Atomic Constant

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1 Objective

To find the Planck constants as well as Rydberg constant by using spectrometer with hydrogen tube

[41]:
```
import scipy as sc
import numpy as np
import sympy as sp
import astropy.units as u
import astropy.constants as co
import matplotlib.pyplot as plt
import tabulate
import matplotlib
from IPython.display import Markdown, display_latex, HTML, Latex
# %matplotlib inline
```

2 Theory

2.1 the wavelength equation from the grading is giving in terms of angle

[2]:
```
lamda, n, R, d, m, theta, h, c, dE = sp.symbols(r"\lambda, n, R_\infty, d, m,␣
↪\theta, h, c, \Delta{E}")
lamda_grading = sp.Eq(lamda, m * d * sp.sin(theta))
lamda_grading
```

[2]:

$$\lambda = dm\sin\left(\theta\right)$$

2.2 The wavelength equation for the balmer series is giving in terms of principal quantum number $'n'$

[3]:
```
lamda_n = sp.Eq(1/lamda, R * (1/4 - 1/n**2))
lamda_n
```

[3]:

$$\frac{1}{\lambda} = R_{\infty}\left(0.25 - \frac{1}{n^2}\right)$$

2.3 The Planck constant equation for the balmer series is giving in terms of principal quantum number $'n'$ and $'\lambda'$

[4]:
```
planck = sp.Eq(h, dE * lamda/c)
planck
```

[4]:

$$h = \frac{\Delta E \lambda}{c}$$

3 Data

[12]:
```
# setting the data
data = {"m":1, "d":(3.3867*u.um).si.value, "Angle":[(7.105+7.168)/2, (7.565+7.
↪555)/2, (8.436+8.432)/2, (11.438+11.420)/2]*u.degree, "n":[6.0, 5.0, 4.0, 3.
↪0]}
```

[55]:
```
from IPython.display import HTML, display
import tabulate
headers = ["Color", "Angle avg", "n"]
table = [
        ["Weak violet", data["Angle"][0], data["n"][0]],
        ["Violet", data["Angle"][1], data["n"][1]],
        ["Blue-Green", data["Angle"][2], data["n"][2]],
        ["Red", data["Angle"][3], data["n"][3]]
        ]

# HTML(tabulate.tabulate(table, tablefmt='html'))
Latex(tabulate.tabulate(table, headers, tablefmt='latex'))
# print(tabulate.tabulate(table, headers, tablefmt='grid'))
```

[55]:

Color	Angle avg	n
Weak violet	7.1365 deg	6
Violet	7.5600000000000005 deg	5
Blue-Green	8.434000000000001 deg	4
Red	11.429 deg	3

4 Calculations

4.1 Finding the Rydberg constant

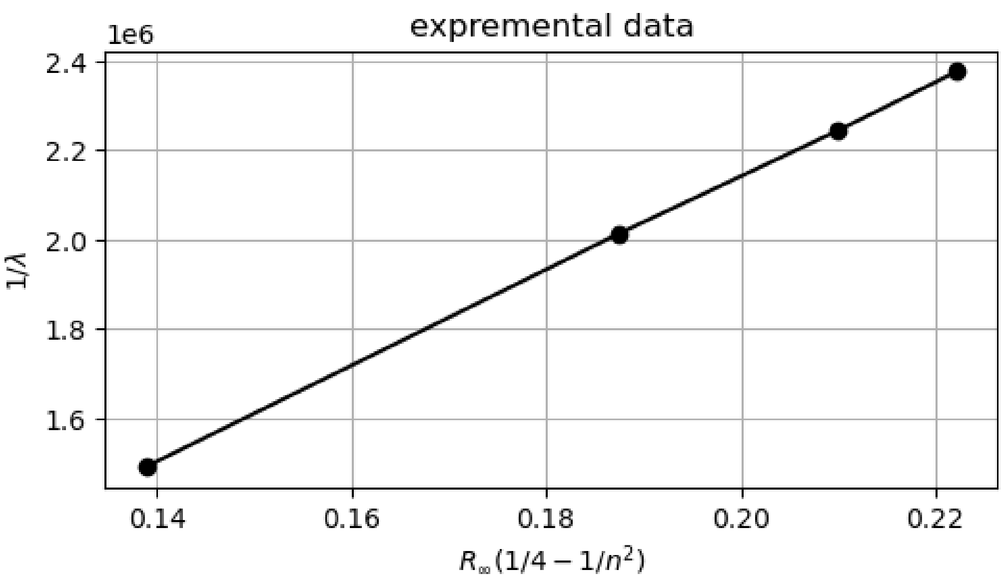
[7]:
```
y = []
x = []
for i in data["n"]:
    x.append(float(lamda_n.rhs.subs({n:i, R:1})))


for i in data["Angle"]:
    y.append(float(1/lamda_grading.rhs.subs({m:1, d:data["d"], theta:i.value *␣
↪sp.pi/180})))
```

```
slope, b = np.polyfit(x, y, 1)


plt.rcParams['figure.dpi'] = 100
plt.rcParams['figure.figsize'] = (6,3)

(fig, ax) = plt.subplots()
ax.plot(x, y, 'k-o')
ax.set(xlabel="$R_\infty(1/4-1/n^2)$", ylabel="$1/\\lambda$",␣
 ↪title='expremental data')
ax.grid()
fig.show()
```



