Astrophysical Absorption Line Exercise

To generate a spectrum of light after it has passed through a slab of gas, and investigate the Lyman α absorption line of hydrogen.

The Intensity I of light of a given wavelength λ is given by: I(λ) = exp[-σ(v)d]

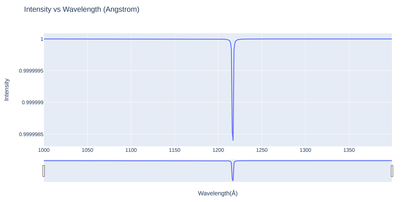
Constants/Variables:
pi=constants.pi
e=4.80e-10
c=3.00e10
m=9.11e-28
z=2
g=2
f=0.4164
T=6.265e8
vo=2.46607e15
nh=0.1
x=0.1

1.Generating spectrum for given values of d with v0=2.46607e15

In [1]:
```
import math
from sympy import symbols,diff
from scipy import constants
import numpy
from decimal import *
import matplotlib.pyplot as plt
import plotly.graph_objects as go

def plotting(d1,v1):
    pi=constants.pi
    e=4.80e-10
    c=3.00e10
    m=9.11e-28
    z=2
    g=2
    f=0.4164
    T=6.265e8
    vo=v1
    nh=0.1
    x=0.1
    xli=[]
    yli=[]

    for i in range (1000,1400):
        l = i
        xli.append(l)
        L = l * 1e-8
        v = c / L
        dv = (v - vo) * (v - vo)
        con_ = (e * e * f * nh * (1 - x) * g) * T / (((dv) + ((T / 4 * pi) * (T / 4 * pi))) * 4 * pi * m * c * z)
        d = d1
        l = math.exp((-con_ * d))

        yli.append(l)
    fig = go.Figure()
    fig.add_trace(go.Scatter(x=xli, y=yli,
                             mode='lines',
                             name='lines'))
    fig.update_xaxes(rangeslider_visible=True)
    fig.update_layout(
    title="Intensity vs Wavelength (Angstrom)",
    xaxis_title="Wavelength(Å)",
    yaxis_title="Intensity"
)
    fig.show()
```

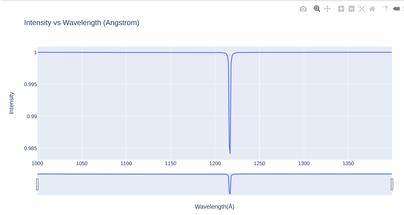
I have provided a range slider for zooming on the dip and also you can hover on the graph to get the exact value of intensity and corresponding wavelength.This will be useful for looking at minimum intensity and its corresponding wavelength. For this purpose I have used the *Plotly graph library*.

In [2]:
```
plotting(1e14,2.46607e15)
```



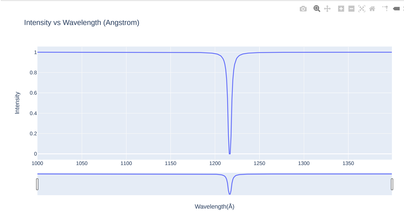
Wavelength corresponding to minimum intensity is 121.7nm or 1217 Å

In [39]:
```
plotting(1e18,2.46607e15)
```



Wavelength corresponding to minimum intensity is 121.7nm or 1217 Å

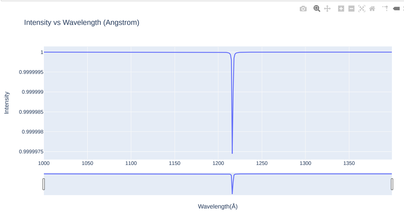
In [40]:
```
plotting(1e21,2.46607e15)
```



Wavelength corresponding to minimum intensity is 121.7nm or 1217 Å

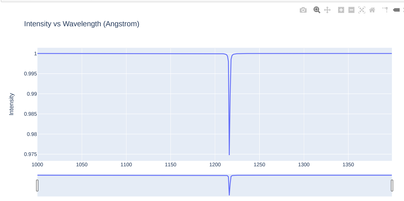
2.Generating spectrum for given values of d with v0=2.46632e15

In [41]:
```
plotting(1e14,2.46632e15)
```



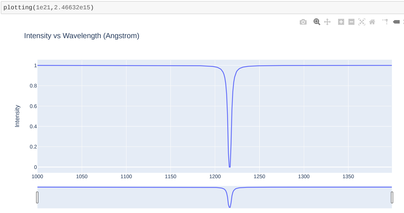
Wavelength corresponding to minimum intensity is 121.6nm or 1216 Å

In [42]:
```
plotting(1e18,2.46632e15)
```



Wavelength corresponding to minimum intensity is 121.6nm or 1216 Å

In [43]:
```
plotting(1e21,2.46632e15)
```



Wavelength corresponding to minimum intensity is 121.6nm or 1216 Å

3. Noting the similarities and differences

Similarities:
1.For all spectra we have approximately the same minimum wavelength (set1=121.7nm,set2=121.6nm)
2.The bandwidth of wavelengths where the intensity of the observed light dips remains about the same despite the change in central frequency (v0). This suggests that the bandwidth is independent of the central frequency.
3.All the graphs follow a similar 'V' shaped pattern.

Differences:
1.On increasing the central frequency we observe that the wavelength corresponding to lowest intensity is lower than that observed in set1 by a difference of 0.1nm or 1Å
2.In both the sets of spectra we can observe that if we increase the thickness of the glass slab more wavelengths appear to get absorbed by the slab and minima is less sharp.
3.The bandwidth of the wavelengths where the intensity of observed light dips increases within the set as the thickness of the slab increases

In [ ]:
```
```