Phys. 128AL - Laser Properties

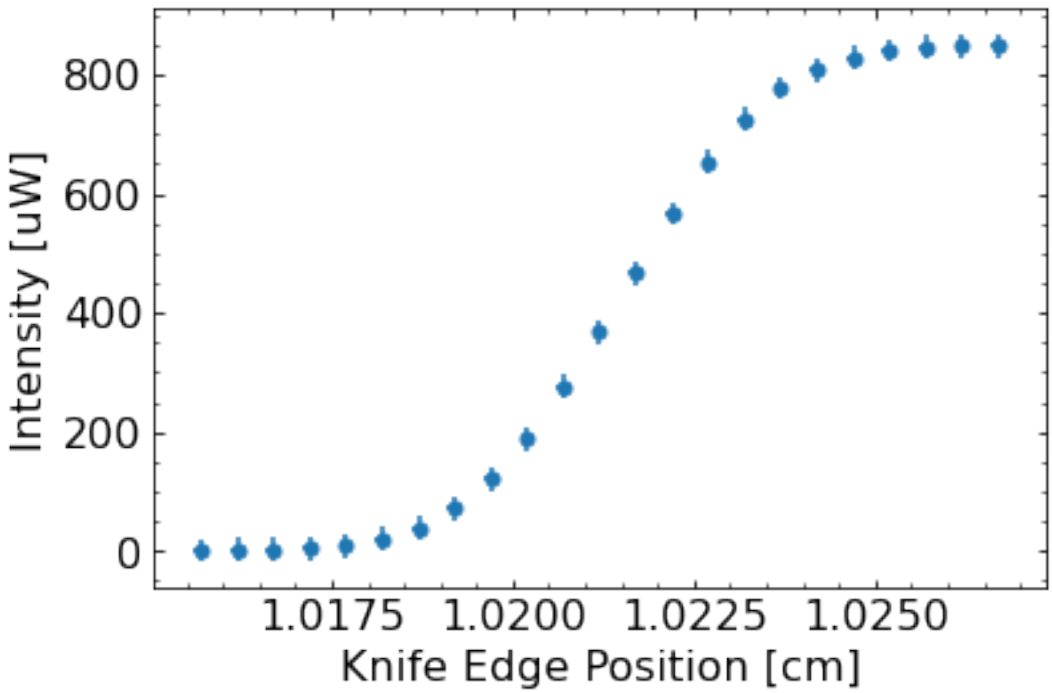
May 3, 2022

[1]:
```
import matplotlib.pyplot as plt
import numpy as np
from matplotlib import rc
rc('font',**{'size':16})
rc('lines', **{'linewidth':3.0})
rc('savefig', **{'facecolor':'white'})
rc('axes', **{'labelsize':16})
rc('xtick', **{'direction':'in', 'top':True, 'minor.visible':True})
rc('ytick', **{'direction':'in', 'right':True, 'minor.visible':True})
```

[2]:
```
P = [849, 849, 847, 841, 829, 808, 778, 725, 654, 567, 467, 368, 276, 188, 121,␣
↪72, 39, 20, 9, 5, 3, 2, 1]
x = [1.0267, 1.0262, 1.0257, 1.0252, 1.0247, 1.0242, 1.0237, 1.0232, 1.0227, 1.
↪0222, 1.0217, 1.0212,
    1.0207, 1.0202, 1.0197, 1.0192, 1.0187, 1.0182, 1.0177, 1.0172, 1.0167, 1.
↪0162, 1.0157]
```

