Université de Montréal

Documentation for Astrometry Routines

Contents

1 LScalc.py

This program has a very simple goal: calculate the linear distance of an astronomical object given a redshift and angular view. To do this, I simply utilized the following set of equations to calculate the quantity of intereset, l.

Parameter	Brief Description
l	Linear Distance in Kiloparsecs
z	Redshift
$d_A(z)$	Angular Distance
θ	Angular Seperation in arcseconds
d_H	Hubble Distance
c	Speed of Light
H_0	Hubble Constant
d_C	Comoving Distance
$E(z)$	Energy Function
$d_M(z)$	Moving Distance
Ω_{rel}	Mass Density of Relativistic Particles
Ω_{mass}	Mass Density of Baryonic and NonBaryonic Particles
Ω_Λ	Mass Density of Dark Energy

$$l = d_A(z) * \theta \tag{1}$$

$$d_A(z) = \frac{d_M(z)}{1+z} \tag{2}$$

$$d_M(z) = \begin{cases} \frac{d_H}{\sqrt{\Omega_k}} \sinh\left(\sqrt{\Omega_k}\frac{d_C(z)}{d_H}\right) & \Omega_k > 0 \\ d_C(z) & \Omega_k = 0 \\ \frac{d_H}{\sqrt{|\Omega_k|}} \sin\left(\sqrt{|\Omega_k|}\frac{d_C(z)}{d_H}\right) & \Omega_k < 0 \end{cases} \tag{3}$$

$$d_C(z) = d_H \int_0^z \frac{dz'}{E(z')} \tag{4}$$

$$E(z) = \sqrt{\Omega_{rel}(1+z)^4 + \Omega_{mass}(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\Lambda} \tag{5}$$

$$\Omega_k = 1 - \Omega_{mass} - \Omega_\Lambda \tag{6}$$

$$d_H = \frac{c}{H_0} \tag{7}$$

2 AScalc.py

This program is almost identitical to **LScalc.py** except that instead of solving for the linear distance we are solving for the angular seperation.

Parameter	Brief Description
l	Linear Distance in Kiloparsecs
z	Redshift
$d_A(z)$	Angular Distance
θ	Angular Seperation in arcseconds
d_H	Hubble Distance
c	Speed of Light
H_0	Hubble Constant
d_C	Comoving Distance
$E(z)$	Energy Function
$d_M(z)$	Moving Distance
Ω_{rel}	Mass Density of Relativistic Particles
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Ω_Λ	Mass Density of Dark Energy

$$\theta = \frac{l}{d_A(z)} \tag{8}$$

$$d_A(z) = \frac{d_M(z)}{1+z} \tag{9}$$

$$d_M(z) = \begin{cases} \frac{d_H}{\sqrt{\Omega_k}} \sinh\left(\sqrt{\Omega_k}\frac{d_C(z)}{d_H}\right) & \Omega_k > 0 \\ d_C(z) & \Omega_k = 0 \\ \frac{d_H}{\sqrt{|\Omega_k|}} \sin\left(\sqrt{|\Omega_k|}\frac{d_C(z)}{d_H}\right) & \Omega_k < 0 \end{cases} \tag{10}$$

$$d_C(z) = d_H \int_0^z \frac{dz'}{E(z')} \tag{11}$$

$$E(z) = \sqrt{\Omega_{rel}(1+z)^4 + \Omega_{mass}(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\Lambda} \tag{12}$$

$$\Omega_k = 1 - \Omega_{mass} - \Omega_\Lambda \tag{13}$$

$$d_H = \frac{c}{H_0} \tag{14}$$