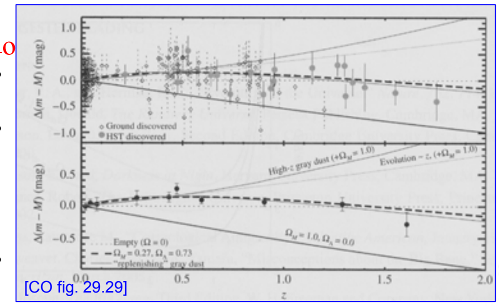
q_o

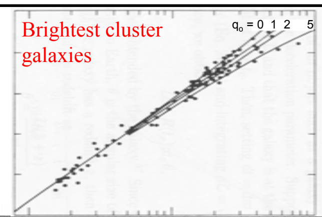
•

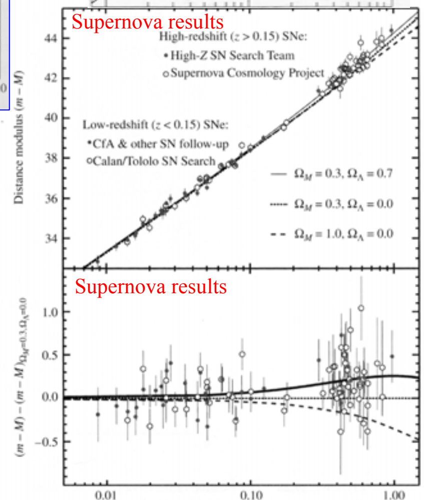
•

•

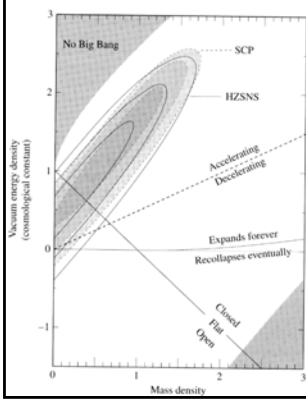


[CO fig. 29.29]

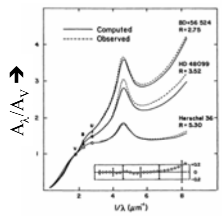




[CO fig. 29.27]



Extinction curves (reddening) Aug. 31



Joint Dark Energy Mission (JDEM)
• SNAP
• Destiny
• ADEPT

Angular Diameters

- RW metric:

$$(ds)^2 = (c\,dt)^2 - R^2(t)\left[\left(\frac{d\varpi}{\sqrt{1-k\varpi^2}}\right)^2 + (\varpi\, d\theta)^2 + (\varpi \sin\theta\, d\phi)^2\right]$$

- What is angular size of galaxy at distance ϖ ?

$$dt = d\varpi = d\phi = 0$$

Galaxy's diameter is proper ~~distance~~ linear diameter:

$$D = \int\sqrt{-(ds)^2} = R(t_e)\,\varpi_e\,\theta$$

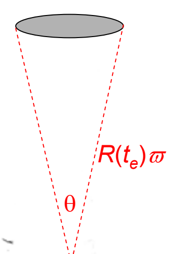
Using ϖ coordinate → Looks like Euclidean result, regardless of curvature of space.

$$\theta = \frac{D}{R(t_e)\,\varpi}$$

but must use $R(t_e)$

$$= \frac{D(1+z)}{\varpi} \qquad \text{USING} \quad 1+z = \frac{1}{R(t_e)}$$

$$\theta = \frac{D(1+z)^2}{d_L}$$

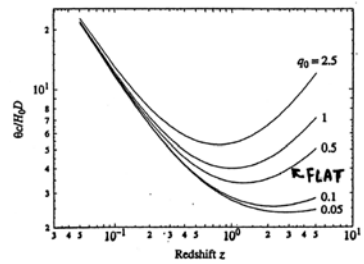


More angular diameter

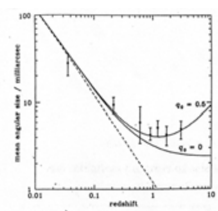
$$\theta = \frac{D(1+z)^2}{d_L}$$

$$\theta = \frac{H_0 D}{c} \frac{q_0^2 (1+z)^2}{q_0 z - (1-q_0)\left(\sqrt{1+2q_0 z} - 1\right)}$$

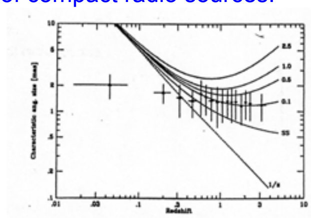
- Surprise!
  - Even for flat universe, θ first decreases but then increases with increasing z.
  - Two competing effects:
    - θ = 1/distance
    - Universe expands under photons while they are in transit.



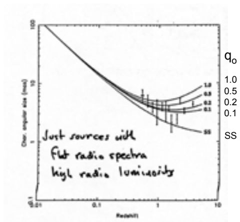
VLBI measurements of compact radio sources:



Kellerman (1993)



Gurvits (1994)



Gurvits, Kellerman & Frey (1999)

Authors say "consistent with" $q_o = 0.5$, no evolution.

More angular diameter

$$\theta = \frac{D(1+z)^2}{d_L}$$

$$\theta = \frac{H_0 D}{c} \frac{q_0^2 (1+z)^2}{q_0 z - (1-q_0)\left(\sqrt{1+2q_0 z} - 1\right)}$$

- Surprise!
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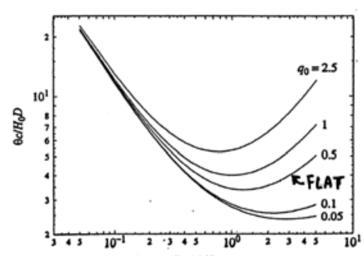
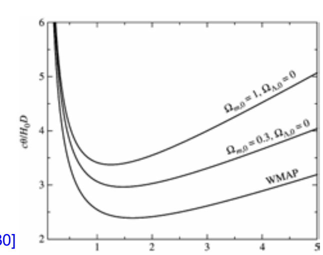


In practice
(because of that @#$% cosmological constant)

$$\frac{c\theta}{H_0 D} = \frac{(1+z)}{S(z)}$$

29.136



[CO Fig. 29.30]