

Mpc := 3.085677581·10²²·m
G := 6.67430·10⁻¹¹· $\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}$
c := 299792458· $\frac{\text{m}}{\text{s}}$
H₀ := 67.4· $\frac{\text{km}}{\text{s}\cdot\text{Mpc}}$

x₀ = $\frac{1}{\Omega_{\text{b}}}$ - q₀

Ω_b := 0.04960
ρ_c := $\frac{3\cdot\text{H}_0^2}{8\cdot\pi\cdot\text{G}}$
ρ_b := Ω_b·ρ_c
Ω_k := 0.0007
k₀ := $\frac{\Omega_{\text{k}}}{\Omega_{\text{b}}}$

Y := $\frac{4}{3}\cdot\pi\cdot\rho_{\text{b}}$

M := 3.693·10⁵¹·kg
q := $\frac{0.3185}{\Omega_{\text{b}}}$
Ω_{bs} := $\frac{\Omega_{\text{b}}}{1 - \Omega_{\text{k}}}$
x := $\frac{1}{\Omega_{\text{bs}}}$ - q

R_0_in:

$$\begin{bmatrix} \frac{1}{\left(-2\cdot Y\cdot G + Y\cdot G\cdot \Omega_{\text{bs}}\right)}\cdot c\cdot \sqrt{-Y\cdot G\cdot \left(-2 + \Omega_{\text{bs}}\right)\cdot \Omega_{\text{bs}}\cdot \left(\frac{1}{q} + 1\right)} \\ \frac{-1}{\left(-2\cdot Y\cdot G + Y\cdot G\cdot \Omega_{\text{bs}}\right)}\cdot c\cdot \sqrt{-Y\cdot G\cdot \left(-2 + \Omega_{\text{bs}}\right)\cdot \Omega_{\text{bs}}\cdot \left(\frac{1}{q} + 1\right)} \\ \frac{1}{\left(-2\cdot Y\cdot G + Y\cdot G\cdot \Omega_{\text{bs}}\right)}\cdot c\cdot \sqrt{Y\cdot G\cdot \left(-2 + \Omega_{\text{bs}}\right)\cdot \Omega_{\text{bs}}\cdot \left(\frac{1}{q} - 1\right)} \\ \frac{-1}{\left(-2\cdot Y\cdot G + Y\cdot G\cdot \Omega_{\text{bs}}\right)}\cdot c\cdot \sqrt{Y\cdot G\cdot \left(-2 + \Omega_{\text{bs}}\right)\cdot \Omega_{\text{bs}}\cdot \left(\frac{1}{q} - 1\right)} \end{bmatrix}$$

=
$$\begin{bmatrix} -1.495\bullet 10^{26} \\ 1.495\bullet 10^{26} \\ -1.278\bullet 10^{26} \\ 1.278\bullet 10^{26} \end{bmatrix}\bullet\text{m}$$

R_0_out:

