~~σ_m the variance of velocity for 1 of the 3 perpendicular directions~~ (60 ~~51~~)

$P = \frac{2}{3}\int_0^\infty \frac{1}{2} m v^2\, n(v)\, dv$ $nm \to n$ $\int = 1$

$= \frac{1}{3} mn \int v^2 f(v) dv = \frac{1}{3} mn \frac{3kT}{m} = nkT$

[e.g., Maxwell Boltzmann distribution

$\therefore P_i = n_i kT$ partial pressure

For 3 directions $\sigma^2 = \frac{3kT}{m}$

Wiki: Max-Boltz distribution function

BeV – 53

dimensional control $\left[\left(\frac{E}{m}\right)\right] = \left(\frac{L}{T}\right)^2$

No dependence on particle mass. Add up the pa

$P = nkT$ ideal gas law

$P = \sum \frac{m_i n_i kT}{m_i} = \sum n_i kT$

combining partial mass conduct of

$P = nkT$ ideal gas law for one species

c) ∴ the Hydrostatic Equilibrium equation for gas in this context call the isotropic Jeans equation

Ci – 147, 182

becomes

$\frac{\rho}{\mu m_p} = \sum \frac{x_i \rho}{A_i m_p} = n_i$

$n = \sum n_i$

$kT \frac{dn}{dr}$ ~~$\frac{d(P\sigma^2)}{dr}$~~ $= -\frac{GM(r)}{r^2}\rho$

divide thru by particle mass m

For gas ~~...~~ which we have implicitly assume is the same for all particles.

$\frac{kT}{\mu m_p}\frac{d\rho}{dr} = -\frac{GM}{r^2}\frac{\rho}{\mu m_p} = -\frac{GM}{r^2} n$

$\frac{\rho}{\mu m_p} = \sum_i \frac{x_i \rho}{A_i m_p} = \sum_i n_i = n$

60 ~~52~~

$$\frac{d\, n\sigma_r^2}{dr} = -\frac{GM}{r^2}\, n$$

Dark matter particles decoupled ~~except in their global mass effect~~ → assumed spherically symmetric

separately?

The pressure of the two species are decoupled. They do not feel each other. gas holds up gas - galaxies "hold" up galaxies

pressure momentum flow to neither kind of particle has to interact ~~with~~ with itself

of course gas molecules hits gas particles and galaxies interact gravitational with galaxies

Similarly Dark matter particles are decoupled but they

And now assume isothermal for both gas and galaxies separately ~~separately~~ — very roughly true

∴ σ_r independent of r

$$\sigma_r^2 \frac{\bcancel{r}}{n} \frac{dn}{dr} = -\frac{GM}{r}$$

$$\sigma^2 \frac{d\ln(n)}{d\ln r} = -\frac{GM}{r}$$

$$\sigma^2 = \frac{kT}{\mu m_p} \text{ for gas} \qquad \sigma_{los}^2 \text{ for galaxies}$$

proton mass — universe made of proton not Daltons $= \text{AMU} = \frac{1}{12} M_{C\text{-}12}$

MB distribution

μ is mean atomic weight

$$\sigma^2 = \frac{kT}{m_p} \sum \frac{X_i}{A_i}$$

$$\frac{1}{\mu} = \sum \frac{X_i}{A_i}$$

$$\frac{kT}{\mu m_p} \frac{d\ln n}{d\ln r} = -\frac{GM}{r} = \sigma_{gal}^2 \frac{d\ln n_g}{d\ln r}$$

but for gas particle ~~with Maxwell~~ Boltzmann distribution

605

$$\frac{d\left(\frac{\cancel{\sum_i X_i} \, kT}{m_i}\right)}{dr} = -\frac{GM(r)}{r^2} \sum_i m_i N_i$$

$$\frac{d\left(\frac{kT}{\ }\right)}{dr} = -\frac{GM(r)}{r^2} \sum_i m_i n$$

~~Omit~~ correct but pointless $\frac{kT}{\mu m_p}\frac{dn}{dr} = -\frac{GM(r)}{r^2}\left(\frac{\rho}{\mu m_p}\right)$ and $\frac{\rho}{\mu m_p} = \sum_i \frac{X_i \rho}{A_i m_p} =$

$\sum_i f_i = 1$

leave explicit

Let $f_i = \frac{n_i}{n}$ ← total particle density

number fraction

and f_i assumed ~~constant with radius~~

~~T too since we assume that the~~ system is Boltzmann

$$\sum_i f_i \, kT \frac{dn}{dr} = -\frac{GM(r)}{r^2} n \sum_i f_i m_i$$

$$\left(\frac{\sum_i f_i kT}{\sum_i f_i m_i}\right) \times \frac{dn}{dr} = -\frac{GM(r)}{r^2} n$$