[8]:
```
Markdown(f"""
The best slope is {slope * 1/u.m}

The percentage difference is {np.abs((slope-co.Ryd.value)/co.Ryd.value)*100}
""")
```

[8]:

The best slope is 10624479.863555742 1 / m

The percentage difference is 3.182615707655924

4.2 Finding the Planck constant value

[9]:
```
E2 = (-13.61*u.eV/4).si
h_sum = 0
for i, j in zip(data["n"], y):
    h_sum += (-(13.61*u.eV/i**2).si.value - E2.value)/co.c.value * 1/j

h_sum /= 4

Markdown(f"""
The avergae value of placnk constant is {h_sum * u.J*u.s}

The percentage difference is {np.abs((h_sum - co.h.value) / co.h.value)*100}
""")
```

[9]: The avergae value of placnk constant is 6.790072417796182e-34 J s

The percentage difference is 2.4751061199704028

5 Conclusion

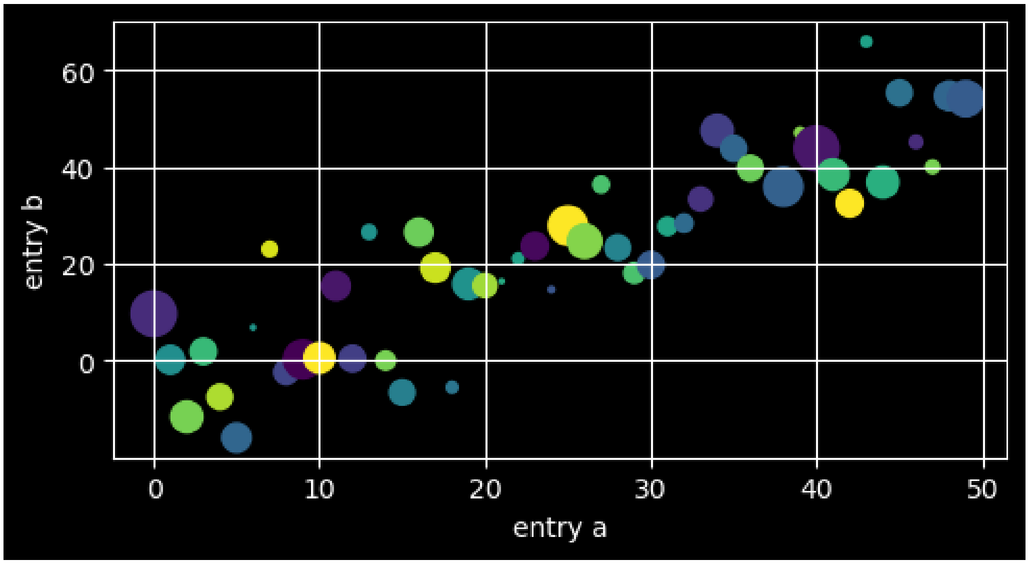
In this lab we used spectrometer to find the actomic constants: Planck h and Rydberg R_∞. We found the planck valuse is about 6.790072417796182e-34 J s. With error difference percentage about 2.5%.

We found the rydberg value us about 10624479.863555742 1 / m. With error difference percentage about 3.2%.

[10]:
```
data = {'a': np.arange(50),
        'c': np.random.randint(0, 50, 50),
        'd': np.random.randn(50)}
data['b'] = data['a'] + 10 * np.random.randn(50)
data['d'] = np.abs(data['d']) * 100

with plt.style.context('dark_background'):
    plt.scatter('a', 'b', c='c', s='d', data=data)
    plt.xlabel('entry a')
    plt.ylabel('entry b')
    plt.grid()
    # plt.clf()
    # plt.close()
    # fig.savefig("pieCharts.png")
    # from IPython.display import Image
    # Image("pieCharts.png")

plt.show()
print(plt.style.available)
```




```
['Solarize_Light2', '_classic_test_patch', 'bmh', 'classic', 'dark_background',
'fast', 'fivethirtyeight', 'ggplot', 'grayscale', 'seaborn', 'seaborn-bright',
'seaborn-colorblind', 'seaborn-dark', 'seaborn-dark-palette', 'seaborn-
darkgrid', 'seaborn-deep', 'seaborn-muted', 'seaborn-notebook', 'seaborn-paper',
'seaborn-pastel', 'seaborn-poster', 'seaborn-talk', 'seaborn-ticks', 'seaborn-
white', 'seaborn-whitegrid', 'tableau-colorblind10']
```

[ ]: