# NASA TECH BRIEF

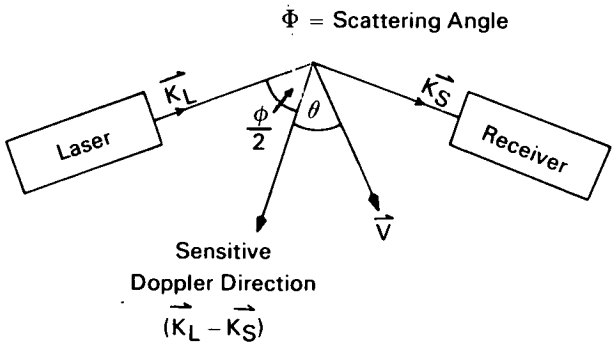


## Laser-Doppler Gas Velometer

A three-dimensional (3-D) laser Doppler instrument was developed to measure both the local mean and the fluctuating gas velocity (subsonic and supersonic) of an air flow. This device was needed because such available physical probes as the hot-wire anemometer disturb the flow when measuring the velocity and turbulence in supersonic jets and wind tunnel flows. This led to the use of a technique (see figure) in which optical heterodyning of a portion of the incident laser beam with the laser light that is scattered from the flowing gas will produce a beat signal at the frequency of the Doppler shift resulting from the motion of the particles in the gas. In this technique either natural or artificial tracers are needed in the flow.

In optical heterodyning, two coherent monochromatic light beams of different frequencies are directed simultaneously onto the photosensitive surface of a photodetector such as a photomultiplier tube. The intrinsic square-law response of the photodetector leads to an electrical output signal with a frequency equal to the frequency difference between the two incident light beams. Optical heterodyning thus allows a direct measurement of the frequency difference between two coherent, monochromatic light beams from a few Hz to a GHz corresponding to almost zero velocity to very high Mach numbers. The measurement of this beat signal frequency together with the geometry of the optical system determines the flow velocity of the gas.

The feasibility of using a laser-Doppler technique for measuring atmospheric wind velocity and turbulence has also been established. In these measurements, only the natural contaminants in the atmosphere are used. A 3-D wind velocity system with a 2-m resolution at an altitude of 300 m is being developed. In addition, the feasibility of using this laser-Doppler technique for detecting clear air turbulence is being studied. This technique might be applied to an on-board warning system for aircraft.




Schematic of the Laser-Doppler Heterodyne Technique

### Notes:

1. Liquid flows can also be measured with this innovation under certain conditions.
2. This innovation may be of interest to researchers involved in measuring the velocities of flow and turbulence.
3. Requests for further information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B70-10143

### Patent status:

No patent action is contemplated by NASA.

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