Paper 12.2

Laser-Induced Iodine Fluorescence Applied to Confined Supersonic Mixing

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ABSTRACT

A laser-induced fluorescence (LIF) measurement system is presented and applied to the study of supersonic gas flows at low density. The LIF technique uses atomic or molecular tracers instead of microscopic particles so that particle lag effects, which are remarkable in low density flows, are avoided. The fluorescence signal of laser-excited molecules provides information about the gas velocity, temperature and pressure, since the signal depends on the spectral position of the laser radiation and the thermodynamic state of the molecules. A suitable molecule for LIF measurements is iodine which can be excited by an argon-ion laser. The argon-ion laser is used in single mode operation at 514.5 nm by inserting an etalon into the laser cavity. The etalon allows the laser to be tuned over two iodine absorption lines (Figure 1), in parallel the emitted fluorescence signal is measured and stored on a PC for further analysis. Although the optical set-up is arranged for pointwise measurements, a flowfield measurement is possible by traversing the optics. A simultaneous measurement of velocity, temperature and pressure of a supersonic free jet flowfield was presented at the 9th International Symposium on Applications of Laser Techniques to Fluid Mechanics in Lisbon (Havermann and Beylich, 1998). In this paper, an application of the iodine LIF technique to the study of mixing layer growth in confined supersonic flows is discussed. Compressible mixing layer growth is reduced considerably with increasing Mach number. An empirical relation between the convective Mach number and the growth rate was first derived for plane mixing flows from Pitot pressure data and schlieren visualisation by Papamoschou and Roshko (1988). Here, a planar test section for confined supersonic mixing was built to study ejector applications and the mixing layer growth was measured for three convective Mach numbers using the iodine LIF technique. The results are in good agreement with the empirical relation for the mixing layer growth rate.

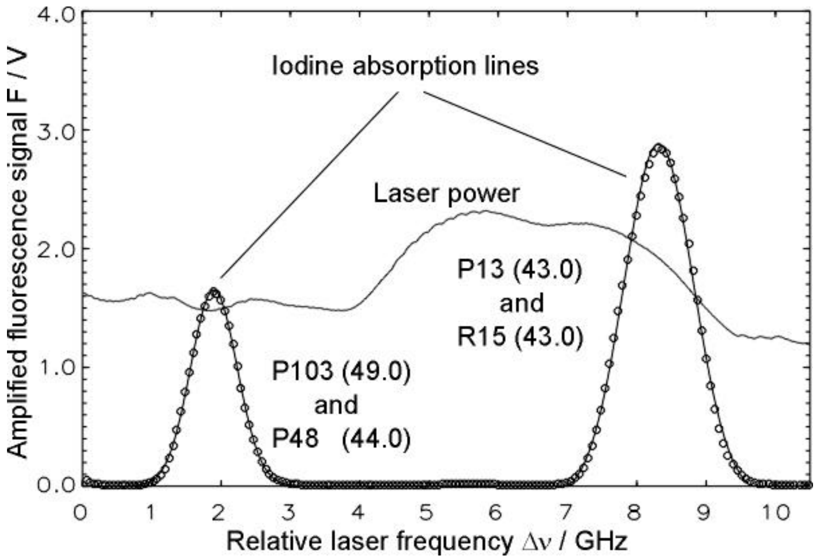

Figure 1. Measured iodine absorption spectrum by tuning a 514.5 nm single mode argon-ion laser. The absorption lines are assigned by their rotational and vibrational quantum numbers. The measured data points are fitted by a Gaussian function. The laser power used for normalisation is also recorded.