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#generic import and constant definition list
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.colors as colors
import h5py
import astropy.constants as cons
from matplotlib.colors import LogNorm
import astropy.units as u
import pandas as pd
import scipy.optimize as opt
#all of the important fundamental constants are put into cgs units
just for convenience
c=cons.c.cgs.value
G=cons.G.cgs.value
h=cons.h.cgs.value
hbar=cons.hbar.cgs.value
Msun=cons.M_sun.cgs.value
Rsun=cons.R_sun.cgs.value
Rearth=cons.R_earth.cgs.value
mp=cons.m_p.cgs.value
me=cons.m_e.cgs.value
mn=cons.m_n.cgs.value
kB=cons.k_B.cgs.value
mu_e=2 #mean mass per electron for He-core or C/O core composition
m_u = 1/cons.N_A.cgs.value #atomic mass unit in grams
from astropy.io import fits

data =
pd.read_csv('planck_data_altered.txt',header=None,delimiter=',',names=
['l','lmin','lmax', 'D(l)', 'D(l)_err'])
print(data.head())

```

	l	lmin	lmax	D(l)	D(l)_err
0	47	32	62	1407.61	51.47
1	78	63	93	2016.71	60.07
2	109	94	124	3027.82	73.29
3	140	125	155	3893.83	87.35
4	171	156	186	4867.41	97.94

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modelldata =
pd.read_csv('changeBaryonNCMB.txt',delim_whitespace=True,header=None,n
ames=['l','cl','random1','random2','random3','random4'])
print(modelldata.head())

```

	l	cl	random1	random2	random3	random4
0	2	1265.37	0.060934	3.95935	1230900.0	35065.9
1	3	1188.27	0.100666	4.95616	1895300.0	41893.7
2	4	1113.31	0.114685	5.09980	2484260.0	45118.4
3	5	1054.85	0.103237	4.74536	3004210.0	46421.8
4	6	1012.43	0.077431	4.14502	3463240.0	46680.0

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model2data =
pd.read_csv('changeBaryonNCMBNk.txt',delim_whitespace=True,header=None
,names=['l','cl','random1','random2','random3','random4','random5','ra
ndom6','random7','random8'])
print(model2data.head())

```

	l	cl	random1	random2	random3	random4	random5
random6 \							
0	2	2879.08	-0.775269	0.003991	-0.775269	0.003954	-1.745700e-07
							0.003991
1	3	2556.67	-1.738680	0.004045	-1.738680	0.014388	-1.370930e-06
							0.004045
2	4	2270.63	-1.767000	0.003992	-1.767000	0.027721	-2.120120e-06
							0.003992
3	5	2054.72	-1.154700	0.003905	-1.154700	0.039224	-2.361990e-06
							0.003905
4	6	1895.45	-0.206992	0.003806	-0.206992	0.046195	-2.096580e-06
							0.003806

	random7	random8
0	-1.745700e-07	1.344580e-08
1	-1.370930e-06	1.615560e-08
2	-2.120120e-06	1.821960e-08
3	-2.361990e-06	1.993250e-08
4	-2.096580e-06	2.136140e-08

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model3data =
pd.read_csv('model3.txt',delim_whitespace=True,header=None,names=['l',
'cl','random1','random2','random3','random4'])
print(model3data.head())

```

	l	cl	random1	random2	random3	random4
0	2	974.695	0.037216	3.69931	1584850.0	14983.6
1	3	960.999	0.072236	4.69053	2452450.0	19880.7
2	4	935.597	0.098440	5.03473	3227740.0	22740.9
3	5	912.635	0.108231	4.94036	3920100.0	24432.9
4	6	894.585	0.101631	4.58372	4540100.0	25418.9

```

fig,ax=plt.subplots(figsize=(8,6))
plt.errorbar(data['l'], data['D(l)'], yerr=data['D(l)_err'],
fmt='r*',markersize=6, ecolor='r', capsize=2, label='Planck Data')
plt.scatter(model1data['l'],model1data['cl'],label='model 1')
plt.scatter(model2data['l'],model2data['cl'],label='model 2')
plt.scatter(model3data['l'],model3data['cl'],label='model 3')
plt.xlim(0,1500)
plt.title('CMB Power Spectrum Comparison')
plt.xlabel('Multipole Moment l')
plt.ylabel(r'$l(l+1)C_l/2\pi$')
plt.legend()
plt.show()

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