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NASA TECH BRIEF

Optical Probing of Supersonic Aerodynamic Turbulence

The theoretical discussions and qualitative experimental results presented concern the feasibility of remotely retrieving statistically correlated signals from supersonic aerodynamic turbulence. Such signals could be used for computing autocorrelograms and cross correlograms exhibiting accurate, reproducible, and readily identifiable flow-related correlation "peaks."

Signals retrieved with a laser quasi-Schlieren system and data retrieved with a laser shadow-correlation system are presented. Cross correlograms and autocorrelograms computed on-line show that both systems can be used for retrieving flow-related signals sufficient for computing accurate and reproducible correlation peaks. Additive traces were not introduced because the Schlieren shadow-sensing modes were used.

A statistical method for obtaining "one-shot" measurements of the decay history of turbulent structures in a stationary frame of reference is introduced, along with the results of two practical applications of the technique. The one-shot methods are the only means through which the turbulence-decay history can be computed from the same statistical sample of data—the information can be computed from a single composite signal retrieved during one run of the facility.

Theoretical analyses show that these one-shot techniques also yield results in three-dimensional turbulent-flow regimes, provided the signal-to-noise ratios of the raw-data time histories are not prohibitive. Such results can be obtained with only minor modification of the beam arrangement and, in some instances, with insertion of time delays between signals.

Since only qualitative results were sought, parallel-beam geometry was applied to increase the signal-to-noise ratio over that of crossed-beam geometry. Although crossed-beam geometry should be used for quantitative measurements, the potential use of parallel beams for retrieval of quantitative results from a restricted class of flows should be investigated.

Spectra are not discussed, and no attempt is made to experimentally establish the flow properties that are measured. These factors should be the objects of a systematic test designed to yield quantitative results.

The qualitative results presented clearly indicate that such remote probing is feasible using statistical correlation, without using tracers. Correlation peaks computed from signals retrieved with either parallel or crossed beams were flow-related, reproducible, and readily identifiable.

Notes:

1. Requests for further information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B70-10665

2. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   (N69-38125), Optical Probing of Supersonic Aerodynamic Turbulence with Statistical Correlation

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code A&TS-PAT
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Source: B. H. Funk and H. A. Cikanek, Jr.
Marshall Space Flight Center
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