Now $f_i = \frac{n_i}{n} = \left(\frac{X_i \rho}{m_i}\right)/n$ where X_i is mass fraction

$\frac{1}{\sum_i f_i m_i} = \frac{\rho}{n}\sum_i \frac{X_i}{m_i}$

so $n = \frac{\rho}{\mu m_p}$ as maybe I should've known.

$$\therefore \frac{\sum_i f_i}{\sum_i f_i m_i} = \frac{\sum_i X_i/m_i}{\sum_i X_i} = \frac{\sum_i X_i/m_i}{1} = \sum_i X_i/m_i$$

$$= \sum_i \frac{X_i}{A_i m_p}$$

The math uses proton mass as ~~the~~ standard mass since the universe is made of protons not daltons = AMU = $\frac{1}{12} m_C$

mean ~~atomic weight~~ mass $= \frac{1}{\mu m_p}$

60 $\cancel{5}$4)

$\therefore \frac{kT}{\mu m_p}\frac{dn}{dr} = -\frac{GM}{r^2}n$ from p 60 5 1.

But unlike the earlier occasion where we used mean atomic mass, it now include free electrons since our gas is nearly entirely ionized and free electrons contribute to the pressure of an ideal gas as much any other particle, but for low mass.

$A_p = 1$

So $\mu^{-1} = \sum_i \frac{X_i}{A_i} \Rightarrow$

$A_e = \frac{m_e}{m_p}$

example pure ionized Hydrogen

$X_p = \frac{m_p}{m_p + m_e}$

$X_e = \frac{m_e}{m_p + m_e}$

$= \frac{m_p}{m_p + m_e} + \frac{m_e}{m_p + m_e} \Big/ \frac{m_e}{m_p}$

$= \frac{2 m_p}{m_p + m_e} \simeq 2$

$\mu = \frac{1}{2}$ which is consistent

$\mu = \frac{\rho}{n\, m_p}$

$\simeq \frac{m_p \cdot n_p}{m_p + m_e} \frac{1}{m_p}$

$= \frac{1}{2}$

d) Hydrostatic Equilibrium for galaxies and dark matter

galaxies
$$\frac{d\, n_{gal}\sigma_{los}^2}{dr} = -\frac{GM(r)}{r^2} n_{gal}$$

~~and~~ d

$P_{gal} = \frac{2}{3}\frac{1}{2} m_{gal} \int_0^\infty v^2 n(v)\, dv$ assuming all galaxies the same mass

$= m_{gal} \frac{1}{3} \sigma_{gal\text{-}3}^2$

$= m_{gal} \sigma_{los}^2$ and $P_g = n_{gal} m_g$

and we assume σ_{los}^2 as a simplifying approximation

dark matter
$$\frac{d\left(n_{DM}\frac{1}{3}\sigma_{DM\text{-}3}^2\right)}{dr} = -\frac{GM(r)}{r^2} n_{DM}$$

e) Combining Hydrostatic eqns

We assume ~~galaxies~~ gas, galaxies and dark matter are all decoupled in a pressure sense — their mutual interactions are only through bulk gravity which spherically symmetric

assume centre for galaxies

$\therefore \frac{kT}{\mu m_p}\frac{r}{n}\frac{dn}{dr} = -\frac{GM(r)}{r} = \sigma_{los}^2 \frac{r}{n_{gal}}\frac{dn_{gal}}{dr} = \frac{r}{n_{DM}}\frac{d\left(n_{DM}\frac{1}{3}\sigma_{DM\text{-}3}^2\right)}{dr}$

We assume σ_{los}^2 for galaxies can be approximated as a constant

But we are less interested in dark matter

6056

$$\frac{kT}{\mu m_p} \frac{d\ln n}{d\ln r} = \sigma_{los}^2 \frac{d\ln n_{gal}}{d\ln r}$$

$$\frac{d\ln n}{d\ln r} = \beta \frac{d\ln n_{gal}}{d\ln r}$$

$$d\ln n = \beta\, d\ln n_{gal}$$

$$n \propto n_{gal}^{\beta}$$

where $\beta = \frac{\cancel{\mu} m_p \sigma_{los}^2}{\cancel{\mu m_p}\, kT}$ is the β parameter of the β model and not the speed parameter β of ~~sp~~ relativity $= \frac{v}{c}$ (Not at work but [illegible] confusion)

$$= \frac{\sigma_{los}^2}{}$$

ratio of "galaxy temperature" ~~t~~ to gas temperature

6057

~~$\frac{kT}{\mu m_p \sigma^2} \frac{d\ln n}{d\ln r} = \frac{d\ln \rho_g}{}$~~

~~β is not N and not the anisotropy parameter of~~

~~$\frac{d\ln n}{d\ln \rho_g}$ β $\ln n = \beta \ln n_g$ $n \propto n_g^{\beta}$~~

