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Local Measurements in Turbulent Flows Through Cross Correlation of Optical Signals

Various methods for measuring turbulent fluctuations in transonic and supersonic flows (at temperatures ranging from 100^{o} to 3000^{o} K) have been studied in an effort to find suitable instruments which combine the necessary linear and time invariant frequency response with a sufficiently high temporal and spatial resolution. This study shows that a method of measurement based on the cross correlation of optical signals will provide the required characteristics. In this method, two collimated beams of radiation are crossed at the point of interest in the flow, and the power loss of each beam through the flow is measured with two independent photodetectors. Although each detector alone yields only an integrated effect along the entire beam path, the technique of forming a cross correlation between the two detector signals removes the unwanted portions of the signals and yields information about the turbulent properties. An additional possibility offered by the technique is that of measuring the correlation between either different thermodynamic properties or different species concentrations. This measurement, in principle, can be achieved by arranging one beam to be sensitive to one property, while the second detects fluctuations of the other property.

The crossed beam correlation method estimates local power spectra, turbulence scales, convection velocities, and eddy lifetimes with the same data reduction procedures that have been developed for conventional two-point measurements using standard probes. In addition, an area integral of thc space-time correlation can be obtained so that "one shot" estimates of forcing functions and true three-dimensional wave number components become possible, avoiding the prohibitively expensive translation of point probes across the source area of interest. Because the optical wavelength can be chosen from any portion of the spectrum, this method appears to offer a versatility and/or selectivity not available with any standard solid probe.

Note:

Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: M. J. Fisher

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Category 01

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