FP18 Atmospheric Trace Gases

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Abstract

This experiment was conducted in the scope of the advanced lab course in physics at the Heidelberg University.

The experiment was conducted in the week of the 8th april, 2019.

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1 Introduction

1.1 Composition

Earths atmosphere is made up of mixture of many gases. Table 1 shows a list of the main components.

Gas	Symbol	Volume Fraction
Nitrogen	N_2	78.084%
Oxygen	O_2	20.942%
Argon	Ar	0.934 %
Carbon Dioxide	CO_2	358 ppmv

Table 1: Gases in the atmosphere

1.2 DOAS

Differential Optical Absorption Spectroscopy (DOAS) is used to determine the concentration of a particular trace gas in the atmosphere - which is the goal of this experiment. The main principle is the following: one takes two images of spectra, one which was taken on earth (so with the atmosphere) and one where the atmosphere is not present (from a satelite). Every gas absorbs specific wave lengths of light, so if one takes a look at the two spectr one can see that there characteristic parts of the spectrum with the atmosphere were the intensities are lower. By knowing which characteristic part belongs to which gas one can determine the density of a specific gas.

1.2.1 Lambert-Beer Law

The intensity of a beam of light (electromagnetic wave) decreases when moving through matter due to absorption and scattering. The amount of Intensity loss can be computed via the Lambert-Beer law. Let $I_0(\lambda)$ be the initial intensity of the light beam. After passing through a medium with length L the Intensity $I(\lambda, L)$ will be

$$I(\lambda, L) = I_0(\lambda) \exp(-\rho L \sigma(\lambda)), \quad (1)$$

where $\sigma(\lambda)$ is the absorption cross section and ρ the concentration of the trace gas.

2 Experimental Procedure

2.1 Characterization of the measuring instruments

There are two different main effects that can cause inaccuracy in the measurements. Due to Brownian motion in the cables a small current can flow - the so called dark current. One can get an estimate for how big it is by conducting a long measurement (in our case one minute) where the camera is covered. The other effect is the offset. Here many short measurements were taken where the camera was also covered. Both dark current and offset are subtracted from all proceeding spectra.

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