COOLING OR WARMING ? SPECTRO-POLARIMETRY OF COMPLEX MATTER

LABORATORY : Institut Lumière Matière

LEVEL : M2
TEAM(S) : ATMOS

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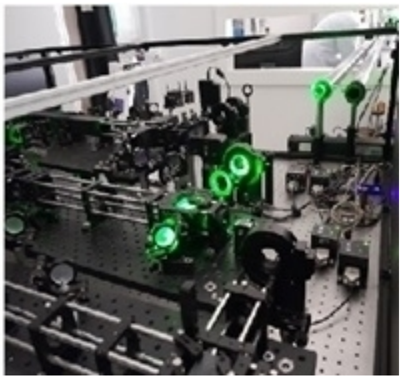
KEYWORD(S) : Backscattering / Absorption / Polarimetry / Spectroscopy

SCIENTIFIC CONTEXT :



Picture of the light backscattering experiment (world-first, [3-5]).

As underscored by the latest IPCC report [1], the main remaining uncertainty on the Earth's climate is linked to our imperfect knowledge of atmospheric particles, which present a wide range of sizes, shapes, and refractive indices preventing analytical solutions to Maxwell's equations. In particular, the Mie theory cannot be applied to such complex-shaped particles, which are highly inhomogeneous and exhibit a very complex morphology, with highly irregular shapes, sometimes with sharp edges. Whether such particles will cool or warm the Earth's climate is governed by the albedo effect, and hence by their ability to backscatter light (absorption governs their ability to warm it). In this context, laboratory measurements are required to quantify the interaction of light with such complex particles, in the aim to quantify their contribution to the Earth's radiative budget, which still needs to be revealed. The state of the art on light scattering and absorption is given in [2]. At iLM however, a groundbreaking laboratory experiment has been developed by A. Miffre [3-5] to quantify light scattering by complex matter in a dilute medium (ambient air) in the specific backward scattering geometry of 180.0°, which governs the albedo effect. This world-first experiment reveals unique spectral and polarimetric signatures of these particles, including their size, shape, and refractive index.

MISSIONS :

Missions :
As a first step, the internship will understand the principle of the existing laboratory experiment [3-5] with the help of A. Miffre and that of a post-doctorate, A. Genoud, also present on this experiment for 2 years. As a second step, the internship will calibrate the existing laboratory experiment with spherical water droplets that obey to the Mie theory to quantify the backscattering cross-sections of these nanoparticles. As a final point, the internship will explore complementary methods of light interaction with these particles.

Required skills to succeed in this internship :
Applicants should have an interest in optics, in performing laboratory experiments, spectroscopy or / and polarimetry.
Skills in laser physics and/or atmospheric physics will also be appreciated, though not absolutely necessary.

Funding :
This research is funded by CNRS and CNES.

More information :
Interested students are strongly encouraged to contact A. Miffre via email to come and visit the experiment.
There is no wrong question, feel you free to contact me.

OUTLOOKS :

This internship can be pursued with a PhD, to be achieved with the help of a 2 years postdoctorate.

BIBLIOGRAPHY :

[1] IPCC, Climate Change, The Physical Science Basis, (2021).
[2] Mishchenko, M.I., and Travis, Light scattering by small particles, NY, (2002).
[3] Miffre, A., T. Mehri, M. Francis and P. Rairoux, J. Quant. Spec. Rad. Transf., 169, 79-90, (2016).
[4] Miffre, A., D. Cholleton, and P. Rairoux, J. Quant. Spec. Rad. Transf., 222, 45-59, (2019).
[5] Miffre, A., D. Cholleton, C. Noël and P. Rairoux, Atmos. Meas. Tech., (2023).