~~$\frac{\mu m_p \sigma^2}{kT}$ ratio of galaxy temperature to gas temperature~~

d) Now if we assume King Profile which is not so good really but again is a reference profile

we have

$$n_{gal} = \frac{n_{gal}}{\left[1 + \left(\frac{r}{r_c}\right)^2\right]^{3/2}}$$

but Ci-179, 182 gives no standard range for r_c

$$\therefore \; n = \frac{n_0}{\left[1 + \left(\frac{r}{r_c}\right)^2\right]^{(3/2)\beta}}$$

~~And~~ then can be used to find $I_x(R)$ the surface brightness in X-ray

King 1972 for coma cluster $r_c = 0.13$ Mpc

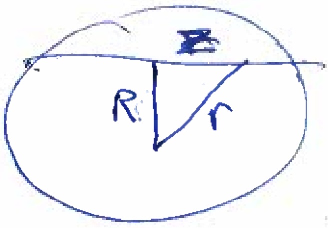
(I. King 1962 was thinking of globular clusters and elliptical galaxies not galaxy clusters)

$r_c \in [.07, .4]$ ~~Mpc~~

Cirimele 1996 & 1997 (in ApJ)

6058

$$I_x(R) = 2\int_R^{\infty} \frac{j_x(r)\, r\, dr}{\sqrt{r^2 - R^2}} \quad (Ci-142)$$



$$j_x \propto n_e n_{ion} \,(Ci-142)$$
$$\underset{\sim}{\propto} n^2$$

$$I_x(R) \propto 2\int_R^{\infty} \frac{1}{\sqrt{r^2 - R^2}} \frac{n_0^2\, r}{\left[1 + \left(\frac{r}{r_c}\right)^2\right]^{3B}}\, dr$$

Doesn't look analytically ~~doable~~ tractable to me

$$\propto 2 r_c n_0^2 \int_{R/r_c}^{\infty} \frac{1}{\sqrt{x^2 - \left(\frac{R}{r_c}\right)^2}} \frac{x\, dx}{(1 + x^2)^{3B}}$$

$$2 r_c n_0^2 \int_0^{\infty} \frac{dx}{(1+x^2)^{3B}}$$ still ~~not~~ tractable $R = 0$

Just an order of magnitude approximation some right behavior.

My guess is they ansatz $= \phi$

$$\sqrt{x^2 - \left(\frac{R}{r_c}\right)} \simeq \sqrt{x^2 + 1}$$ or somehow an $O(1)$ approximation

Seems pretty bad to me.

16059

$$\Sigma_X(R) \propto 2 r_c n_0^2 \int_{R/r_c}^{\infty} \frac{x \, dx}{(1+x^2)^{3\beta+\frac{1}{2}}}$$

$$= 2 r_c n_0^2 \left[\frac{(1+x^2)^{-3\beta+\frac{1}{2}}}{-3\beta+\frac{1}{2}} \right]_{R/r_c}^{\infty}$$

$$= 2 r_c n_0^2 \frac{\left(1+\left(\frac{R}{r_c}\right)^2\right)^{-3\beta+\frac{1}{2}}}{3\beta-\frac{1}{2}}$$

which is valid if $3\beta - \frac{1}{2} > 0$

$$\beta > \frac{1}{6}$$

and $\beta \in [\frac{1}{2}, 1]$

and $\beta = 2/3$ is the reference value (Ci-18)

For $\beta = 2/3$

$\cancel{\Sigma_X(R/r_c \gg 1) \propto \left(\frac{R}{r_c}\right)^{-\frac{1}{2}(2+\frac{1}{2})} =}$

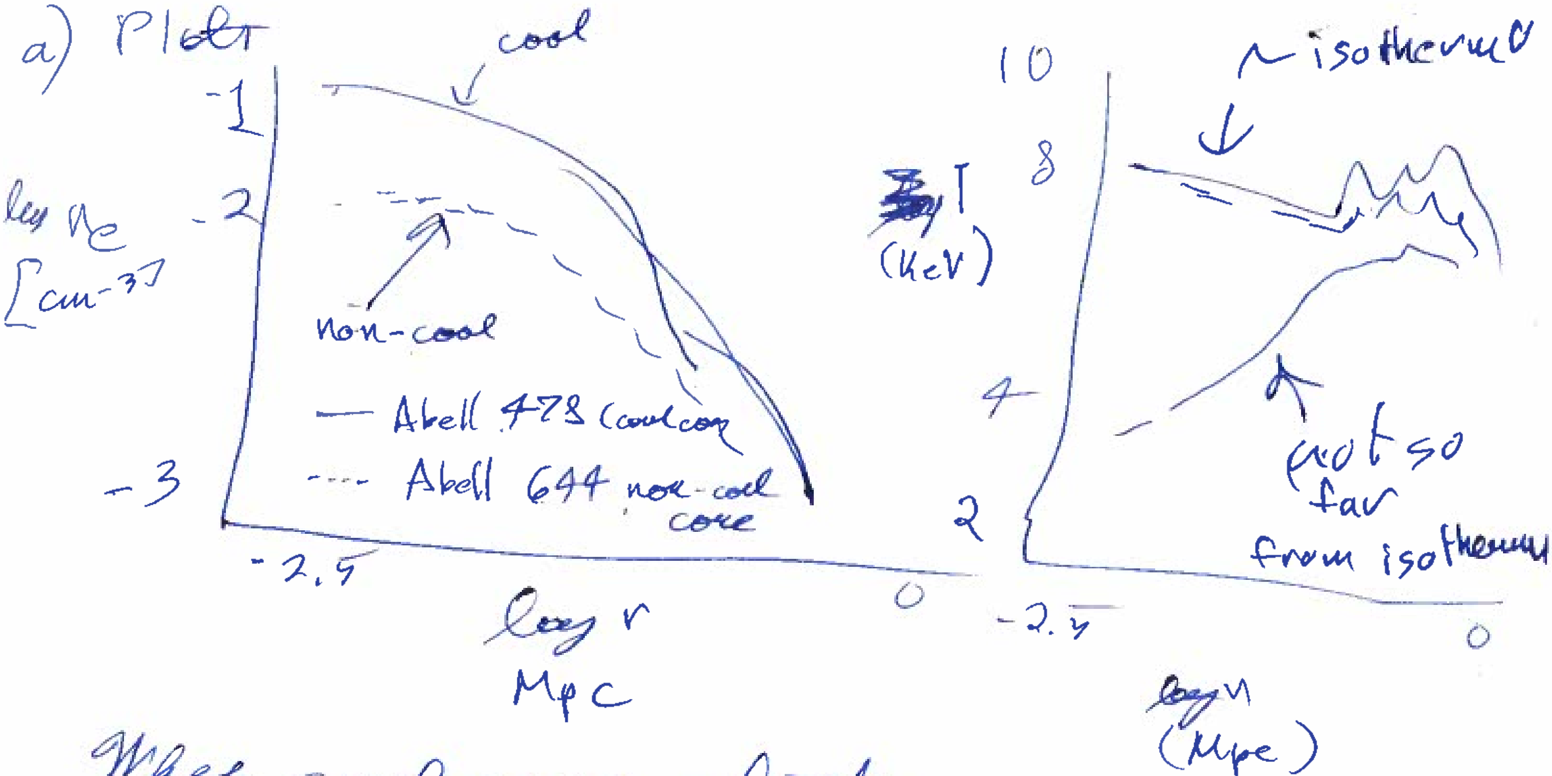
$n(r \gg r_c) \propto r^{-2}$ and $n_{gal} \propto \left(\frac{r}{\ }\right)^{-3}$

and ~~so~~ the gas distribution is more extended than galaxy distribution

6060) But the β-model is only a reference model
— a standard of comparison for more realistic models which deviate from it a lot in general (Ci-182)

11) Cool-Cores & Non-Cool Core Clusters Ci-182

a) Plot



Where cool core clusters higher density $j_X \propto n_e n_i \propto n_e^2$ Ci-194 for ff emission

$\therefore$ $t_{cool} \propto \frac{E_{gas}}{j_X} \propto \frac{1}{n_e^2}$ estimate of time to go to zero T (Ci-228)

6061

for cool cores

$t_{coo} < t_{\text{age of universe}} = 13,8$ Gyr

$\sim 10^{10}$ yr

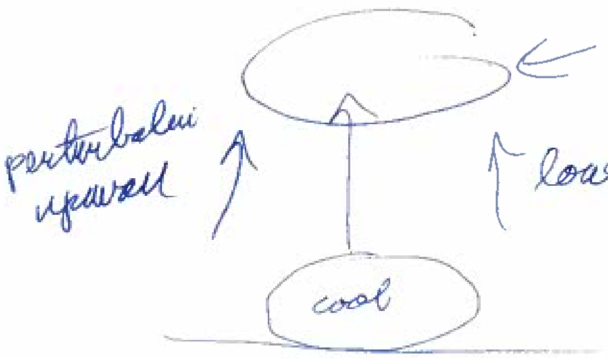
cooling radius

~~for clusters~~

Cool core clusters are convectively stable

somewhat obviously?

Plausibility argument without understanding



← but ~~abadiabatic cooling~~ ~~makes it denser~~ ~~support it~~ it tries ~~to expand~~ – no runaway ~~and so sink~~ ~~expansion and lowering of density~~

lower density surrounding gas but hotter and so pressure can contract it and make it denser and it sinks

~ abadiabatic heating not enough to counteract.

