PROJECT FACTSHEET

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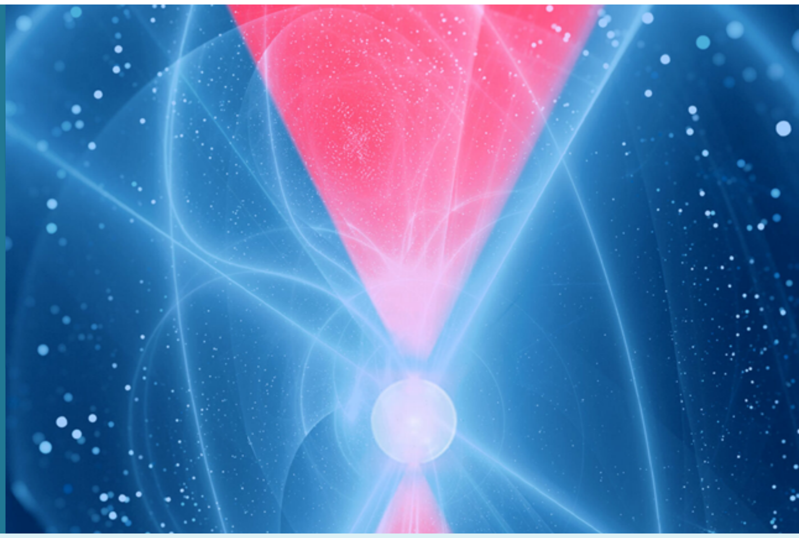
FRAGOLA

Development of advanced 1-D, non-perturbative, laser based diagnostics of neutral and charged species, using FRequency AGile Optical LAttices



Inspiration

The advent of lasers in 1960 and the further improvement of laser technology to this day, have provided with a plethora of novel, non-mechanical, generally non-intrusive, resonant and non-resonant techniques for the detailed study and characterization of neutral and charged species, as well as their precise manipulation through optical forces. Laser based techniques are thus promising replacements for mechanical probes, which are currently the state of the art in neutral gas and plasma metrology and manipulation, with the former offering numerous advantages over the latter, such as non-intrusive, non-perturbative and non-destructive capabilities, fast acquisition times, species selectivity in the case of resonant schemes and more precise measurements of quantities of interest, such as temperature, density, flow velocity etc.

Innovation

We propose the use of single shot Coherent Rayleigh-Brillouin scattering (CRBS) as an effective, non-resonant temperature, density, and velocity measurement technique, applicable to almost any species, neutral and/or charged, in quiescent conditions or in a flow. 0D-CRBS has proven to be a powerful technique for the determination of the temperature, speed of sound, pressure, polarizability, shear and bulk viscosity of a gas or gas mixture, atomic or molecular. Additionally, 0D-CRBS is currently considered the only technique to enable the in-situ measurement of nanoparticles, while recent work has showcased the technique's ability to perform gas flow velocimetry at flow velocities as low as 5 m/s, with respective temporal and spatial resolutions of ~150 ns and ~100 µm.

Here, we propose the dimensional extension of the demonstrated capabilities of 0D-CRBS, thus drastically increasing its usefulness and measurement capabilities in real experimental conditions of interest. Towards that goal, we introduce the novel, never before demonstrated concept of 1D-CRBS as an invaluable tool for fast, accurate and line-localized measurements across the length of any quiescent or flow profile, such as e.g. the boundary layer at hypersonic and/or re-entry conditions, for a variety of gases, gas mixtures.

Additionally, we propose, for the first time, the application of this innovative technique for the remote, non-intrusive temperature, density and velocity diagnostics of ions in a plasma/plasma flow. This work will ultimately allow for the validation of developed simulation codes, thus enabling their better assessment of the modeled scenarios (e.g. thermal load on vehicles upon entry into a planetary atmosphere).

Impact

A major objective of FRAGOLA will be the demonstration of the diagnostic capabilities of the developed 1D-CRBS concept in a variety of real experimental conditions. Towards that goal a prototype, portable version of the 1D-CRBS experimental setup will be developed, demonstrating and validating its diagnostic capabilities in a multitude of established experimental facilities at LIST, in close collaboration with the Plasma Process Engineering and Nanomaterials and Nanotechnologies groups. Additionally, the option of collaborating with research facilities across Europe will be actively explored (e.g. in arc torches, wind tunnels etc).

Finally, a major task to be achieved with FRAGOLA is, not only to establish a fruitful and sustainable research program in laser diagnostic development and photonics applications within LIST, but also to educate and train a critical mass of researchers in the field, thus creating a highly skilled, and if possibly diverse, core of researchers in laser diagnostics in Luxembourg. To achieve this, we aim to build up on our unique expertise with CRBS but also to complement this effort with additional laser diagnostic techniques in collaboration with the different research groups across LIST, ultimately aiming at creating a new, laser processing and optical manipulation RDI team within LIST's Scientific Instrumentation and Process Technology (SIPT) unit.

Partners

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Contact

5, avenue des Hauts-Fourneaux
L-4362 Esch-sur-Alzette
phone: +352 275 888 - 1 | LIST.lu

Alexandros GERAKIS (alexandros.gerakis@list.lu)

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY