Lab2_Ultrasound_Gregor_Notebook

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0.1 Ultrasound lab notebook

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In this lab an experiment is conducted which is similar to the double slit experiment with light waves. Instead of light ultrasound waves are used which is useful because the wavelength is in the centimeter range which makes things easier.

The setup of the experiment includes following instruments:

A computer to run the data collection software

An oscilloscope (Tektronix 2205) and amplifier

digital multimeter

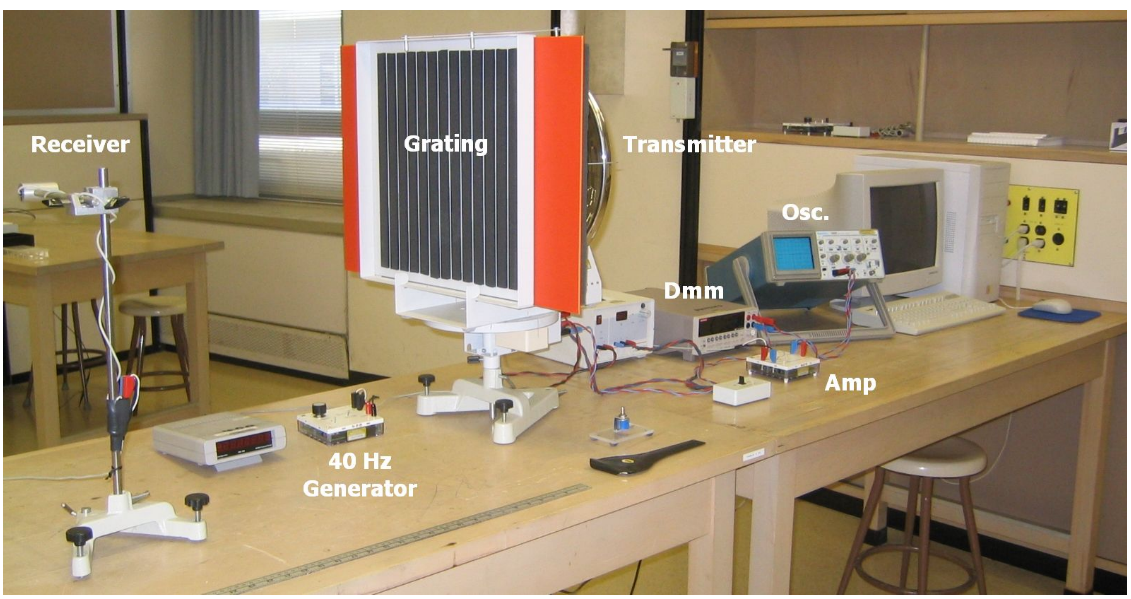
power supply with adjustemnt switch

turntable

transmitter with slits and slats

controller and display for oscillator frequency

Receiver



- Procedure

The computer is used to collect data points when rotating the transmitter relative to the receiver. The receiver itself is placed at approx. infinite distance (not really) from the transmitter. The transmitter is set up so that it is pointed to a concave mirror (looks like a satellite dish) to reflcet the signal towards the slits. Slits and slats are attached to a frame infront of the transmitter. The panes can slide in an out to reveal many or fewer slits. Additionally, there is a thermometer in the room to read the room temperature which will be important later for the evaluation of the speed of the sound waves.

First the temperature of the room is read which is about 24.5 +- 0.5°C. Then the distance between the transmitter and receiver is measured. They are placed opposite of another on two separate tables and a tape measure will be used to measure this distance. The distance is 302.4cm +- 0.5cm Then measurements of the slits and slats are taken. Calipers are used to measure the inner distance of the slits on various spots.

Slit measurements are:

9.60 mm +-0.1mm (for all)

9.52 mm

9.66 mm

9.52 mm

Then the slats are measured by clamping them between the two metal ends of the caliper.

Slat measurements are:

20.52 mm +- 0.1mm (for all)

20.50 mm

20.40 mm

20.40 mm

Setting different voltages for the turntable like 5.3V and 2.5V will change the speed. 5.3V can be used for course adjustment and 2.5V for finer movements.

