ATMOSPHERIC TEMPERATURE FROM RAMAN SCATTERING

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ABSTRACT

Raman scattering signatures are functions of the scattering-gas temperature, and are therefore of potential use for practical atmospheric temperature probes. The method described uses either ratios of pure rotational Raman scattering intensities for air utilizing various spectral bandpasses, or, alternatively, ratios of air-rotational to nitrogen-vibrational scattering intensities. Three aspects of work relating to the development of such probes are discussed in this presentation: (1) fundamental absolute Raman data,[1] (2) construction of air spectra from these data,[2] and (3) temperature-sensitivity of the signature.[2]

The fundamental data described are the absolute rotational and vibrational scattering cross sections. Recent measurements in this laboratory of rotational cross sections for N_2, O_2, and CO_2 are emphasized, as are their use in predicting absolute magnitudes of Raman scattering signals. Next is described the computation of air rotational Raman spectra as a function of temperature calculated through use of the experimentally-measured cross sections. The spectra are based additively upon nitrogen and oxygen contributions, since pure rotational Raman scattering from water vapor is very weak.

Finally, the sensitivity of the scattering intensity ratios to temperature is explored as a function of choice of spectral bandpass for the monitored rotational Raman scattering. Various compromises will be discussed which must be made in choosing bandpasses appropriate for specific purposes and experimental conditions.

1. This work was supported in part by NASA Lewis Research Center on Contract NAS3-15825. A more complete description of this material can be found in "Absolute Intensity and Polarization of Rotational Raman Scattering from N_2, O_2 and CO_2" by C. M. Penney, R. L. St. Peters, and M. Lapp, NASA Report No. CR-121091,[2] January 1973.
2. This work was supported in part by Aerospace Research Laboratories, Wright-Patterson Air Force Base on Contract F33615-71-C-1867. A more complete description of this material can be found in "Application of Light-Scattering Techniques for Measurements of Density, Temperature, and Velocity in Gas-dynamics," by M. Lapp, C. M. Penney, and J. A. Asher, Aerospace Research Laboratories, WPAFB, Report No. ARL 73-0045 (in press).