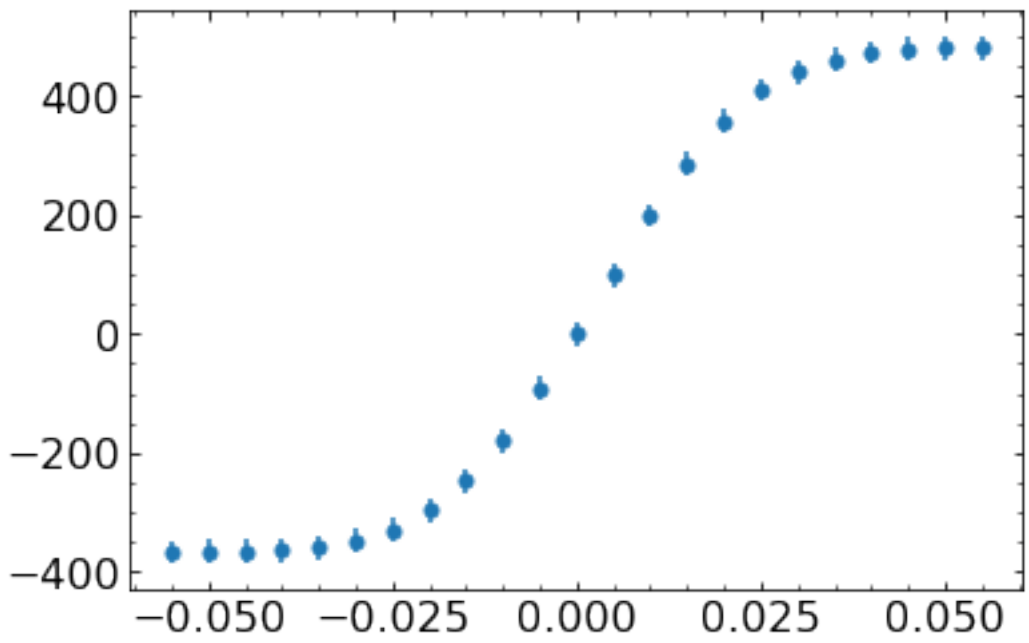
[3]:
```
plt.errorbar(x, P, yerr=20, xerr=0.0001, linestyle=' ', marker='o',␣
↪elinewidth=1.5, label='Data', markersize=5)
plt.xlabel('Knife Edge Position [cm]')
plt.ylabel('Intensity [uW]')
```

[3]:
```
Text(0, 0.5, 'Intensity [uW]')
```



[4]:
```
P = [481, 481, 479, 473, 461, 440, 410, 357, 286, 199, 99, 0, -92, -180,
     -247, -296, -329, -348, -359, -363, -365, -366, -367]
x = [0.055, 0.05, 0.045, 0.04, 0.035, 0.03, 0.025, 0.02, 0.015, 0.01, 0.005,
     0, -0.005, -0.01, -0.015, -0.02, -0.025, -0.03, -0.035, -0.04, -0.045, -0.
 ↪05, -0.055]
plt.errorbar(x, P, yerr=20, xerr=0.0001, linestyle=' ', marker='o',␣
 ↪elinewidth=1.5, label='Data', markersize=5)
```

