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# STRANGE BEHAVIER OF THE MEASUREMENT OF ATMOSPHERIC TEMPERATURE PROFILES OF THE ROTATIONAL RAMAN LIDAR

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## 1. Introduction

Careful experiment on the measurement of the lower troposphere atmospheric temperature have been conducted using the rotational Raman lidar installed at Technical Research Center of the KANSAI Electric Power Co., INC.

The purpose of this paper is to show the results of the temperature observation and the calibrations analysis.

## 2. Experimental Apparatus

Fig.1 show the schematic diagram of the rotational Raman lidar. The transmitter laser beam is the second harmonic(532 nm)of a Nd:YAG laser. The rotational Raman backscatter is collected by the telescope(0.5 m diameter). The signal is filtered through a narrowband filter of ~ 0.3 nm bandwidth and is then detected by three photomultipliers (two Stokes and one Mie signal) followed by a digital storage oscilloscope. Lidar receiving f.o.v is 0.4 mrad.

Table 1 show the system paremeters.

## 3. Calibration and Analysis

The advantage of this rotational Raman system is that the geometric factor, Y(R) and the transmission of the atmosphere, t(R) are canceled by 2channel Raman signal measurement method. [1] Temperature can be thus estimated from the ratio of the two channel Stokes signal power, $R(=P_1/P_2)$, without calibration of Y(R) and t(R). [2]

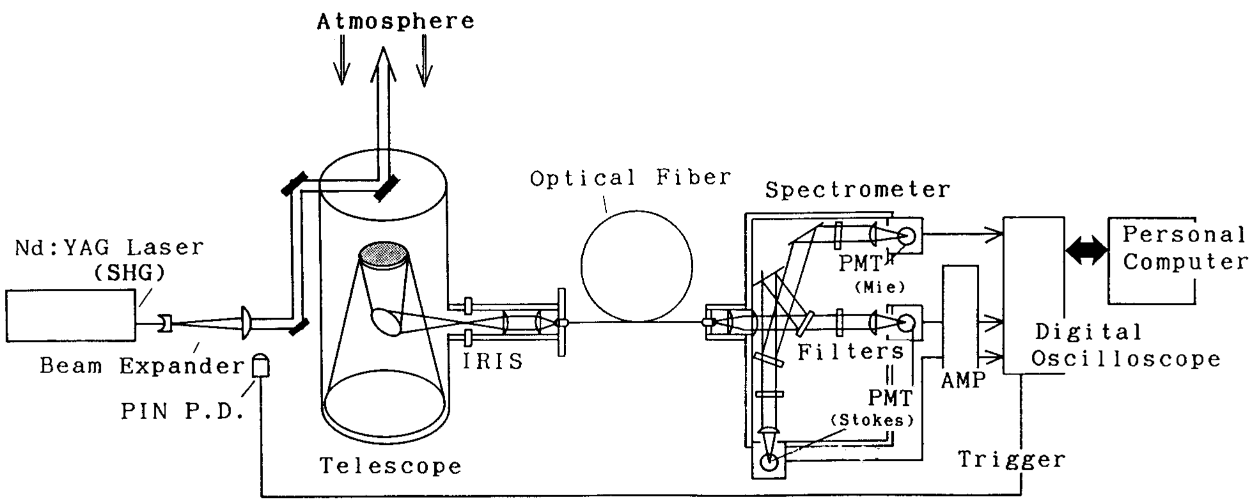



Fig.1 Schematic Diagram of the rotational Raman lidar

(a) Theoretical Calibration Method

The relation between the ratio R and temperature T can be estimated theoretically using:

- analytical relation of rotational Raman backscatter of $N_2$ and $O_2$ molecules, [3]
- transmission spectrum of the filters,
- temperature coefficient of the center wavelength of the filters, and
- correction for the sensitivity of PMTs and amplifiers.

The relation between the estimated R and T is approximated as the linear function: R=aT+b, where a and b are constants.

(b) Laboratory Calibration Method

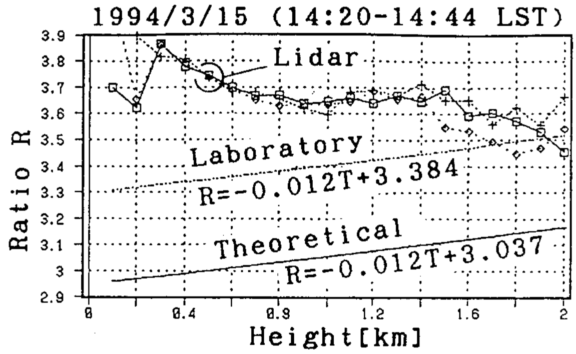
The laboratory experiment with the temperature controlled gas cell was conducted. The relation between the measured R and T was derived from the experimental data.

Fig. 2 shows the measured lidar profiles of the ratio, R and the estimated R in terms of the two calibration methods. The pulse averaging time is 10 minutes and the accumulating number of laser pulses is 12,000. Both theoretical and laboratory calibration curves use the measured temperature at 50 m and the assumption of the lapse rate of -0.9 ℃/100 m.

In Fig. 2, the lidar data have discrepancy from both theoretical and laboratory calibration data and the slope of the lidar ratio is shifted from the real temperature profiles and time dependent.

Table 1. Rotationl Raman Lidar Parameters

| | |
|---|---|
| Transmitter | |
| Wavelength | 532.0 nm |
| Energy/Pulse | 270 mJ |
| Pulse Width | 5 ns |
| Repetition Rate | 20 Hz |
| Receiver | |
| Telescope Diameter | 0.5 m |
| Field of View | 0.2-0.5 mrad |
| Filter Bandwidth | 0.3 nm |
| Mie Rejection | >$10^8$ |
| Detector | |
| Photomultiplier Tube | R3234-01 (HAMAMATSU) |
| Signal Prosessor | |
| Digital Osciloscope | Lecroy 9430/9310 |
| Personal Computer | NEC-PC9801 |



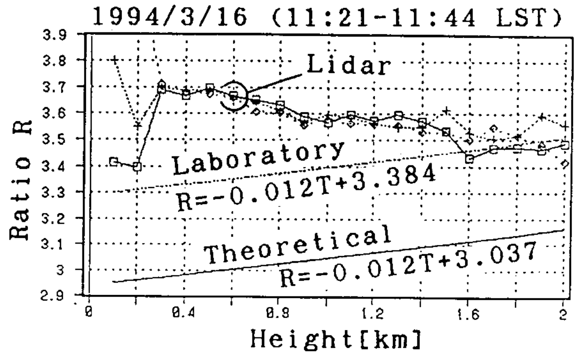




Fig. 2 Height Profiles of the ratio R for lidar and the calibrations data

## 4. Discussions

In order to find these strange error sources, careful experimental study was carried out to compare theoretical and measured rotational Raman spectra. When compared with Stokes and anti Stokes scattering, the discrepancy of the Stokes scattering was lager than the anti Stokes. It is suspected that the discrepancy with measured and theoretical ratio is due to aerosol fluorescence noise.

We will further analyze the Raman spectra of actual field observation, especially by using the anti Stokes lidar system for comparison in detail.


References

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(3)Penney, C. M., R. L. St. Peters and M. Lapp: J. O. S. A., 64, p712(1974)