Κβαντική πληροφορία και επεξεργασία

Μαρία Λεκού

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Λύση της Lane-Emden

Διαφορική εξίσωση:

$$\frac{1}{\xi^2}\frac{d}{d\xi}\xi^2\frac{d\theta}{d\xi}+\theta^{1/\gamma-1}$$

Ή αλλιώς:

$$y = d\theta/d\xi$$
$$y' = -\frac{2}{\xi}y - \theta^{1/\gamma-1}$$

```
thetaall={}
ksiall={}
ksith=np.zeros(int((xend/step -1)),float)
for g in range(0,N): #ολοκλήρωση για κάθε γ
    y[0]=1
    y[1]=0
    i = -1
    theta = []
    ksith =[]
    for ksi in np.arange (0+step , xend , step):
        i=i+1
        ksith.append(ksi)
        y=rk4Algor2(ksi,step,2,y,f,g) #Runge kutta
        theta.append(y[0])
        if np.isnan(theta[i]) or theta[i]<0:
            theta.remove(theta[i])
            ksith.remove(ksith[i])
            break

    thetaall[g]=theta
    ksiall[g]=ksith
```

Λύση της Lane-Emden

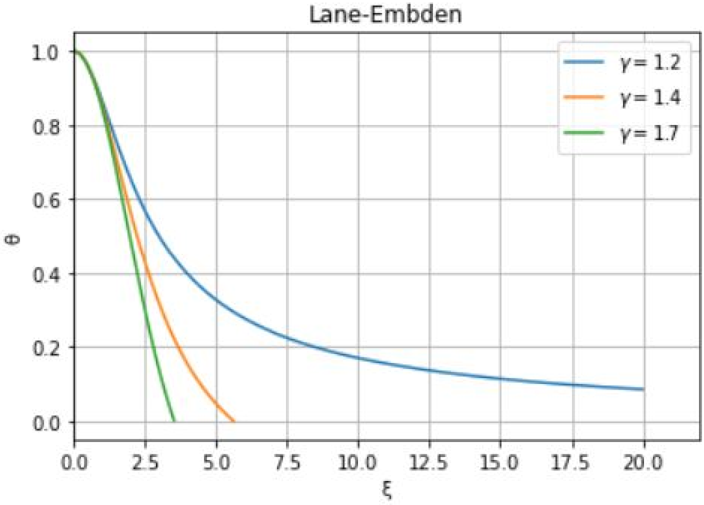


Figure 1

$$h(ak) = \left(\frac{4\pi\rho_0\alpha^3}{ak}\int_0^{\xi_R}\theta^{1/(\gamma-1)}(\xi)sin(ak\cdot\xi)\xi d\xi\right)^2$$

$$\tilde{f}(k) = \frac{h(ak)}{h(\frac{a\pi}{R})} = \frac{h(ak)}{C(\gamma)}$$

```
def h_integr(i,g,k): #το μέγεθος που είναι να ολοκληρωθεί
    olokl=thetaall[g][i]**(1/(gamma[g]-1))*np.sin(a(g)*k*ksiall[g][i])*ksiall[g][i]
    return olokl

def h(k,g):
    final=(step/3)*(h_integr(0,g,k)+h_integr(len(thetaall[g])-1,g,k))
    for c in range(1,len(thetaall[g])-1):
        if c%2==0:
            final+=(step/3)*4*h_integr(c,g,k)
        elif c%2==1:
            final+=(step/3)*2*h_integr(c,g,k)
    final=(((4*np.pi*p0*a(g)**3)/(a(g)*k) )*final)**2
    return final
```

Figure 1

```
fkall=[]
kplotall=[] #k/sqrt(4πG)
kall=[]
for g in range(0,len(gamma)): #για κάθε γ
    fk=[]
    kplot=[]
    kappa=[]
    counting=0
    for k in np.arange(np.pi/R(g),100,0.05):
        counting+=1
        kappa.append(k)
        fk.append(h(k,g)/h(np.pi/R(g),g))
        kplot.append(k/np.sqrt(4*np.pi*G/Kg))
        if fk[counting-1]<10**(-5):
            break
    fkall.append(fk)
    kplotall.append(kplot)
    kall.append(kappa)
```

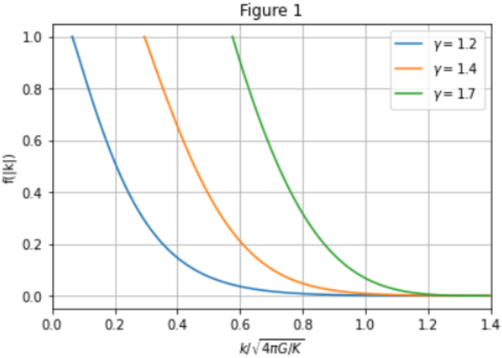


Figure 2

Entropy:

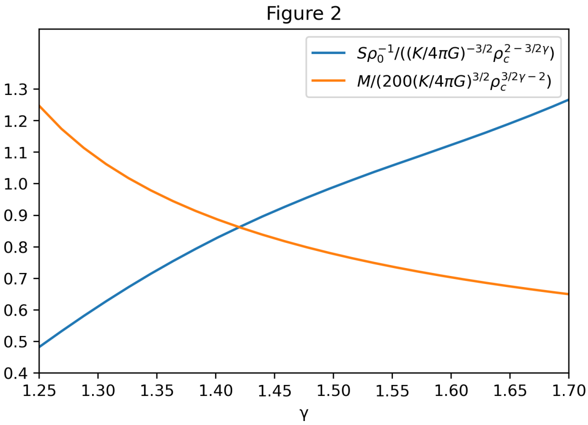
$$S = -4\pi \int_{k_{min}}^{\infty} f(k) \cdot ln\big(f(k)\big) k^2 dk$$

Mass:

$$M = 4\pi \rho_0 a^3 \int_0^{\xi_R} \theta^{1/\gamma - 1}(\xi) \xi^2 d\xi$$

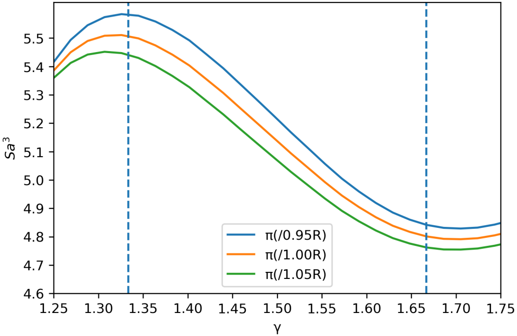
```
def S_integr(k,g): #το μέρος της εντροπίας που είναι προς ολοκλήρωση
    return ( h(k,g)/h(np.pi/R(g),g))*np.log(h(k,g)/h(np.pi/R(g),g))*k**2

def M_integr(i,g): #το μέρος της M που είναι προς ολοκλήρωση
    return thetaall[g][i]**(1/(gamma[g]-1))*ksiall[g][i]**2

def S(g): #εντροπία
    kmin=np.pi/R(g)
    return  (-4*np.pi)*simpsonS(S_integr,kall[g][0],40,0.05,g)

def M(g): #μάζα
    return 4*np.pi*p0*a(g)**3 *simps(M_integr,0,len(thetaall[g])-1,0.01,g)
```

```
Sg=[(S(t)*p0**(-1))/((Kg/(4*np.pi*G))**(-3/2)*pc**(2-(3/2)*gamma[t])) for t in range(len(gamma))]
Mg=[M(t)/(200*(Kg/(4*np.pi*G))**(3/2)*pc**(3/2*gamma[t]-2)) for t in range(len(gamma))]
```



Ελέγχουμε την Sa^3 για διαφορετικά k_{min}

```
kminS=[0.95,1,1.05]
Sa=[0]*3
for i in range(3):
    def intSa(k,g):
        return ( h(k,g)/h(np.pi/(kminS[i]*R(g)),g))*np.log(h(k,g)/h(np.pi/(kminS[i]*R(g)),g))*k**2
    def Saaa(g):
        kmin=np.pi/(kminS[i]*R(g))
        return  (-4*np.pi*a(g)**3)*simpsonS(intSa,kmin,40,0.05,g)
    Sa[i]=[Saaa(t) for t in range(len(gamma))]
```



Τέλος παρουσίασης