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Non-intrusive diagnostics of micro-flows by Raman spectroscopy

S. Montero

Laboratory of Molecular Fluid Dynamics, IEM-CSIC, Serrano 121, 28006, Madrid (Spain)

emsalvador@iem.cfmac.csic.es

State-of-the-art Raman spectroscopy based on multichannel CCD detectors refrigerated by liquid N_2, jointly with computer controlled spectrometers and sampling chambers, provides a powerful tool for the diagnostics of gas, liquid, and even solid micro-flows. Merits of this technique are **a)** its universality, in the sense that all molecular species are detectable, **b)** high space (~1 micron) and time resolution (~10^{-9} s), **c)** high accuracy (up to 1 %) quantitative measurements of number densities, rotational and vibrational populations and temperatures, **d)** wide Raynolds and Knudsen number range, **e)** wide spectral range (~5000 cm^{-1}), and **f)** long term stability (hours). First, an overview of Raman spectroscopy methodology for flowing media will be presented. Then, a number of examples from the Laboratory of Molecular Fluid Dynamics involving gas, liquid, and solid micro-flows will be repored. These include **a)** supersonic jet mapping [1,2], **b)** structure of shock waves [3,4], **c)** molecular condensation [5,6], **d)** liquid-solid filaments [7], **e)** evaporative cooling [8], and **f)** molecular collisions [9,10]. Apart from these examples the possibilities of Raman spectroscopy for the study of confined micro-flows, transonic flow, gas-dynamic behaviour of mixtures, relaxation and transport properties in gases, as well as mapping and characterization of evaporative cooling processes will be discussed.

References

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