL : M2
TEAM(S) : ATMOS

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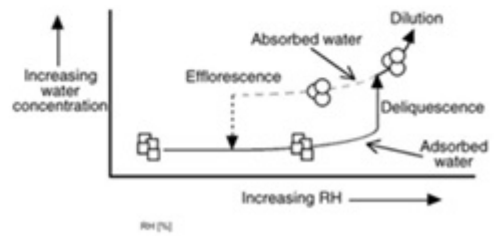
KEYWORD(S) : Backscattering / Nonlinear optics / Nanoparticles

SCIENTIFIC CONTEXT :



Probing the phase transition of atmospheric nanoparticles with linear and nonlinear optics.

As underscored in IPCC reports on climate change [1], the main uncertainty in understanding the Earth's climate is due to our imperfect knowledge of the interaction between atmospheric nanoparticles with electromagnetic radiation. Examples of such particles are numerous: sea-salt particles, silica and metal oxide particles forming mineral dust are prime examples, existing in the air we breathe. Their ability to warm or cool the Earth's climate is far to be understood, due to their complexity, either solid or liquid, dielectric or semi-conductors, and presenting a highly irregular shape, sometimes even with sharp edges. As a result, no analytical solutions to Maxwell's equations exist for such complex-shaped particles which are difficult to model mathematically while their surfaces are difficult to access to studies [2]. The dependence of the Earth's climate on the particles' shape is yet poorly understood. Moreover, one should account for the modifications of the nanoparticles' surface and volume when phase transitions occur. This is especially true for sea-salt nanoparticles, which are present at the air-water interface (atmosphere-ocean interface), and lead to crystallized solid particles or liquid nanoparticles when phase transitions occur.

MISSIONS :

In this internship, a better understanding of the interaction of the electromagnetic radiation with such condensed matter is targeted. Current research [3, 4] primarily examines linear processes such as scattering and extinction, leaving out non-linear methods, while recent advancements, like Hyper-Rayleigh scattering, which offer precise techniques for studying solid-liquid interfaces.

The goal of this internship is to combine linear [3, 4] and non-linear [5, 6] optics to put light on the surface of such nanoparticles and on their phase transitions from solid to liquid (deliquescence, efflorescence).
After understanding the two existing apparatuses [3-6], the intern will focus sea-salt nanoparticles as a case study, to explore changes in the particle shape at different humidity levels, covering deliquescence and efflorescence phase transitions.

Required skills: interest in atmospheric nanoparticles or / and in optics.
Funding : Labex iMust, highlighting its significance among the various internships offered within the LabEX (Laboratoire d'Excellence) framework.

More information: Do not hesitate to contact A. Miffre to ask questions, come and visit the experiments.

OUTLOOKS :

Nanoparticles surface-to-volume effects, phase transitions

The internship can be pursued with a PhD.

BIBLIOGRAPHY :

[1] IPCC, The Physical basis, Climate Change, (2021).

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[5] Bachelier, G., et al., Phys. Rev. B, 82 (23), 235403, (2010).

[6] Butet, J., et al., Nano Lett., 10 (5), 1717-1721, (2010).