6062

But why non-cool core cluster

recent cluster merger on tem scale of $\gtrsim 1$ Gyr I guess

- merger has ~~randomized~~ Alter relaxed condition of pre-merger clusters

Table of Relative ~~Average~~ Typical Behaviors Ci-184

Cool Core	non-Cool core
- outward increasing profil	flattish temperature profile
- higher central density	lower central density
- regular → i.e. spherically symmetric	irregular → less spherically symmetric
- has BCG	- tends not too but Virgo Cluster is irregular Ci-176 but M87 is supergiant elliptical cwith near center a BCG.
little substructure No diffuse radio halo central radio galaxy	substructure diffuse radio halo no central radio galaxies but ~~[illegible]~~ M87 has radio lobes and so is a radio galaxy

606

12) Cluster Virial Mass

King Profile for Galaxy number density}

Mass Density Profile (Dark matter mainly)

& Scaling relations

a) $M_{vir} \cong 10^{14} - 10^{15} \, M_\odot$ (Ci-165) from velocities & G

Probably M_{200} (i.e. M_{vir} for $\Delta_c = 200$)

galaxies of clusters

r_{vir} ~ 200 Mpc

for large galaxy $M_{vir} \sim 10^{12} M_\odot$

$r_{turnaround}$ ~ 1 Mpc

r_{vir} the radius ~~out~~ ~~to~~ which ~~the~~ interior has been virialized

In spherical collapse model Ci-200-20

r_{vir} is set by an overdensity ratio to ρ_{crit}

$\rho = \Delta_c \rho_{crit,0}$

defines the ~~r_{vir}~~

Fiducial value but better to ...

$$\Delta_c = \frac{\rho}{\rho_{crit,0}} = 200$$

Ci-203

For $\Delta_c = 200$

$r_{vir} = r_{200}$

Spherical collapse model of dark matter halos Ci-201

Ci-19

$$\rho_{crit,0} = \frac{3H^2}{8\pi G} \simeq 1.9 \times 10^{-29} \ldots$$

$$h = \frac{H_0}{100} = \frac{H_0}{70}\,\frac{70}{100} = h_{70}\,(.7)$$

$$h^2 = h_{70}^2\,(.5)$$

$$\rho_{crit,0} = 10^{-29}\, h_{70}^2 \;\mathrm{g/cm^3}$$

$\approx$ 6 proton/m^3

ISM fiducial

≈ 1 ~~atom~~/cm^3

$= \frac{1}{cm^3}\left(\frac{10^2 cm}{1m}\right)^3$

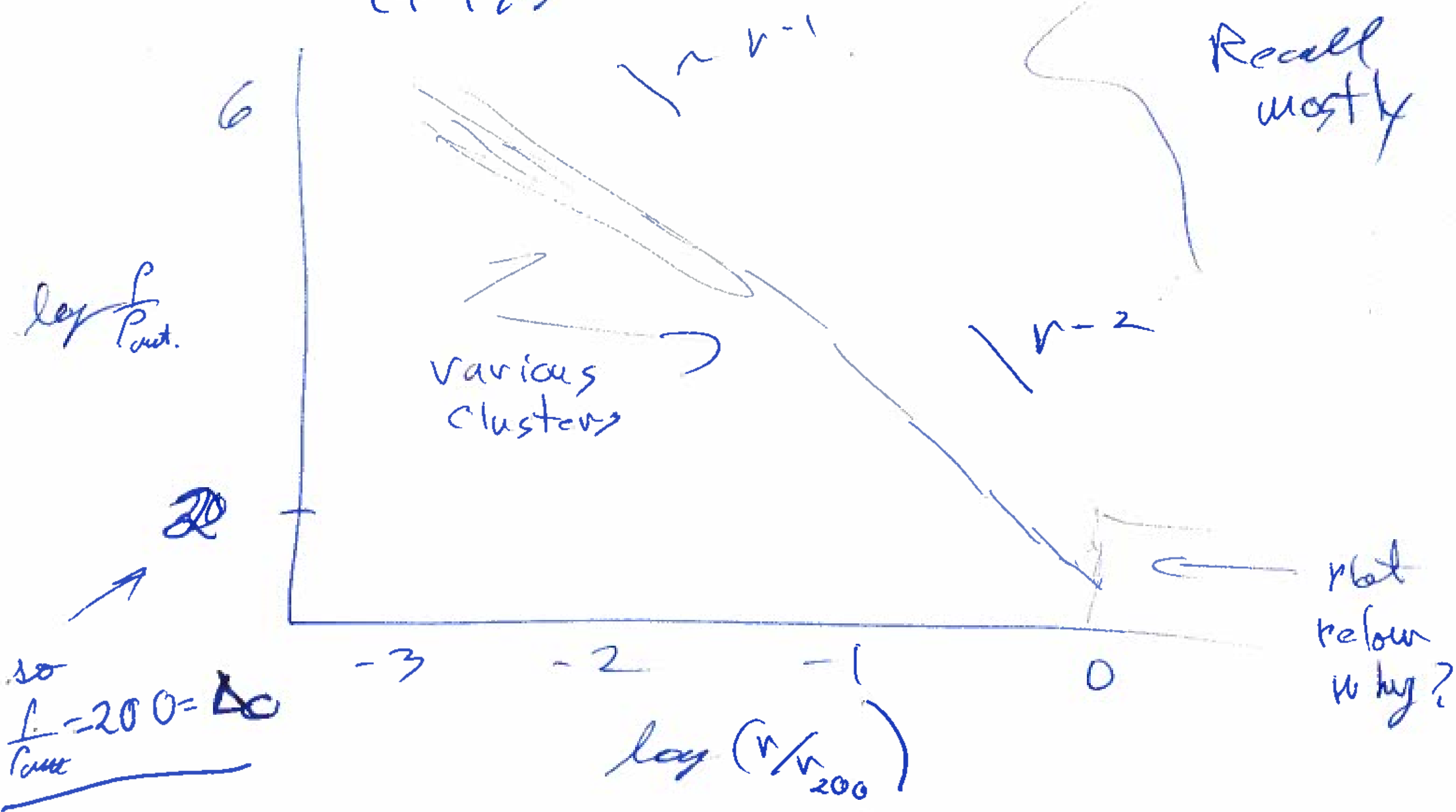
$= 10^6 \frac{atom}{m^3}$

6064 b) Somehow density is measured (Ci-184-186)

84 – 90 % dark matter

$\underbrace{84}_{\text{biggest clusters}}$ $\underbrace{90}_{\text{smallest}}$

Ci-174
Ci-175



so $\frac{\rho}{\rho_{crit}} = 200 = \Delta_c$

The profile is NFW-like,
– No surprise: ~~but~~ ~~not~~ N-body simulation $(10^{-6} M_\odot < M_{halo} < 10^{15}$
J. Wang 2020

gave NFW profile fits

$(0 \to 30) \times r_s$

~~mostly~~ within 10%, but systematic deviations suggest some improvement possible

6065

$$\rho_{NFW} = \begin{cases} \dfrac{4\rho_s}{x + 2x^2 + x^3} \\ x = r/r_s & \left\{ \begin{array}{l} r_s \text{ is scale radius} \\ \rho_s \text{ is scale density} \end{array} \right. \\ \dfrac{4\rho_s}{x} & x < 1 \\ \rho_s & x = 1 \\ \dfrac{4\rho_s}{x^3} & x >> 1 \end{cases}$$

logarithmic slope $\dfrac{d\ln\rho}{d\ln r} = \dfrac{d\ln\rho}{d\ln x} = \dfrac{x}{\rho}\dfrac{d\rho}{dx} = \dfrac{x}{\rho}\left[\dfrac{-4\rho_s(1+4x+3x^2)}{(\quad)^2}\right]$

$$= -x\frac{(1+4x+3x^2)}{(x+2x^2+x^3)} = -\frac{(1+4x+3x^2)}{(1+2x+x^2)}$$

$$= -\frac{8}{4} = -2$$

6066) c) $M_{vir} \propto T^{3/2}$ average temperature

Scaling relation

$L_x \propto T^3$ measure by exponential cutoff of free emission

useful for estimating M_{vir} and L_x

$C_i - 524$
$C_r - 142$

~~B) Influence of Environment on Galaxy properties~~

B) Large scale structure (LSS) cosmic web

Above groups and clusters of galaxies are superclusters, filaments, sheets, walls + Voids (size scale 10–100 Mpc)

$C_i - 186$ etc.

doesn't use this term superclusters unbounded & irregular, defining edge is eye-of-beholder

galaxies not in clusters groups clusters of voids field galaxies

size scale 50–100 Mpc and larger upto ~1 Gpc (?)

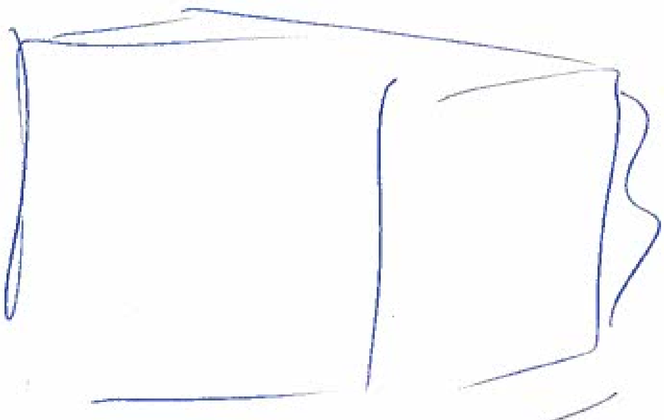
Wik

Supervoid R = 220 (50) Mpc

0.4 Gpc maybe

6067

Particular large-scale structure realized ~~in nature~~
in the observable universe
is now called cosmic web



Cosmic Present

400 Mpc (Wik)

- cubes of this size seem to have same propert[ies]

- size scale of cosmological principle

→ Observable universe homogeneous and isotropic on large enough scale

but there are some structures ~~claim the~~ larger $\gtrsim 1$ Gpc?

