```
#
# This calculates the Mass-Metallicity relation in galaxies
#
z,hb,o3a,o3b,ha,n2=loadtxt('GRB_emi.txt', unpack=True, usecols=(1,9,11,13,15
    ,17))
g=np.genfromtxt('GRB_emi.txt',unpack=True,dtype='str',usecols=(0))
#
Z2=[]
z2=[]
g2=[]
for i in range(0,len(z)):
    o3n2 = log10((o3b[i]/hb[i])/(n2[i]/ha[i]))
    if o3n2 <=2 and o3n2 >=-1:
                # Z = 8.73 - 0.32*o3n2          # Old relation from PP04
                Z = 8.987-0.297*o3n2-0.0592*o3n2**2-.0090*o3n2**3       #
                    New relation xxx.lanl.gov/abs/1801.01133
        Z2.append(Z)
        z2.append(z[i])
        g2.append(g[i])
print (Z2)
#
# Calculates mean ratio of [OIII] doublet
#
ratio=[]
for i in range(0,len(z)):
    if o3b[i]>0 and o3a[i]>0:
        x = o3b[i]/o3a[i]
        ratio.append(x)
ratio_mean = np.sum(ratio)/np.size(ratio)
print ('Mean [OIII]5006 to [OIII]4958 line ratio = %f' % ratio_mean)
#
# READ MASS
#
z3,mass,dmass=loadtxt('GRB_mass.txt',unpack=True,usecols=(1,2,3))
g3=np.genfromtxt('GRB_mass.txt',unpack=True,dtype='str',usecols=0)
#
mass3=[]
dmass3=[]
Z3=[]
z3b=[]
for i in range(0,len(g2)):
    for j in range(0,len(g3)):
        if g2[i]==g3[j]:
            mass3.append(mass[j])
            dmass3.append(dmass[j])
            Z3.append(Z2[i])
            z3b.append(z3[j])
print (Z3,mass3)
#
# Plot mass-metallicity relation
#
plt.errorbar(mass3,Z3,xerr=dmass3,fmt='g^', ecolor='y')
xlabel('log (M*/M_sun)')
ylabel('12+log (O/H)')
#
# Linear correlations x:y and y:x
#
x=arange(7.5,11.5,.1)
coeffs = numpy.polyfit(mass3,Z3,1)
plot(x,coeffs[0]*x+coeffs[1])
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corr = numpy.corrcoef(mass3,Z3)[0,1]
print ('Correlation coefficient x vs. y = %f' % corr)
y=arange(7.9,9.3,.1)
coeffs = numpy.polyfit(Z3,mass3,1)
plot(coeffs[0]*y+coeffs[1],y)
corr = numpy.corrcoef(Z3,mass3)[0,1]
print ('Correlation coefficient y vs. x = %f' % corr)
```