$$\begin{bmatrix} \frac{1}{\left(Y\cdot \left(q\cdot G\right)\right)}\cdot \sqrt{\frac{\left(Y\cdot q^2\cdot G\cdot c^2\cdot \Omega_{\text{bs}} + \sqrt{-6\cdot Y^2\cdot q^4\cdot G^2\cdot c^4\cdot \Omega_{\text{bs}}^2 + 3\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}^2\cdot c^4 + 2\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}\cdot c^4}\right)}{\left(q\cdot \Omega_{\text{bs}}\right)}} \\ \frac{-1}{\left(Y\cdot \left(q\cdot G\right)\right)}\cdot \sqrt{\frac{\left(Y\cdot q^2\cdot G\cdot c^2\cdot \Omega_{\text{bs}} + \sqrt{-6\cdot Y^2\cdot q^4\cdot G^2\cdot c^4\cdot \Omega_{\text{bs}}^2 + 3\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}^2\cdot c^4 + 2\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}\cdot c^4}\right)}{\left(q\cdot \Omega_{\text{bs}}\right)}} \\ \frac{1}{\left(Y\cdot \left(q\cdot G\right)\right)}\cdot \sqrt{\frac{\left(Y\cdot q^2\cdot G\cdot c^2\cdot \Omega_{\text{bs}} - \sqrt{-6\cdot Y^2\cdot q^4\cdot G^2\cdot c^4\cdot \Omega_{\text{bs}}^2 + 3\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}^2\cdot c^4 + 2\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}\cdot c^4}\right)}{\left(q\cdot \Omega_{\text{bs}}\right)}} \\ \frac{-1}{\left(Y\cdot \left(q\cdot G\right)\right)}\cdot \sqrt{\frac{\left(Y\cdot q^2\cdot G\cdot c^2\cdot \Omega_{\text{bs}} - \sqrt{-6\cdot Y^2\cdot q^4\cdot G^2\cdot c^4\cdot \Omega_{\text{bs}}^2 + 3\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}^2\cdot c^4 + 2\cdot Y^2\cdot q^3\cdot G^2\cdot \Omega_{\text{bs}}\cdot c^4}\right)}{\left(q\cdot \Omega_{\text{bs}}\right)}} \end{bmatrix}$$

=
$$\begin{bmatrix} 4.693\bullet 10^{26} \\ -4.693\bullet 10^{26} \\ 1.28\bullet 10^{26} \\ -1.28\bullet 10^{26} \end{bmatrix}\bullet\text{m}$$

R_in:

$$\begin{bmatrix} \frac{1}{\left[2\cdot \left(c^4 - \frac{1}{q^2}\cdot c^4\right)\right]}\cdot \left(4\cdot M\cdot G\cdot q\cdot c^2 + 4\cdot M\cdot G\cdot x\cdot c^2 + 2\cdot M\cdot G\cdot c^2 - 2\cdot G\cdot M\cdot \frac{c^2}{q} + 4\cdot G\cdot M\cdot \frac{c^2}{q}\cdot x\right) \\ \frac{1}{\left[2\cdot \left(c^4 - \frac{1}{q^2}\cdot c^4\right)\right]}\cdot \left(4\cdot M\cdot G\cdot q\cdot c^2 + 4\cdot M\cdot G\cdot x\cdot c^2 - 6\cdot M\cdot G\cdot c^2 + 2\cdot G\cdot M\cdot \frac{c^2}{q} - 4\cdot G\cdot M\cdot \frac{c^2}{q}\cdot x\right) \end{bmatrix}$$

=
$$\begin{bmatrix} 1.276\bullet 10^{26} \\ 9.324\bullet 10^{25} \end{bmatrix}\bullet\text{m}$$

R_out:

$$\begin{bmatrix} \frac{1}{\left[2\cdot \left(-5\cdot q\cdot c^4 + 3\cdot c^4 + 2\cdot x\cdot c^4\right)\right]}\cdot \left(-2\cdot c^2\cdot M\cdot q^2\cdot G + 2\cdot \sqrt{-4\cdot c^4\cdot M^2\cdot q^4\cdot G^2 + 3\cdot M^2\cdot q^3\cdot G^2\cdot c^4 + 2\cdot M^2\cdot q^3\cdot G^2\cdot x\cdot c^4}\right) \\ \frac{1}{\left[2\cdot \left(-5\cdot q\cdot c^4 + 3\cdot c^4 + 2\cdot x\cdot c^4\right)\right]}\cdot \left(-2\cdot c^2\cdot M\cdot q^2\cdot G - 2\cdot \sqrt{-4\cdot c^4\cdot M^2\cdot q^4\cdot G^2 + 3\cdot M^2\cdot q^3\cdot G^2\cdot c^4 + 2\cdot M^2\cdot q^3\cdot G^2\cdot x\cdot c^4}\right) \end{bmatrix}$$

=
$$\begin{bmatrix} 9.46\bullet 10^{24} \\ 1.272\bullet 10^{26} \end{bmatrix}\bullet\text{m}$$