Also part of the setup is finding the angle theta = 0 position for the turntable relative to the receiver. First the turntable is adjusted so that it is roughly perpendicular to the setup. Whilst having an eye on the oscilloscope the turntable is adjusted until the maximum amplitude is observed. The turntable is attached to a potentiometer which is used to get a voltage reading so as to accurately note the postion. The maximum amplitude was observed at a voltage of 1.1613 VDC which describes = 0°

Next the frequency of the transmitter is adjusted to get a maximum amplitude on the oscilloscope. Making sure to move the hand away from the nob to not interferce with the electronics after adjustement. By moving around the max with small turns of the dial the maximum amplitude is recorded when the frequency is at 40081Hz. Then the gain is adjusted until a maximum is seen on the oscilliscope without introducing clipping.

- Readings

  First set of readings are with 6 slits. An offset of approx 45° is made and the data collection software is opened. Readings: angle voltage 1.18050, receiver rms voltage 412.653e-3 The turntable will be moved iin small increments and then another data point will be collected. The graph on the computer is constantly adjusting to accomodate for every new data point added. The angle voltage is steadily decreasing with each incrememnt. The end result is a graph with 5 bigger peaks and smaller fluctuations in between.

  The collection of data points will occur over a 90° sweep. The last angle voltage is 0.85235 The exported data will then be roughly plotted to see if the same graph is obtained.

  The same will be done for 4 slits. The graph shoes 3 big peaks and a couple smaller ones in between Starting with an angle voltage of 1.45419 and ending with 0.85288

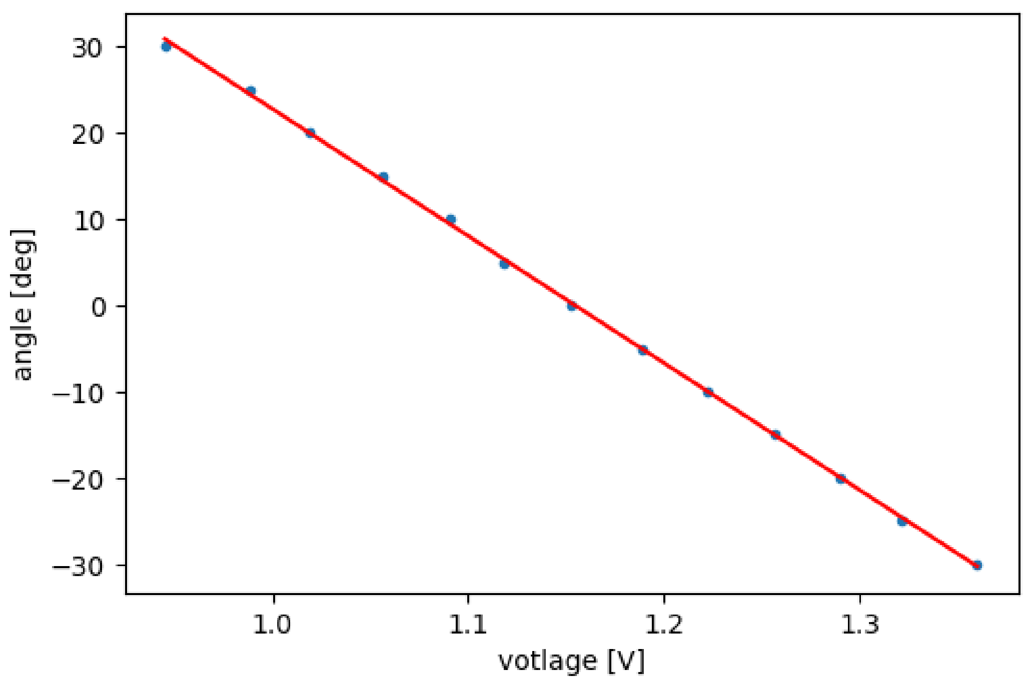
Same procedure for 2 slits. The graph shows three less distinct and distorted peaks or bumps rather in this case Starting with an angle voltage of 1.45445 and ending with 0.86557
Same procedure with 1 slit. The graph shows only three very flat bumps probably influenced by the anomaly at the beginning. This should be fixed later when plotting them here. Starting with an angle voltage of 1.46200 and ending with 0.88600
With all the data collection there seems to often be an anomaly at the beginning. These points should be excluded from analysis and plotting.
Same procedure with 0 slit. The graph shows only tiny fuctuations so no visible peaks which is probably influenced by the anomaly at the beginning. This should be fixed later when plotting them here. This reading is useful to see the amount of noise in the system. Starting with an angle voltage of 1.46482 and ending with 0.84239

Next a voltage to angle data collection will be made angle voltage 0 1.1523 5 1.1180 10 1.0909 15 1.0563 20 1.0194 25 0.9886 30 0.9450 Same measurements at the other side of table starting at -30° angle votlage -30 1.3602 -25 1.3218 -20 1.2905 -15 1.2567 -10 1.2225 -5 1.1894 Proper table below

[1]:
```python
import numpy as np
import matplotlib.pyplot as plt
plt.rcParams['figure.dpi'] = 100
from scipy.optimize import curve_fit
import pandas as pd

angle = np.array([-30, -25, -20, -15, -10, -5, 0, 5, 10, 15, 20, 25, 30])
voltage = np.array([1.3602, 1.3218, 1.2905, 1.2567, 1.2225, 1.1894, 1.1523, 1.
 ↪1180, 1.0909, 1.0563, 1.0194, 0.9886, 0.9450])
data1 = np.column_stack((voltage, angle))
#print(data1)

# making a table to nicely read raw data
fig, ax = plt.subplots(1,1)
column_labels = ["voltage", "angle"]
df =pd.DataFrame(data1, columns=column_labels)
ax.axis('tight')
ax.axis('off')
ax.table(cellText=df.values, colLabels=df.columns, loc="center", cellLoc =␣
 ↪"center")
plt.show()

plt.plot(voltage, angle, '.')
def func(x, m, b):
    return m*x + b
popt, pcov = curve_fit(func, voltage, angle)
a, b = popt # used for conversion later from voltage to degrees
print('angle vs voltage = %.5f * x + %.5f' % (a, b))
plt.plot(voltage, func(voltage, *popt), 'r'); plt.ylabel('angle [deg]'); plt.
 ↪xlabel('votlage [V]')
plt.show()
```

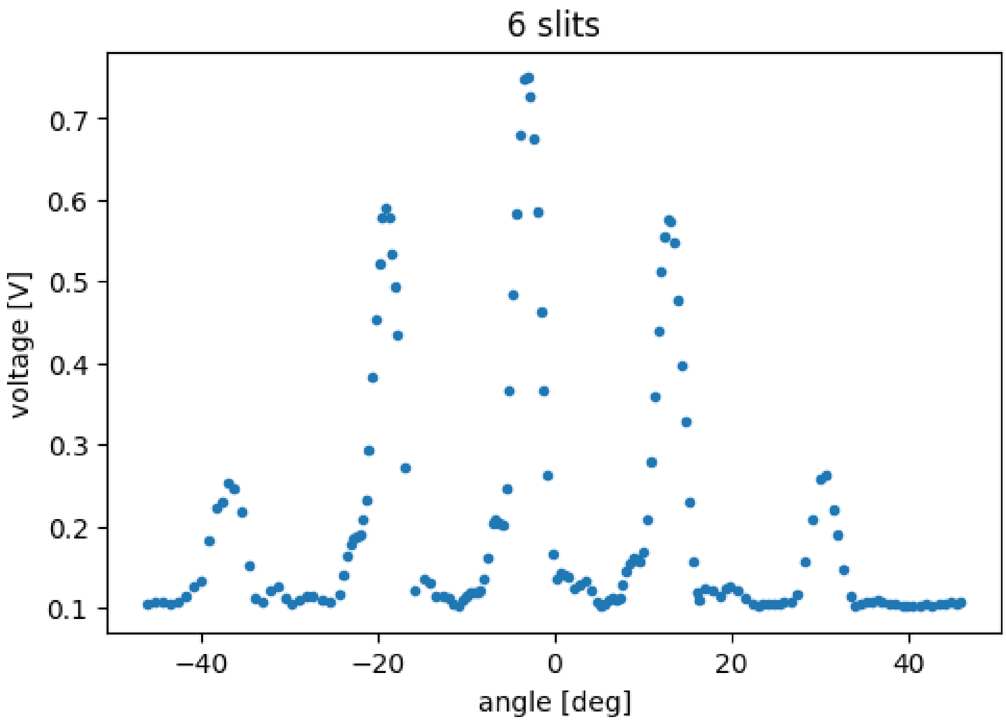
voltage	angle
1.3602	-30.0
1.3218	-25.0
1.2905	-20.0
1.2567	-15.0
1.2225	-10.0
1.1894	-5.0
1.1523	0.0
1.118	5.0
1.0909	10.0
1.0563	15.0
1.0194	20.0
0.9886	25.0
0.945	30.0

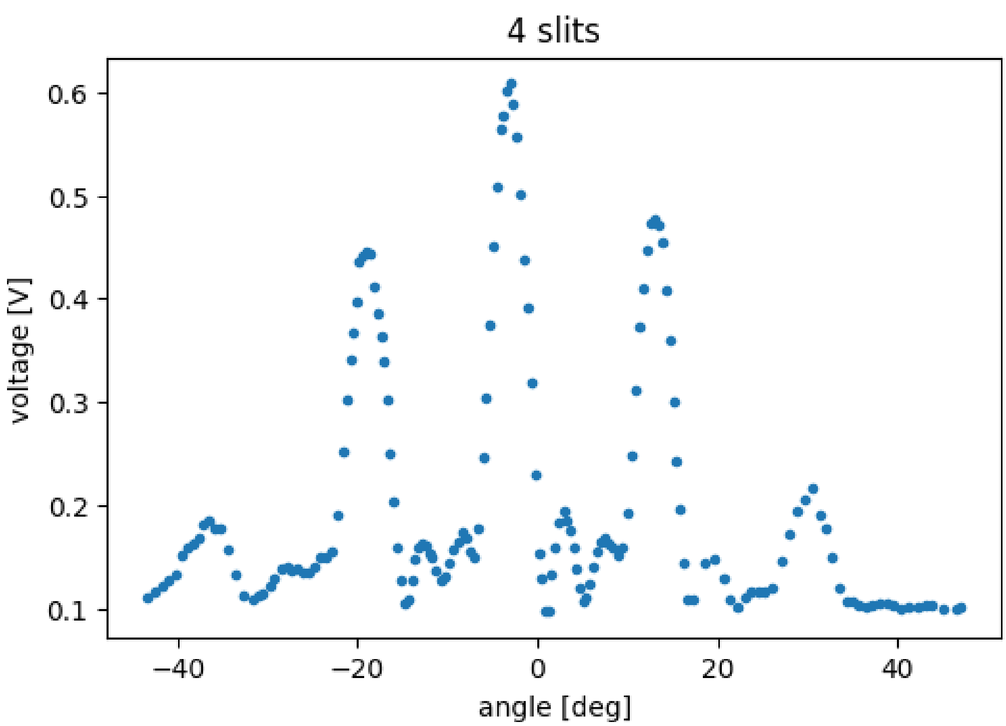
```
angle vs voltage = -147.23923 * x + 170.02281
```