[4]:
```
<ErrorbarContainer object of 3 artists>
```



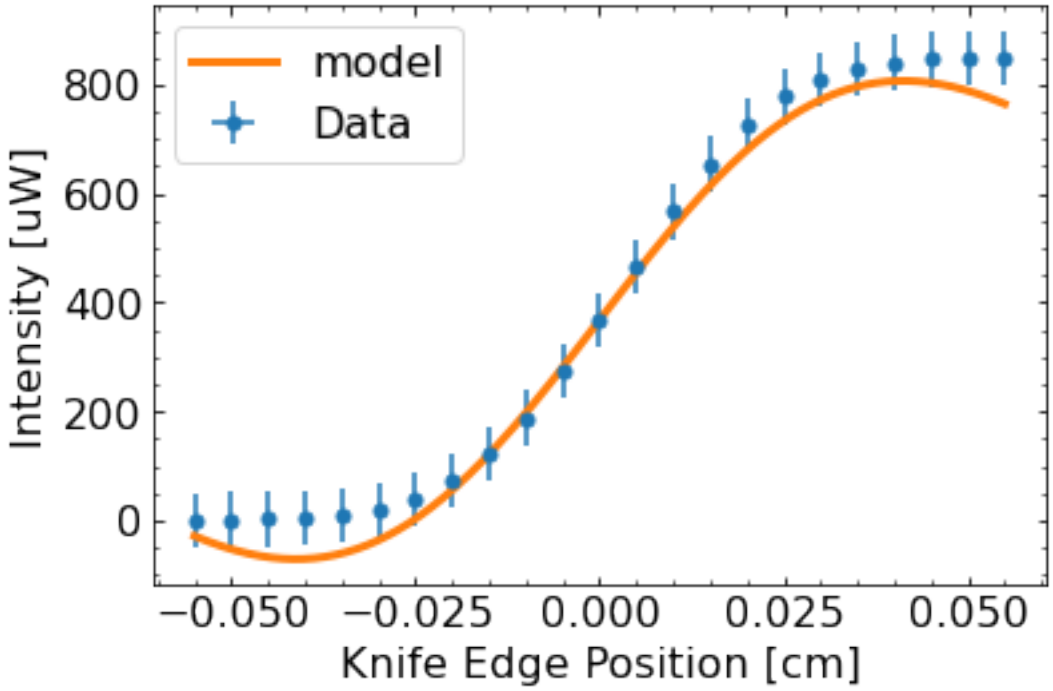
[16]:
```
from scipy import optimize

uncertainties = np.ones(len(P))

x_fine = np.linspace(-0.055, 0.055, 1000)
data = x
def model(x_data, a, b):  # important to put x_data first
    return 2*x_data*a*np.exp(-b*x_data**2) + 368

bestpar, covariance = optimize.curve_fit(model, x, P, sigma=uncertainties,
                                         absolute_sigma=True)
print(bestpar)
model_uncertainties = np.sqrt(np.diag(covariance))
print(model_uncertainties)
```

```
[8775.62666329  293.9657808 ]
[10.58393723  0.68640693]
```

[41]:
```
P = [849, 849, 847, 841, 829, 808, 778, 725, 654, 567, 467, 368, 276, 188, 121,␣
 ↪72, 39, 20, 9, 5, 3, 2, 1]
x = [0.055, 0.05, 0.045, 0.04, 0.035, 0.03, 0.025, 0.02, 0.015, 0.01, 0.005,
     0, -0.005, -0.01, -0.015, -0.02, -0.025, -0.03, -0.035, -0.04, -0.045, -0.
 ↪05, -0.055]
plt.errorbar(x, P, yerr=50, xerr=0.0001, linestyle=' ', marker='o',␣
 ↪elinewidth=1.5, label='Data', markersize=5)
plt.plot(x_fine, model(x_fine, 8775.62669211, 293.96578253), label='model')
```

```
plt.xlabel('Knife Edge Position [cm]')
plt.ylabel('Intensity [uW]')
plt.legend()
```

[41]: <matplotlib.legend.Legend at 0x2e7a967eca0>



[38]:
```
a_ = 8775.62666329
b_ = 293.9657808
c_ = 114.9
x_ = 0
h = 1e-5

def f(x_, a_, b_, c_):
    return 2*x_*a_*np.exp(-b_*x_**2) + 368 - c_

tol = 1e-7
maxiter = 100

for i in range(maxiter):
    #increment = -f(x)/fprime(x)
    fprime = (f(x_ + h, a_, b_, c_) - f(x_ - h, a_, b_, c_))/(2*h)
    increment = -f(x_, a_, b_, c_)/fprime
    x_ += increment
    print(i, x_, increment)
```

```
    if np.abs(increment) < tol:
        break
print(i, x_)
```

```
0 -0.014420623002290422 -0.014420623002290422
1 -0.015456304836903436 -0.001035681834613015
2 -0.01547195513083591 -1.5650293932474444e-05
3 -0.01547195883548855 -3.7046526401564627e-09
3 -0.01547195883548855
```

[ ]: