Experiments in Special Relativity
Session programme

All talks are 12 minutes long, with 3 minutes reserved for discussion. Please upload your talk onto the computer before your session begins.

Session 1 - Room 1525-323

13:00 **Introduction**

13:05 **Measuring the speed of light**

Speaker: Peter Granum Nielsen
Opponents: SPE, TF

13:20 **Special Relativity, Lifetime of a muon**

Speaker: Lærke Lyhne
Opponents: TKL, PGN

13:35 **Measuring the speed of light with a pulsed laser**

Speaker: Esben Rohan Christensen
Opponents: SPE, TF

13:50 **Break**

Session 2 - Room 1525-323

14:00 **Refractive Index of Air using Michelson-Morley Interferometer**

Speaker: Filip Jensen
Opponents: TKL, ERC

14:15 **Relativistic Mass of the Electron**

Speaker: Toke Frederiksen
Opponents: LL, FJ

14:30 **Lifetime of a muon**

Speaker: Simon Purup Eskildsen
Opponents: PGN, ERC

14:45 **Measurement of the Speed of Light with a pulsed laser - and Determination of the Refraction Index of lead glass**

Speaker: Thomas Kirk Larsen
Opponents: LL, FJ

15:00 **Closing**

Talk abstracts

Measuring the speed of light

Peter Granum Nielsen

In this project I have found a value for the speed of light using a laser and a series of lenses and mirrors. One of the mirrors is rotating, which is the key element in the experiment. By measuring the frequency f the rotating mirror and the displacement of the light dot, the speed of light can be calculated. My value for the speed of light is $c = 1.53 \times 10^8 \pm 2.92 \times 10^5$ m/s. This is almost exactly equal to 1/2 the real value of c, but I cannot see that I have made any mistake. It could be a coincidence.

Special Relativity, Lifetime of a muon

Lærke Lyhne

In this experiment the decay of muons from cosmic rays has been observed for a few days. From the collected data the average lifetime has been calculated. Unfortunately the result had a deviation on 82.3% compared to the theoretically value. The result might be more accurate if the experiment ran for a longer time.

Measuring the speed of light with a pulsed laser

Esben Rohan Christensen

The second Principle of Relativity states that the speed of light is a natural constant independent of the viewer. This project aims to study the profound importance and characteristics of light. The speed of light is found with a simple laser experiment by measuring the change in the light's time of flight as a function of change in distance of the light path. The study finds a value for c of 0.303 ± 0.003 m/ns $= (1.01 \pm 0.01)c$, which agrees with the theoretical value within the uncertainties of the experiment. Furthermore, the refraction index of lead glass is estimated by placing a piece of it of known length inside the light path and measuring the delay from normal. The uncertainties of this experiment are quite large but the result demonstrates the finiteness of light in different mediums. Finally, the laser that has been used in the experiment is analyzed in order to say something about its divergence. A divergence angle, which agrees with would be expected of a laser of this caliber, is found, showcasing the huge divergence of the laser compared to NASA's very well-collimated lasers.

Refractive Index of Air using Michelson-Morley Interferometer

Filip Jensen

In this rapport a modified version of the Michelson Morley experiment will be used to measure the refractive index of air with precision as the goal. The result in the rapport is $1.0002787 \pm 3.9 \times 10^{-6}$ which has a descend precision but also suffers from a couple of unknown factors such as the temperature and composition of the air.

Relativistic Mass of the Electron

Toke Frederiksen

This report aims to find the speed of an electron with a known kinetic energy, and then compare said speed to the classical and relativistic predictions. This is done by letting electrons from the radioactive decay of ^{207}Bi pass through two aligned scintillators. The time it takes the electron to pass through the two scintillators will be the time of flight of the electron. The distance between the scintillators is known and therefore we can calculate the speed of the electron. Three different speeds are obtained: $v_1 = (0.54 \pm 0.2)c$, $v_2 = (0.86 \pm 0.3)c$ and $v_3 = (0.77 \pm 0.5)c$. These speeds agree with the speeds predicted by the theory of relativity as expected. Except for which probably is because the quality of the data is poor because the experiment were running for a short time. The theory of relativity occurs to be correct. An increase in kinetic energy will therefore lead to an increase in mass rather than speed, when the speed is near that of light.

Lifetime of a muon

Simon Purup Eskildsen

In this report we make an experimental measurement of the average lifetime of a muon at rest. A scintillation counter is used in order to measure the time from when a muon stops till it decays. The measurements ran over the course of 5 days. The lifetime calculated from the data collected deviates from the expected value, but includes it within the uncertainties1.

Measurement of the Speed of Light with a pulsed laser - and Determination of the Refraction Index of lead glass

Thomas Kirk Larsen

The report describes an experiment in two parts. The first part of the experiment consists of a measurement of the speed of light with a pulsed laser. This is carried out by detecting variances in travel time for the laser pulses, when the distance between laser and detector is varied. The second part of the experiment consists of a determination of the refraction index of lead glass. This is carried out by detecting variances in travel time for the laser pulses, when lead glass tubes of varying lengths are inserted between laser and detector. By focusing on variances in lengths and travel times, systematic errors due to cord lenghts and other delays in electronics are

ruled out. The data set of the first part of the experiment - the measurement of the light speed - is quite unextensive. The measurements are very consistent and also consistent with the actual light speed, but they are too few to really comment on the reliability of the measurements. The data set of the second part of the experiment - the determination of the refraction index of lead glass - are more comprehensive. The measurements show more variance than is the case for the first part of the experiment. This is due to two things: 1. More data collected. 2. This part of the experiment involves more potential sources of lacking accuracy in the measurements.