Paper 17.2

Local Acquisition of Mean and Turbulent Fluid Acceleration in Highly Turbulent Flow by the Means of Laser-Doppler Velocimetry

by
B. Lehmann, J. Helbig
Deutsches Zentrum für Luft- und Raumfahrt
Institut für Antriebstechnik
Abt. Turbulenzforschung
Müller-Breslau-Str.8
D-10623 Berlin, Germany
e-mail: bernhard.lehmann@dlr.de

ABSTRACT

The problem of variable velocity in the probe volume of an LDA optics is discussed for introduction. It is shown, that even under the very conservative flow conditions of a low-speed air jet the local turbulent acceleration of fluid leads to velocity variations in the probe volume which make the common assumption of velocity constancy during the measurement very doubtful.

A technique to analyse these velocity differences might be, on the other side, valuable as a source of new and extended information on local turbulent flow properties. The according local acceleration may, by example, give information on particle trajectory and separation processes.

The technique and a crucial experiment are mentioned which are used to estimate experimentally the local acceleration in turbulent flow and to confirm its suitability. The measurement technique is based on multiple frequency analysis of individual Doppler bursts (see Fig.1). The verification experiment is made in a stagnation flow which impinges axially on the end face of a 5 mm diameter rod.

Then in the experiment of actual interest we report the analyses of the local acceleration features in stagnation flows in front of a stagnation plate with and without the presence of combustion. The expectation was that in the case of combustion the level of local accelerations should be increased compared with the cold turbulent flow. This behaviour could not be confirmed by the experiments. It seems more probable that the accelerations are reduced by means of damping effects due to the increase of viscosity in the combustion flow.

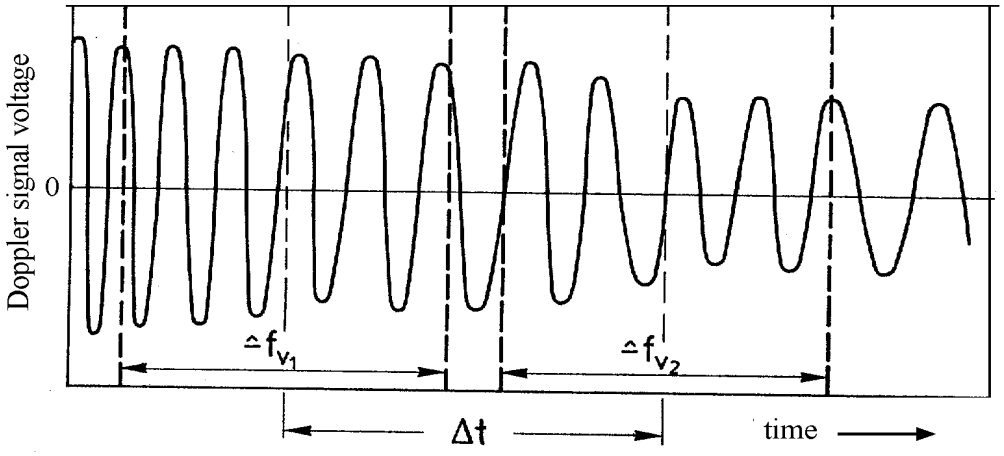

Fig.1: Schematic of multiple frequency analysis of a Doppler burst