ANALYSIS OF EXPERIMENTAL DATA ON RAMAN SCATTERING CROSS-SECTIONS OF ATMOSPHERIC GASES

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ABSTRACT

At present a method of Raman scattering laser spectroscopy is considered to be the most promising one for remote atmospheric sounding. When designing lidars which use this principle and quantitatively processing the results of observations, sufficiently reliable data on back cross-sections of Raman scattering by atmospheric components are necessary. The Raman scattering cross-sections published earlier are characterized by a spread which is stipulated by the conditions of experiment.

In the article there are analized available experimental data on some atmospheric gases and made attempts to reduce them to uniform experimental conditions on the basis of the ratios resulting from Platchek's polarizability theory. After introducing the necessary corrections expressed through the depolarization rate of scattered radiation, back Raman scattering cross-sections of a number of atmospheric gases are estimated for the most usable wavelengths of home industry lasers.

The calculations show that a root-mean-square spread of corrected data, as a rule, does not exceed 10%. Table 1 contains different authors' data on back Raman scattering cross-sections of molecular nitrogen. There are also presented tables of absolute and relative Raman scattering cross-sections of the molecules: O_2, H_2O, CH_4, H_2, NO_2, N_2O, NO, O_3, CO_2, CO for three wavelengths of laser lines of 347.2 nm, 337.1 nm, and 265 nm. The cross-sections are given with account of corrections for the conditions of the experiment with a polarized and non-polarized laser radiation.

Table 1. Raman scattering cross-sections of the molecular nitrogen vibration band reduced to laser pumping conditions at λ = 265 nm.

Reference		11	8	15	16	10	9	12	Mean values
Author's λ_0[Å]		5145	4358	3371	3471.5	5145	4880	4358	For non-polarized laser radiation
Correction		1				$\frac{2}{2-\rho_{N_2}}$		$\frac{2}{1+\rho_{N_2}}$	
$\sigma_e^e(\pi)$ 10^{30}cm^2	Corrected	8.1Q	8Q 9.61Σ	7.6 9.6	8.1Q	8.1Q	6.9Q	7Q	7.7(Q) ± 2%
	Uncorrected	6.21Q	6.8Q	7Q	7.3Q	6.1Q	5.2Q	2.7Q	5.9(Q) ± 10%