LASER RADAR STUDY USING RESONANCE ABSORPTION FOR REMOTE DETECTION OF AIR POLLUTANTS

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ABSTRACT

A laser radar using resonance absorption has an advantage of increased detection range and sensitivity compared with that achieved by Raman or resonance back scattering .

In this paper, new laser radar system using resonance absorption is proposed and results obtained from this laser radar system are discussed.

NO_2, SO_2 gas has an absorption spectrum at 4500 Å and 3000 Å respectively as shown in Fig. 1. A laser light including at least a set of an absorption peak λ_1 and a valley λ_2 is emitted into a pollutant atmosphere. The light reflected with a topographical reflector or an atmospheric Mie scattering as distributed reflectors is received and divided into two wavelength components λ_1, λ_2. From the ratio of these two components Y (x), the distribution of the pollutant gas n(x) can be calculated by

$$n(x) = \frac{1}{2(\sigma_1 - \sigma_2)} \frac{d\,Y(x)}{d\,x}$$

, where σ_1, σ_2 correspond to the absorption cross sections of the pollutant gas at λ_1 and λ_2 respectively.

The laser radar system used in the investigation is shown in Fig. 2 and consists of a dye laser transmitter, an optical receiver with a special monochrometer and a digital processer. Table 1 shows the molecular constants of NO_2, and SO_2 and the dye laser used in this experiment.

		NO_2	SO_2
λ_1	($\mathring{A}$)	4482	3001
λ_2		4469	3014
$\sigma_1 - \sigma_2$ (cm^2)		2.0×10^{-19}	2.5×10^{-18}
$\lambda_1 - \lambda_2$ ($\mathring{A}$)		13	13
Dye Material		calcein blue	SHGed Rhodamine B
Spectrum width ($\mathring{A}$)		30	30
Pumping Source		Sum of SHGed and fundamental Nd: YAG	SHGed Nd: YAG

Table 1 Molecular constants of NO_2 and SO_2 and dye laser used

In this system, the absolute concentration of the pollutant gas can be measured in comparison with a standard gas cell. The concentration of NO_2, SO_2 as low as 0.1 ppm have been measured at 100 m depth resolution. For a 1 mJ laser output, the observable range of this system achieved up to 300 m using the distributed Mie reflector.

The capability and technical limitation of the system will be discussed in detail.

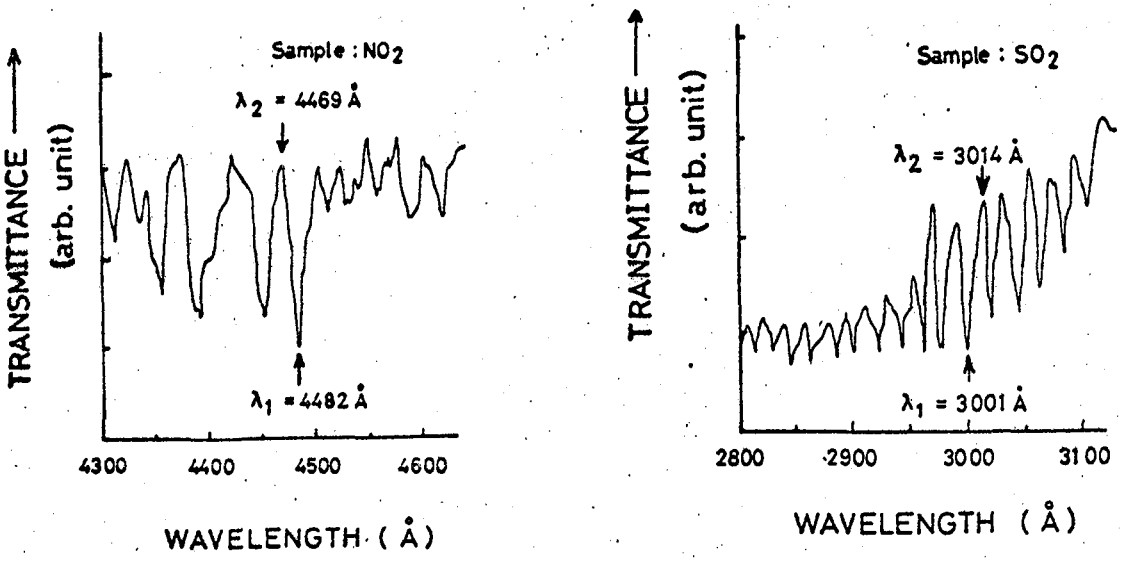

Fig.1 Absorption spectrum of NO_2 and SO_2

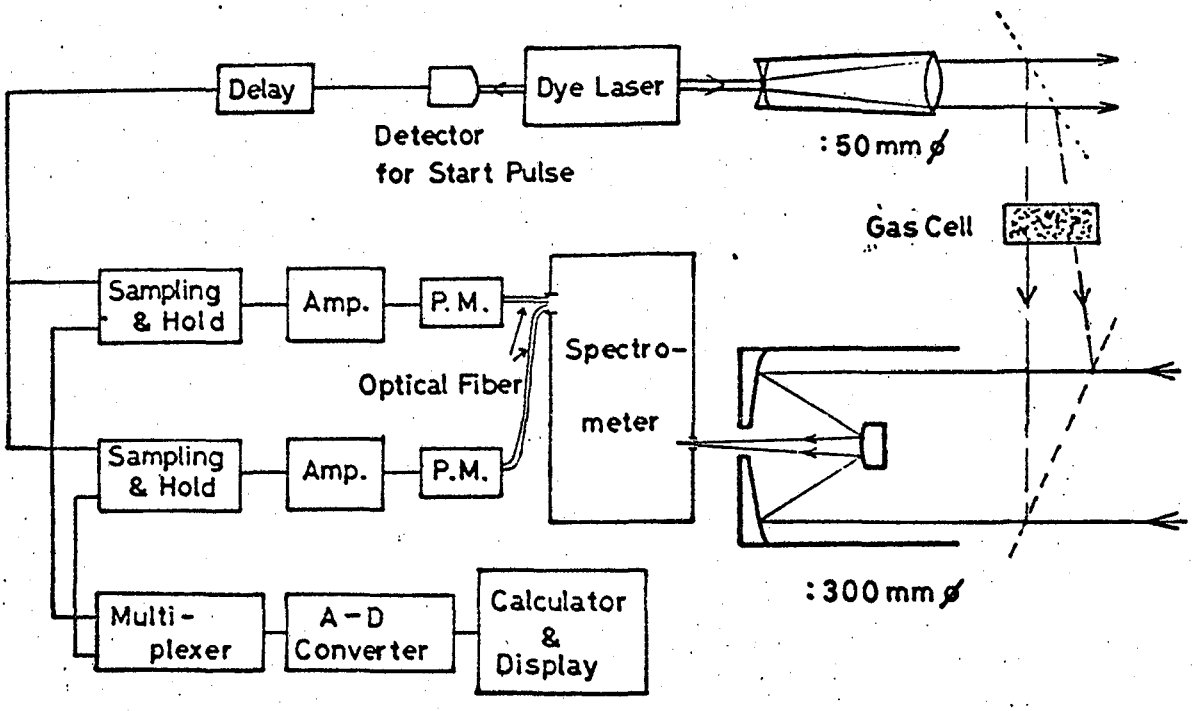

Fig.2 Schematic diagram of laser radar system using resonance absorption for detection of air pollutants.