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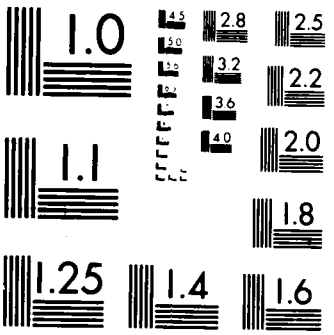
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An axisymmetric jet flow facility with a laser fluorescence flow visualization system has been developed. Advanced techniques in nonlinear optics and spectroscopy are being used to track oxygen molecules for velocity measurements. Similar techniques are being used to determine the distribution of energy states of oxygen molecules for temperature measurements. Density can also be measured by observing the direct light scattering from both oxygen and nitrogen. The great advantage of these techniques is they are non-obtrusive, instantaneous, two-dimensional and require no seeding of the flow with foreign material.

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FINAL TECHNICAL REPORT:

(DOD-URIP) VELOCITY MEASUREMENTS AND FLOW VISUALIZATION IN TURBULENT THREE-DIMENSIONAL SUPERSONIC FLOWS USING OXYGEN FLOW TAGGING

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AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
AFOSR-86-0219

February 17, 1988

The equipment that was purchased under this grant has been used to build a new laboratory for flow diagnostics. An axisymmetric jet flow facility was constructed. This facility is capable of operating over a wide range of stagnation pressures with various gases including air. The ejector can be routed through a high flow rate Stokes pump or directly to the atmosphere to permit a wide variation of the downstream pressure. The test section is enclosed by four high-quality UV optical windows for flow field diagnostics. This facility was built using money from the DOD-URIP Grant and an additional $80,000 from Princeton University. The facility is currently operating in the subsonic regime up to approximately Mach 1. New nozzles are under construction which will operate at Mach 2 and at Mach 2.87. This latter Mach number corresponds to that of the flow facility at the Princeton Gas Dynamics Laboratory and will allow us to configure diagnostic systems for that flow facility.

The remainder of the DOD-URIP Grant funds were used to purchase state-of-the-art laser systems, a high-sensitivity ultraviolet camera, and timing and data acquisition equipment to do flow field diagnostics research. Four technical papers, six conference presentations, and one report have so far been generated from the work in this laboratory. In essence, this equipment has allowed us to develop new methods for instantaneously measuring velocity, temperature, and density in high-speed air flows. Advanced techniques in nonlinear optics and spectroscopy are being used to track oxygen molecules for velocity measurements. Similar techniques are used to determine the distribution of energy states of oxygen molecules for temperature measurements. Density is measured by observing direct light scattering from both oxygen and nitrogen. The great advantage of these techniques is that they are instantaneous, two-dimensional, and requie no seeding of foreign material. The final piece of equipment for this laboratory, an intensified ultraviolet camera system, arrived at the end of January 1988. That camera now enables us to simultaneously measure velocity and density profiles in a Mach 1 axisymmetric free jet. Work is continuing with the objective of developing velocity, density, and temperature measuring capabilities in the vicinity of Mach 3.

PUBLICATIONS

1. R. Miles, C. Cohen, J. Connors, P. Howard, S. Huang, E. Markovitz, and G. Russell, "Velocity Measurements by Vibrational Tagging and Fluorescent Probing of Oxygen," Optics Letters 12, 1987, page 861.

2. R. Miles, J. Connors, P. Howard, E. Markovitz, and G. Roth, "Proposed Single-Pulse, Two-Dimensional Temperature and Density Measurements of Oxygen and Air," (to be published in Optics Letters).

3. R. Miles, G. Russell, J. Connors, E. Markovitz, "Acquisition and Visualization of Three-Dimensional Fluid Dynamic Data," Prepared for NSF Workshop on Image Processing and Analysis, Columbus, OH, October 16-18, 1987.

4. R. Miles, J. Connors, E. Markovitz, and G. Roth, "Coherent Anti-Stokes Raman Scattering (CARS) and Raman Pumping Lineshapes in High Fields," SPIE Meeting, Los Angeles, CA, January 11-15, 1988.

REPORTS

1. R. Miles, "Demonstration of Two-Dimensional Temperature Maps of Flow Fields Representative of Hypersonic Test Environments," Report to Lockheed-California Company, MAE Report #1794T, October 1987.

PRESENTATIONS

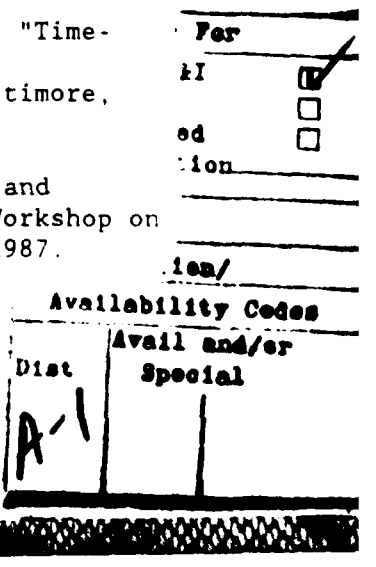
1. R. Miles, "Multi-Point Oxygen Flow Tagging by Raman Excitation + Laser Induced Electronic Fluorescence," November 24-26, 1985, Thirty-Eighth Meeting of the Division of Fluid Dynamics, American Physical Society, Bulletin of the American Physical Society 30, Paper CH-3, page 1720, New York: American Physical Society, 1985.

2. R. Miles, "Oxygen Flow Tagging by Raman Excitation + Laser Induced Electronic Fluorescence," June 1986, CLEO'86-IQEC'86, Conference on Lasers and Electro-Optics, San Francisco, CA (Invited Paper).

3. G. Russell and R.B. Miles, "Analytical Visualization of 3D Fluid Dynamic Structures," Thirty-Ninth Meeting of the Division of Fluid Dynamics, American Physical Society, Bulletin of the American Physical Society, 31, page 1722, Paper DG-5, Columbus, OH, November 1986.

4. R. Miles, J. Connors, S. Huang, E. Markovitz, and G. Russell, "Time-Resolved Velocity Profiles by Vibrational Tagging of Oxygen," CLEO'87/IQEC'87, Conference on Lasers and Electro-Optics, Baltimore, MD, April 27-May 1, 1987.

5. R. Miles, G. Russell, J. Connors, E. Markovitz, "Acquisition and Visualization of Three-Dimensional Fluid Dynamic Data," NSF Workshop on Image Processing and Analysis, Columbus, OH, October 16-18, 1987.



6. R. Miles, J. Connors, E. Markovitz, G. Roth, and P. Howard, "Instantaneous 2D Temperature and Density Measurements in Oxygen and Air," 40th Anniversary Meeting of the Division of Fluid Dynamics of the American Physical Society, Eugene, OR, November 22-24, 1987.

7. R. Miles, J. Connors, E. Markovitz, and G. Roth, "Coherent Anti-Stokes Raman Scattering (CARS) and Raman Pumping Lineshapes in High Fields," SPIE Meeting, Los Angeles, CA, January 11-15, 1988.

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