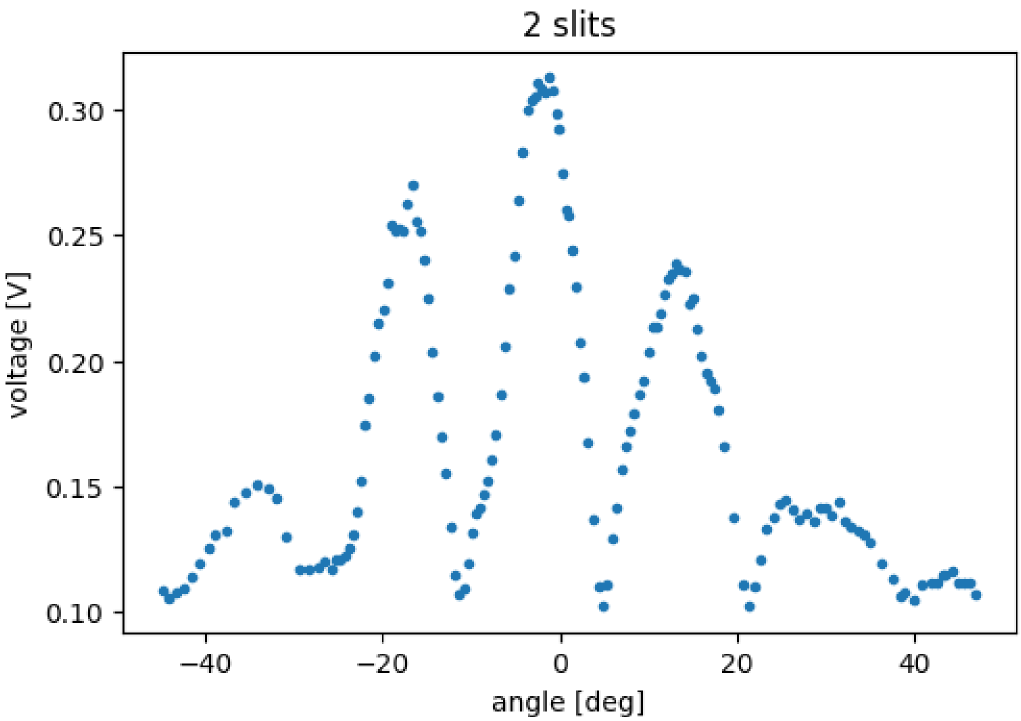


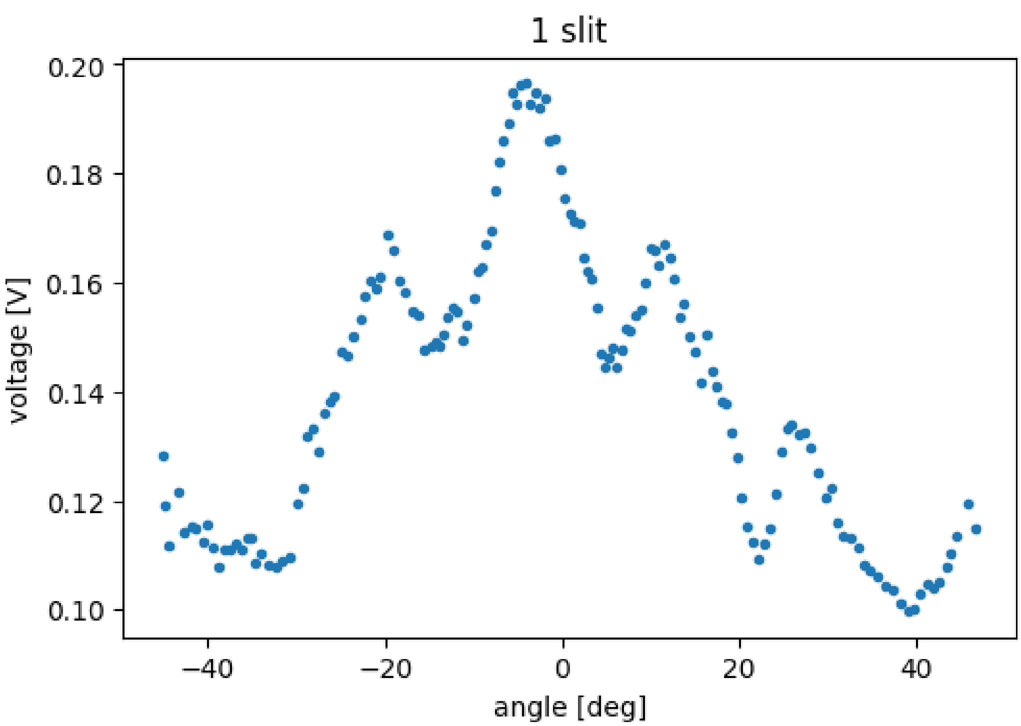
[2]:
```
# Reading in raw data from csv files

#print(a, b)
```