- are ~~there~~ just fluctuations

or is the cosmological principle failing

E.A. Milne introduced name cosmological principle in 1930s

It seems every month or so there are at least two papers coming to the opposite conclusion on the issue

Einstein introduced idea in mathematical cosmology for universe of stars
— he had little idea of the scale size

6068) Obviously if the cosmological principle is failing, it is doing so very inconspicuously

— strong evidence for it is the CMB

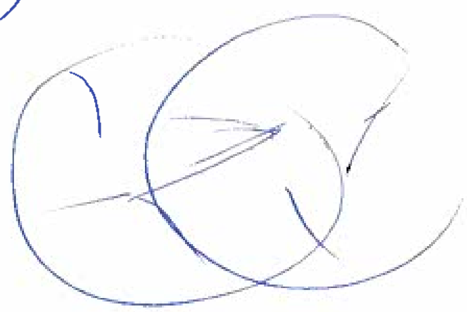
↳ departures are tiny

$$\frac{\Delta I_{sp}}{I} \simeq 10^{-5}$$ (W.V. CMB features)

Also Baryonic accoustic Oscillations (BAOs)

Comoving $a_0 = 1$ at cosmic present

$r = 490$ Mly $\simeq 150$ Mpc



The cosmological principle doesn't have to hold.

— hierachical universe consider before 1960s

↳ structures on larger scales forever

↳ No end of greatness

↳ perhaps fractal → same on all scales after a point.

6069

14) Influence of Environment on Galaxies

Denser the galaxy environment ~~the~~ larger the ratio of ETGs/(SFGs+ETGs)

Morphology CSFR Density Relation - a lot quantitative

R = 10 - 20 in voids

R = 80 - 90 in densest cluster or nodes of filaments.

galaxies in voids are called void galaxies

- interesting because ~~they~~ perhaps evolved mostly in isolation since earlier universe

Do NOT seem odd in obvious features

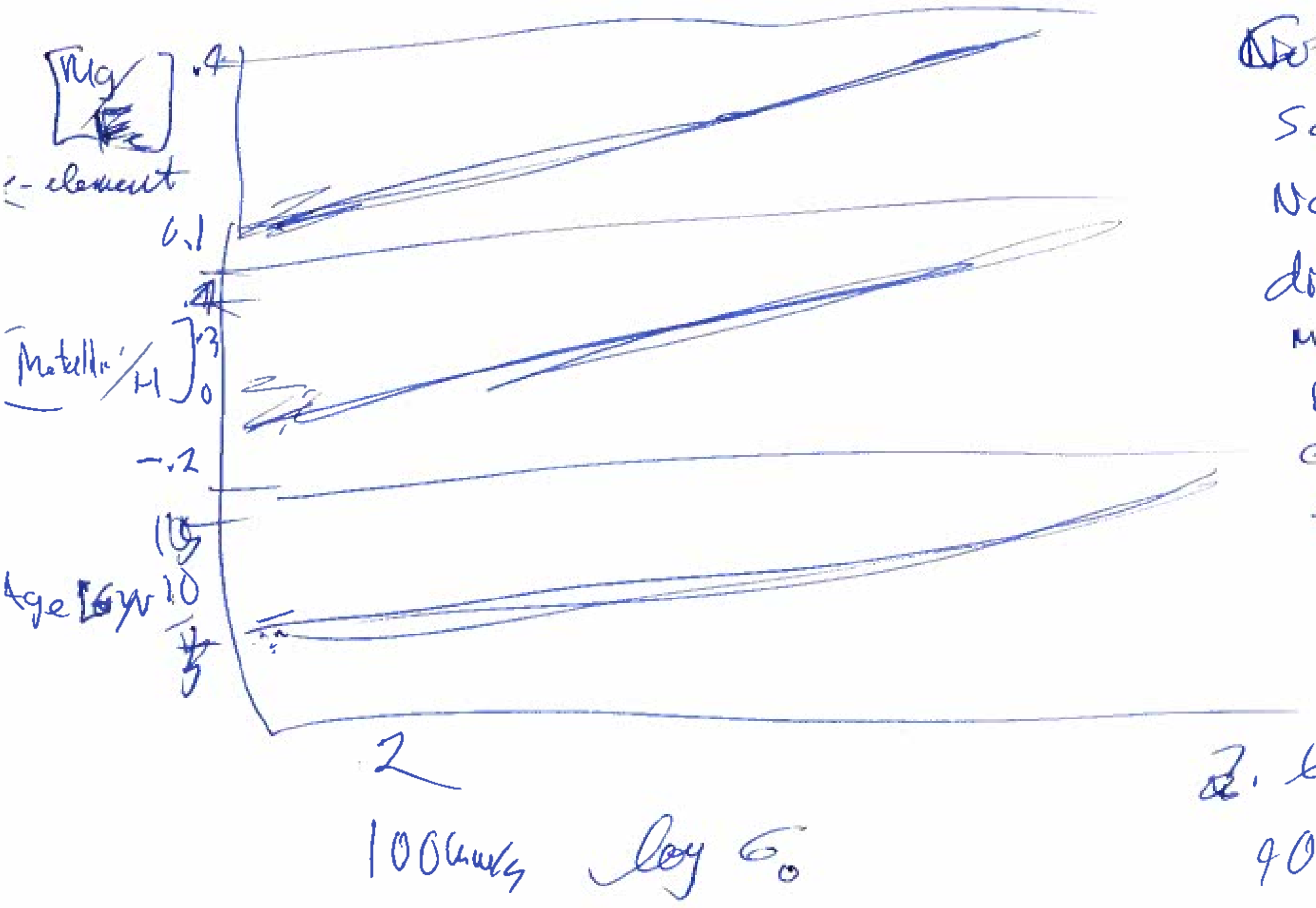
Typically Somewhat smallish SFGs with disks, spiral arms not much different galaxies in moderate density environments

