

B.E.T.A.=Bureau of Extra-Terrestrial Affairs
X-File-051: *Cosmography* 🚀

Alumno/a 🧐 :
CURSO:

1. Cosmography(I)

In Cosmography we define, for $a(t)$:

$$\text{Hubble function : } H(t) = \frac{1}{a} \frac{da}{dt} \quad (1)$$

$$\text{deceleration function : } q(t) = -\frac{1}{aH^2} \frac{d^2a}{dt^2} \quad (2)$$

$$\text{jerk : } j(t) = \frac{1}{aH^3} \frac{d^3a}{dt^3} \quad \text{snap : } s(t) = \frac{1}{aH^4} \frac{d^4a}{dt^4} \quad (3)$$

$$\text{crackle/lerk function : } l(t) = \frac{1}{aH^5} \frac{d^5a}{dt^5} \quad (4)$$

2. Cosmography(II)

Cosmographic parameters in current time are denoted by $(H_0, q_0, j_0, s_0, l_0)$ and are a target of present and future cosmological measurements. Since:

$$a(t) = a(0) + \frac{da}{dt}(0)t + \frac{d^2a}{dt^2}(0)t^2 + \cdots + \frac{1}{n!} \frac{d^n a}{dt^n}(0)t^n + \mathcal{O}(t^{n+1}) \quad (5)$$

and then H with redshift z

$$H(z) = H(0) + \frac{dH}{dz}(0)z + \frac{d^2H}{dz^2}(0)z^2 + \cdots + \frac{1}{n!} \frac{d^n H}{dz^n}(0)z^n + \mathcal{O}(z^{n+1}) \quad (6)$$

a) Check, with explicit calculations, the relationships below :

$$\dot{H} = -H^2(1 + q)$$

$$\ddot{H} = H^3(3q + j + 2), \quad \ddot{H} = H^4(-3q^2 - 12q - 4j + s - 6)$$

$$\ddot{H} = H^5(30q^2 + 60q + 10qj + 20j - 5s + l + 24)$$

b) Find out the dimensions and units of cosmographic parameters, explaining why the Hubble law is related to them, $v = H(z)d(z)$.