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Introduction to Aerodynamic Measurement Technology Special Section

WE are pleased to introduce this special section of the *AIAA Journal* on aerodynamic measurement technology. This is the third such special section sponsored by the AIAA Aerodynamic Measurement Technology Technical Committee (AMT-TC) that was formed in 1990. The others appeared in March 1993 and March 1996. Most papers in this section are revised versions of papers originally presented at sessions hosted by the AMT-TC during the AIAA 36th Aerospace Sciences Meeting held in Reno, Nevada, on Jan. 12–14, 1998.

The focus of the AMT-TC is to promote advanced and novel techniques for flowfield and surface measurement in ground-based or flight applications. In recent years, we have seen significant improvements in both the quality and quantity of measurements (or measurable parameters) available to the aerodynamic community. This progress has been the result of significant advances in hardware technology, such as micromachined sensors and improved charge-coupled device cameras for flowfield imaging, and the development of innovative measurement approaches, such as pressure-sensitive paints and laser-based spectroscopic techniques. The 12 papers included in this special section illustrate some recent trends in flowfield measurements. The flows of interest cover the full range from incompressible to supersonic flow and from low-temperature nonreacting air to high-temperature combustion gases. The techniques described here are also intended for use in laboratory-scale research experiments, full-scale testing and evaluation, and even sensors for active control systems.

The first two papers describe progress in multihole pressure probe techniques for measurement of velocity. These papers focus on miniaturization and calibration, two issues essential to improving the accuracy and usefulness of probe-based techniques. Smaller probes are potentially less intrusive and can be used closer to surfaces. Calibration algorithms that provide accurate conversion of the multiple pressure readings to a single velocity, both magnitude and direction, in (nearly) real time are advantageous for both ground and flight tests.

The remaining 10 papers describe advances in optically based approaches for measurement of velocity, temperature, chemical species concentrations, and particulate levels in various flows. Not only do these techniques provide the capability for nonintrusive measurements and real-time sensing, they also promise sufficient accuracy and spatial and temporal resolution to be useful for validation of numerical models that simulate complex, three-dimensional, time-dependent flows. Of these 10 papers, the first 5 focus on measurement of velocity, and the second 5 deal with the measurement of scalars.

Most of the velocity work is based on Doppler-shifted laser scattering. The first of these papers explores advances in an established technique, laser Doppler anemometry (LDA), that permit in-flight measurements of wing flows. In comparison to LDA, which uses temporal filtering of light scattered by particles in a flow to determine velocity, variations of a technique based on spectral filtering are described in three other papers. In these approaches, the spectral filter is used to measure the Doppler shift between the wavelength of the incident laser and the light scattered by moving particles *or gas molecules*. The spectral filtering is performed either interferometrically, for example, with a tunable Fabry–Perot device, or with a tunable laser and a gas cell that provides a sharp absorption feature. This approach can be tailored to provide instantaneous, two-dimensional images of velocity vector fields or high data rates of one or more velocity components at a few locations. A fifth paper describes a flow tagging approach to determine simultaneously velocity at a number of flowfield locations. In flow tagging, various positions in the flow are marked at some initial time, and then the flow is interrogated at a later time to determine the displacement of the marked fluid and thus the flow velocity.

The last five papers describe spectroscopic methods for measurement of various scalar parameters in hostile environments such as supersonic and combustion flows. Four of these papers describe the measurement of gas temperature and species concentration using coherent anti-Stokes Raman spectroscopy, the application of laser-induced fluorescence for imaging in hypersonic shock tunnels, the application of diode-laser absorption for the control of combustion processes, and the measurement of soot concentrations using laser-induced incandescence. For each of the applications (actual or intended), the measurement requirements exceed the capabilities of traditional probe techniques. In many cases, these requirements include (near) real-time response for evaluation or control applications or multiparameter or multipoint capability for short-duration testing. The physics of an emerging laser diagnostic technique, picosecond pump/probe spectroscopy, is discussed in the fifth paper.

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