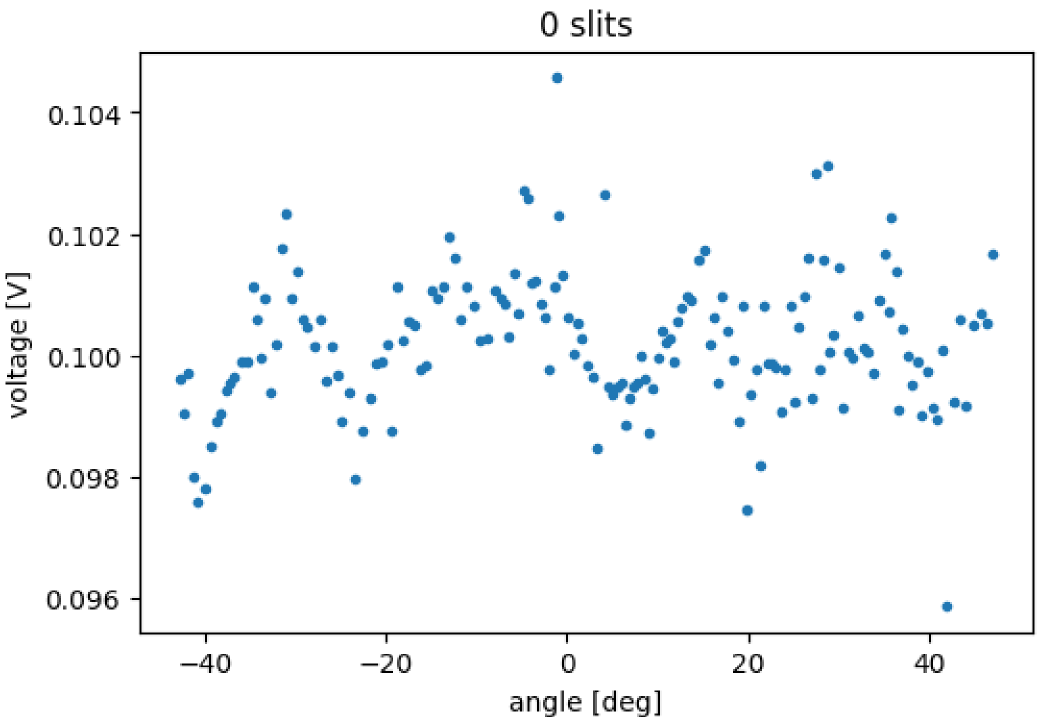
```
# making garphing function to not repeat myself
def graph(file):
    array_in = np.loadtxt(file, delimiter=',')
    x = array_in[:,0] # taking second element of each row (second column)
    y = array_in[:,1] # taking third element of each row (third column)
    # trying to adjust where 0 is but doesn't quite work as wanted
    plt.plot((x*a + b)-(1.1613*a+b), y, '.'); plt.xlabel('angle [deg]'); plt.
 ↪ylabel('voltage [V]') # plotting the data and giving it a red colour

#print(1.1613*a+b)

# 6 slits
graph("6slitdata13.csv")
plt.title('6 slits')
plt.show()

# 4 slits
graph("4slitdata1.csv")
plt.title('4 slits')
plt.show()

# 2 slits
graph("2slitdata13.csv")
plt.title('2 slits')
plt.show()

# 1 slit
graph("1slitdata11.csv")
plt.title('1 slit')
plt.show()

# 0 slits
array_in = np.loadtxt("data0.csv", delimiter=',')
x = array_in[:,0] # taking first column
y = array_in[:,1] # taking second column
# excluding last four data points here to remove anomaly
x_adj = x[:-4]
y_adj = y[:-4]

plt.plot((x_adj*a + b)-(1.1613*a+b), y_adj, '.'); plt.xlabel('angle [deg]');␣
 ↪plt.ylabel('voltage [V]') # plotting the data and giving it a red colour
plt.title('0 slits')
plt.show()
```


6 slits
voltage [V]
angle [deg]
0.1
0.2
0.3
0.4
0.5
0.6
0.7
−40
−20
0
20
40


4 slits
voltage [V]
angle [deg]
0.1
0.2
0.3
0.4
0.5
0.6
−40
−20
0
20
40


2 slits
voltage [V]
0.30
0.25
0.20
0.15
0.10
−40
−20
0
20
40
angle [deg]


1 slit
voltage [V]
0.20
0.18
0.16
0.14
0.12
0.10
−40
−20
0
20
40
angle [deg]


0 slits
voltage [V]
0.104
0.102
0.100
0.098
0.096
−40
−20
0
20
40
angle [deg]

[ ]: