

LASER RADAR TECHNIQUES FOR REMOTE MEASUREMENT
OF ATMOSPHERIC TEMPERATURE

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ABSTRACT

This paper presents quantitative comparison of several single-ended laser radar techniques for the remote sensing of atmospheric temperature and also reports some results of the laser radar measurements of atmospheric temperature in laboratory and field experiments.

Several laser radar schemes utilizing temperature-dependent optical interaction processes have been proposed and tested, including the N₂ vibrational Raman method,¹⁾ the rotational Raman scattering method,²⁻⁴⁾ the differential absorption method, and Na resonance scattering method applicable to the upper atmosphere.⁵⁾ Because the measurement of temperature is an absolute rather than a relative one, the rotational Raman scattering scheme has been investigated in our experiments.

The laser radar system used in the testing is shown in Fig. 1, consisting of a doubled Nd-YAG laser delivering 10 mJ, 20 pps output pulses at 532 nm, a 50-cm Fresnel-lens telescope, and a unit of light detection and signal processing electronics. The following techniques were employed to obtain very high signal-to-noise ratio values which are enough to the accurate measurement of the absolute atmospheric temperature: (1) an iodine molecular filter to block out adjacent intense Mie/Rayleigh scattering by more than a factor of 10^5 , (2) tuning and stabilization of the Nd-YAG laser oscillation to make coincide its second harmonic wavelength with that of the absorption line of iodine molecule, (3) an angle tuned interference filter to separate two signal wavelengths of the pure rotational Raman scattering of air molecules, and (4) a detection and display system to allow real time, analog and digital processings of intensity ratio of the two Raman scattering signals by eliminating pulse-to-pulse variation in the laser output and signal returns.

The spectra of rotational Raman scattering of nitrogen, oxygen and air molecules were observed carefully to derive the scattering parameters

necessary for designing and operating the laser radar system.

Experimental and analytical results of accuracy and range capability of the laser radar for remote measurement of atmospheric temperature tested in laboratory and field will be reported at the Conference.

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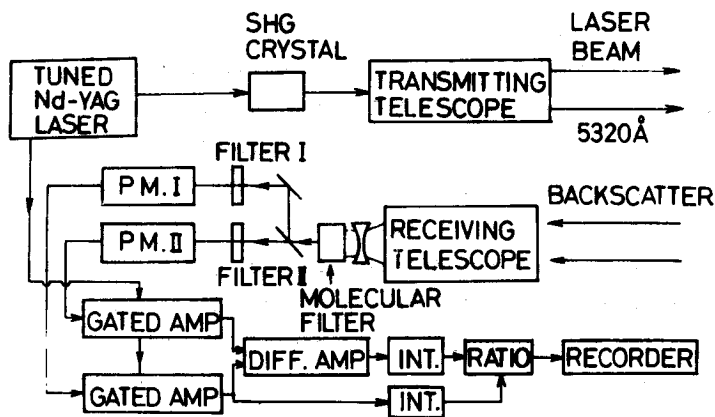


Fig. 1 Block diagram of the laser radar system for remote measurement of atmospheric temperature.