

Plotting and Comparison of the Maxwell-Boltzmann Distribution and the Bose-Einstein Distribution

Importing the required Python Libraries

```
import numpy as np
import matplotlib.pyplot as pl
```

Defining the variables and the parameters

```
k_B = 8.617*10**(-5) # units of eV K^(-1)
T = [10,100,500,1000,5000,10000] #in units of K
#T = 300 # Kelvin
#print(E)
T_Col = ["red", "green", "blue", "cyan", "magenta", "yellow"]
#print (col)
T_Label = ["T = 10 K", "T = 100 K", "T = 500 K", "T = 1000 K", "T = 5000 K", "T = 10000 K"]
#print(leg)

E_mn_mu = np.arange(-2,2,0.0001) #in units of eV
BE_Dbn = np.zeros([len(T), len(E_mn_mu)])
MB_Dbn = np.zeros([len(T), len(E_mn_mu)])
```

Defining the distribution functions

```
def BE(E_mn_mu, Tmp):
    x = E_mn_mu/(k_B*Tmp)
    return (1/(np.exp(x)-1))

def MB(E_mn_mu, Tmp):
    x = E_mn_mu/(k_B*Tmp)
    return (np.exp(-x))
```

Calculating the two distributions as functions of energy at some given values of temperature

```
for i in range(len(T)):
    BE_Dbn[i,:] = BE(E_mn_mu, T[i])
    MB_Dbn[i,:] = MB(E_mn_mu, T[i])
```

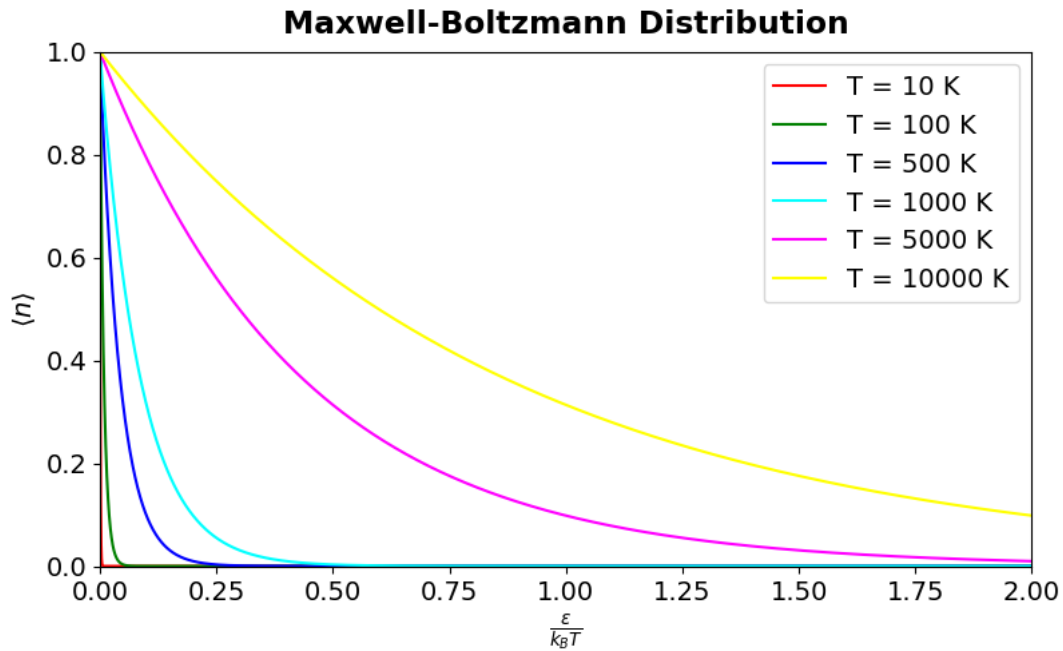
```
<ipython-input-9-e75c1b5da766>:3: RuntimeWarning: overflow encountered in exp
return (1/(np.exp(x)-1))
<ipython-input-9-e75c1b5da766>:7: RuntimeWarning: overflow encountered in exp
return (np.exp(-x))
```

Plotting the Maxwell-Boltzmann Distribution

```
pl.close()
pl.rcParams.update({'font.size': 14})
pl.rcParams["figure.figsize"]=[9,5]
for i in range(len(T)):
    pl.plot(E_mn_mu, MB_Dbn[i,:], label= T_Label[i], color = T_Col[i])

pl.title('Maxwell-Boltzmann Distribution', fontweight = 'bold', pad = 10)
pl.ylabel(r'$\langle n \rangle$')
pl.xlabel(r'$\frac{\epsilon}{k_B T}$')
pl.ylim(0,1)
pl.xlim(0,2)
pl.legend()
pl.show()
```

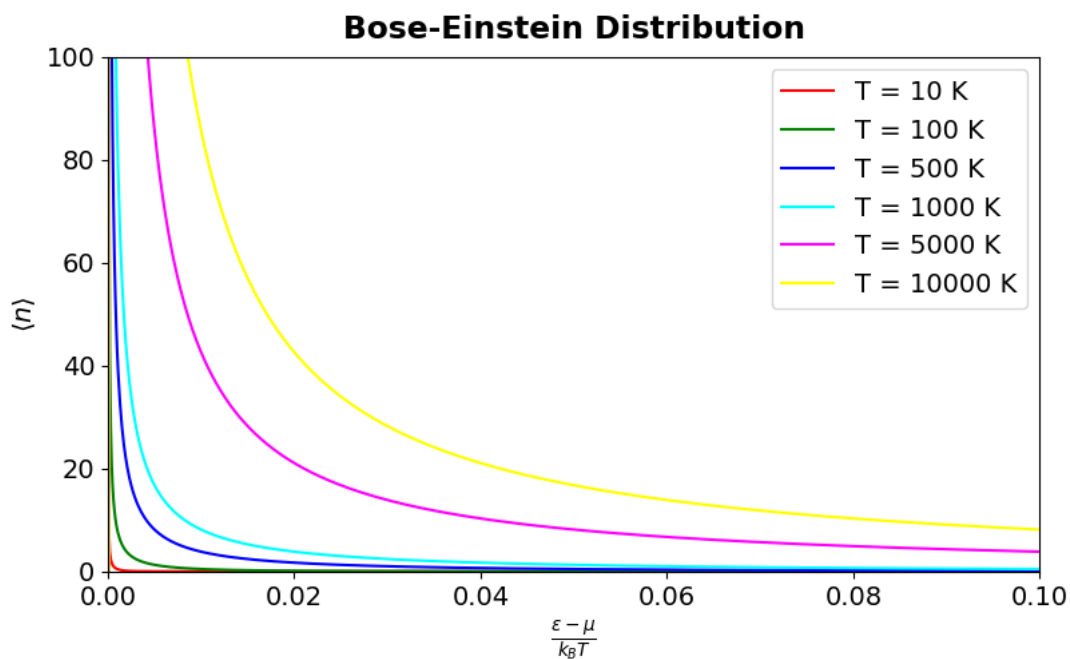
```
plt.show()
```



Plotting the Bose-Einstein Distribution

```
pl.close()
pl.rcParams.update({'font.size': 14})
pl.rcParams["figure.figsize"]=[9,5]
for i in range(len(T)):
    pl.plot(E_mn_mu, BE_Dbn[i,:], label= T_Label[i], color = T_Col[i])

pl.title('Bose-Einstein Distribution', fontweight = 'bold', pad = 10)
pl.ylabel(r'$\langle n \rangle$')
pl.xlabel(r'$\frac{\epsilon - \mu}{k_B T}$')
pl.ylim(0,100)
pl.xlim(0,0.1)
pl.legend()
pl.show()
```



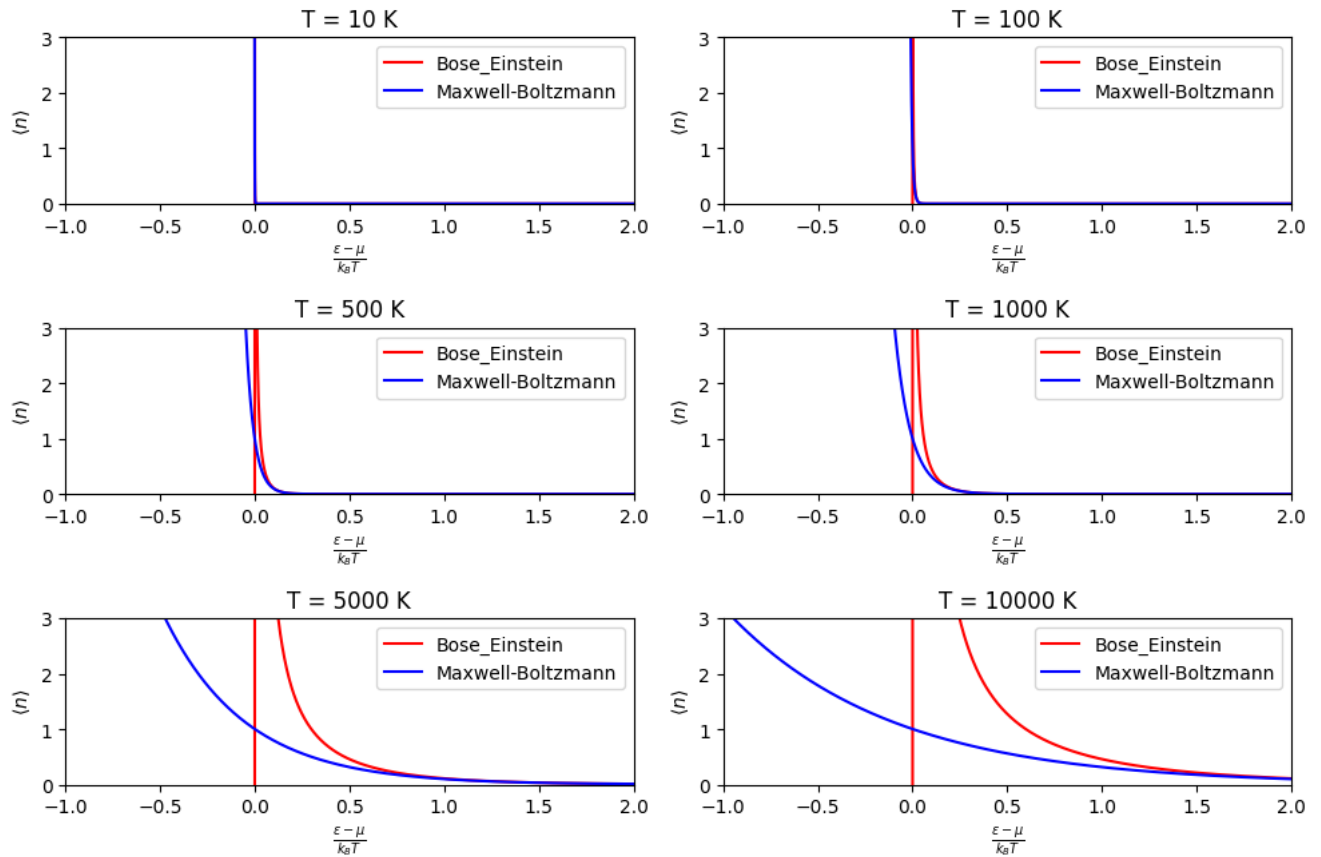
Plotting and comparing MB and BE distributions for different temperatures

```

pl.close()
pl.rcParams.update({'font.size': 10})
pl.rcParams["figure.figsize"]=[10,7]
#pl.suptitle('Maxwell-Boltzmann vs Bose-Einstein: Comparison ', fontweight = 'bold', pad = 30)
pl.suptitle('Maxwell-Boltzmann vs Bose-Einstein: Comparison at Various temperatures', fontweight = 'bold')
for i in range(len(T)):
    pl.subplot(3,2,i+1)
    pl.plot(E_mn_mu, BE_Dbn[i,:], label= 'Bose_Einstein', color = 'red') # Plotting the Bose-Einstein Distri
    pl.plot(E_mn_mu, MB_Dbn[i,:], label= 'Maxwell-Boltzmann', color = 'blue') # Plotting the Maxwell-Bolzm
#    pl.plot(E_mn_mu, FD_Dbn[i,:], label= 'Fermi-Dirac', color = 'blue') # Plotting the Fermi-Dirac Distbn
    pl.xlabel(r'$\frac{\epsilon - \mu}{k_B T}$')
    pl.ylabel(r'$\langle n \rangle$')
    pl.xlim(-1,2)
    pl.ylim(0,3)
    pl.title(T_Label[i])
#    pl.close('Temperature' T_label[i] 'Plot')
    pl.legend()
pl.tight_layout()
pl.show()

```

Maxwell-Boltzmann vs Bose-Einstein: Comparison at Various temperatures



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