second task of InPTA

May 16, 2022

0.1 Need to reproduce the result in table A1... using equations of A.1 and 3

objective: to reproduce the results in the first row of table A.1 which is

$$Y_{nr500}/Y_{500}$$

- defination of the Y is given as:

$$Y_{nr_{500}}/Y_{500} = \frac{\int_0^{nr_{500}} drP(r)4\pi r^2}{\int_0^{r_{500}} drP(r)4\pi r^2}$$

$$P(r) = P_{500} * P_0/(x^\gamma(1+x^\alpha)^{(\beta-\gamma)/\alpha}) \ldots \alpha, \beta, \gamma, c_{500} \; are \; given$$

$$x = r/r_s, r_s = r_{500}/c_{500}$$

* r500 is the radius of the sphere in which the integration is done

[38]:
```
import numpy as np
import math as m
import matplotlib.pyplot as plt
from scipy import integrate
```

[101]:
```
#writing the constants in the equation
c_500 = 1.156
alpha = 1.0620
beta = 5.4807
gamma = 0.3292
P_0 = 23.13
diff = (beta-gamma)/alpha

#defining r_500
r_500 = 1.15 #Mpc #1.351 (earlier value used)
#reason for taking r_500 = 1.15 for matching the values
```

the reference for the values for the r_500 is taken to match the output in the table. I otherwise used the below mentioned paper to check for the values of the parameters and r_500 using Table C.1

paper: The universal galaxy cluster pressure profile from a representative sample of nearby systems (REXCESS) and the Y SZ – M 500 relation

[97]:
```
#function we need to integrate

def f(x):
    return x**2/(x**gamma *(1 + x**alpha)**diff)

#using quad to integrate from 0 to r_500 for denominator
res, err = integrate.quad(f, 0, r_500)

print("The numerical result is {:f} (+-{:g})"
   .format(res, err))

#using quad to integrate from 0 to n*r_500 for denominator
n = 1
res_1, err_1 = integrate.quad(f, 0, r_500)

print("The numerical result is {:f} (+-{:g})"
   .format(res_1, err_1))
#=================================================
n = 2
res_2, err_2 = integrate.quad(f, 0, 2*r_500)

print("The numerical result is {:f} (+-{:g})"
   .format(res_2, err_2))
#=================================================
n = 3
res_3, err_3 = integrate.quad(f, 0, 3*r_500)

print("The numerical result is {:f} (+-{:g})"
   .format(res_3, err_3))
```

```
The numerical result is 0.041332 (+-5.79516e-09)
The numerical result is 0.041332 (+-5.79516e-09)
The numerical result is 0.062360 (+-5.79516e-09)
The numerical result is 0.070086 (+-2.49954e-09)
```

[98]:
```
print("For the n = 1, the ratio of Ynr500/Yr500 is {:f} (+-{:g})".format(res_1/
 ↪res, err_1/err))
```

```
For the n = 1, the ratio of Ynr500/Yr500 is 1.000000 (+-1)
```

[99]:
```
print("For the n = 1, the ratio of Ynr500/Yr500 is {:f} (+-{:g})".format(res_2/
 ↪res, err_2/err))
```

```
For the n = 1, the ratio of Ynr500/Yr500 is 1.508766 (+-1)
```

[100]:
```
print("For the n = 1, the ratio of Ynr500/Yr500 is {:f} (+-{:g})".format(res_3/
↪res, err_3/err))
```

```
For the n = 1, the ratio of Ynr500/Yr500 is 1.695696 (+-0.431314)
```