I'm sure I was working through some concepts in some book when I made these notes. I'm not certain which one though, so apologies.

Basic Stuff : Basic units, values, etc..

$F = ma$. $\quad Kg\, m s^{-2}$.

$W = \int_{x_1}^{x_2} F(x) \cdot dx$. $= F \cdot \Delta x \quad Kg\, m^2 s^{-2}$

$[W] = [E]$. $\quad Kg\, m^{+2} s^{-2}$. $\rightarrow 10^3 g\, [10^2]^{+2} cm^{+2} s^{-2}$

$10^3 g\, 10^4\, cm^{+2} s^{-2}$

1 Joule $= 1\, Kg\, m^2 s^{-2} = 10^7$ erg

$1\, erg = 10^{-7} N$

$L_\odot = 3.9 \times 10^{33}$ erg $\qquad M_\odot = 1.99 \times 10^{33}\, g$

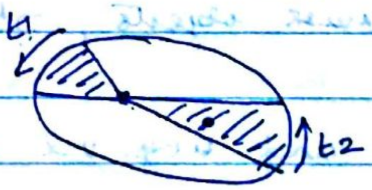
Sun L & M $\simeq 10^{33}$ SI

$1\, pc \approx 3.08 \times 10^{18}$ cm ≈ 3 Ly.

1 Ly $\approx 9.4 \times 10^{18}$ cm $\approx 9.4 \times 10^{15}$ m

Kepler's laws

Kepler's laws : ①  Sun 1 of 2 focii of ellipse

②  $A_1 = A_2 \quad t_1 = t_2$

equal areas in equal intervals of time.

③ . 

$T^2 \propto a^3$

period — semi major axis

$$\frac{T_1^2}{T_2^2} = \frac{a_1^3}{a_2^3} \qquad \frac{T_1}{T_2} = \left(\frac{a_1}{a_2}\right)^{3/2}$$

$$\cancel{m}v^2 = \frac{GM\cancel{m}}{R}$$

$$M = \frac{Rv^2}{G}$$

$$R_1 = \frac{M_1 G}{v_1^2} \qquad R_2 = \frac{M_2 G}{V_2^2}$$

velocity / rotation curve measurements.

If towards outer edge of Baryonic matter only galaxy M is same

$$v_1^2 = \frac{MG}{R_1} \qquad V_2^2 = \frac{GM}{R_2}$$

$v \propto R_1^{-1/2}$ if M const. within radii R_1 & R_2

Virial theorem

Virial Theorem: For a stable self gravitating, spherical distribution of equal mass objects, total KE = $-\frac{1}{2}$ PE.

N objects of Mass m and avg. vel $\vec{v}$, radius R_{tot}.

$M_{tot} = N \cdot m$.

KE of each object = $\frac{1}{2} m v^2$.

Total sys KE = $\frac{1}{2} m N v^2 = \frac{1}{2} M_{tot} v^2$.

Grav. pot E = $-\frac{1}{2} \frac{G M_{tot}^2}{R}$

As per virial theorem

$\cancel{KE} = KE = -\frac{1}{2} PE$

$= \frac{1}{4} \frac{G M_{tot}^2}{R_{tot}^2}$

Hamiltonian

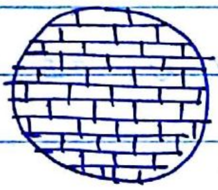
Hamiltonian $\boxed{H = T + V}$ ($T \to$ KE, $V \to$ PE)

Homogeneity, Isotropy

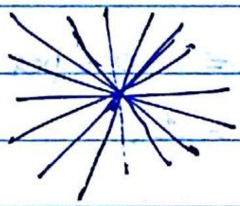
$\boxed{\text{Homogeneity}}$

on scales $d \lesssim 30$ Mpc $\longrightarrow$ inhomogeneous

$d \gtrsim 300$ Mpc ~ isotropic & homogeneous



Homogen.



Isotropic

Expansion Hubble 1920s.

$z + 1 = \frac{\lambda_{obs}}{\lambda_{rest}}$ $\qquad z = \frac{v}{c}$ for $v \ll c$

$z \propto d \propto \frac{v}{c}$

$d \propto \frac{v}{c}$ $\qquad$ ~~d~~ $\qquad v = H_0 d$ $= \cancel{H_0 d}$

$\frac{v}{c} = z = \frac{H_0 d}{c}$

$H_0 \approx 40 - 100 \ \text{km s}^{-1} \text{Mpc}^{-1}$

$H_0 = 100h \ \text{km s}^{-1} \text{Mpc}^{-1}$

$h \approx 0.4 - 1$

Peculiar velocity

$\boxed{\text{Peculiar velocity}}$ = small [$\sim 100 km s^{-1}$] vel. of galaxies w.r.t background geometry (Hubble flow)

comoving distance = remains fixed.
doesn't depend on time; scale factor accounted.

proper distance = present distance.
i.e. distance as measured by a ruler now.

At the present time
comoving distance = proper distance as
$\boxed{\text{Scale factor now} = 1}$.

$$d_{12}(t) = \frac{R(t)}{R(t_0)} d_{12}(t_0). \qquad R(t_0) = 1.$$

at t. present

$$d(t) = \underline{a(t)\, d(t_0)}$$