$\boxed{6070}$

Other ~~than~~ morphology ~~Does~~ +SF does environment have an effect?

— Seems subdominant Ci-188

~~Particular~~ For Example Scaling relations for ETGs Ci-139 with (star) central despersion σ_0



Ci-188 says Not much difference made by environment effects

So stellar mass and dynamical mass more important than environments for some things

But environment can still have a subtle influence.

15) Large-Scale Structure (LSS) & Galaxy Clustering

6071

~~d~~istance r between galaxies

$\sim$ 1 Mpc (fiducial value not highly accurate)

and galaxy size

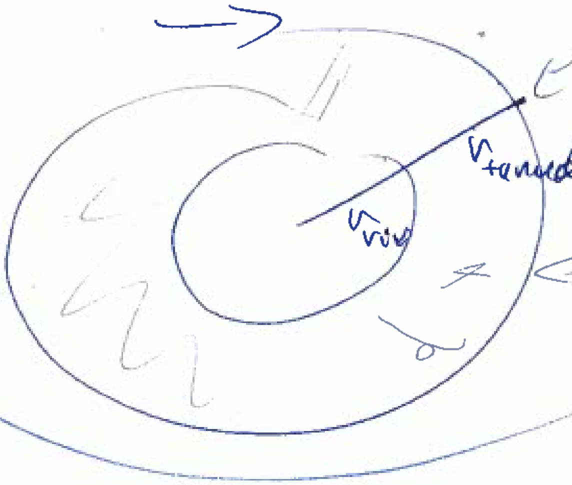
— well disk diameter $\sim$ 30 kpc for Milky Way ~~and~~ roughly that order for most spirals.

$$- \; r_{200} \simeq 206.3 \left(\frac{M_{200}}{10^{12} M_\odot}\right)^{1/3} \left(\frac{H}{H_{70}}\right)^{-2/3} \text{ kpc} \quad \text{Ci-205}$$

virial

$$\frac{\rho}{\rho_{av}} \simeq 200$$ consider a fiducial virialization requirement

$F_{grav} + F_{cos\,const} = 0$



$r_{turnaround} \simeq 1$ Mpc

There is some interest in the dark matter and baryonic matter between r_{virial} and $r_{turnaround}$

Bound loosely but not virialized and little effect on interior by shell theorem re spherically symmetric

6072

LSS can extend
~ 400 Mpc or maybe more.

So one needs large mapping survey

SDSS-III for example

$\sim 10^6$ galaxies $\begin{cases} t_c = 7.5 - 13.5 \text{ Gyr} \\ t_{\text{look back}} = 0.3 - 6.3 \text{ Gyr} \end{cases}$

$z \in [0.2, 0.7]$

Vol Obs. Univ $\frac{4\pi}{3}(14 \text{ Gpc})^3 \approx 10^4 \text{ Gpc}^3$

on 8500 square degrees of sky $\sim (90 \text{ deg})^2$

and volume $\simeq 13 \text{ Gpc}^3 = (2.35 \text{ Gpc})^3$

Qualitatively the cosmic web emerges.

But statistics $\Rightarrow$ quantitative analysis

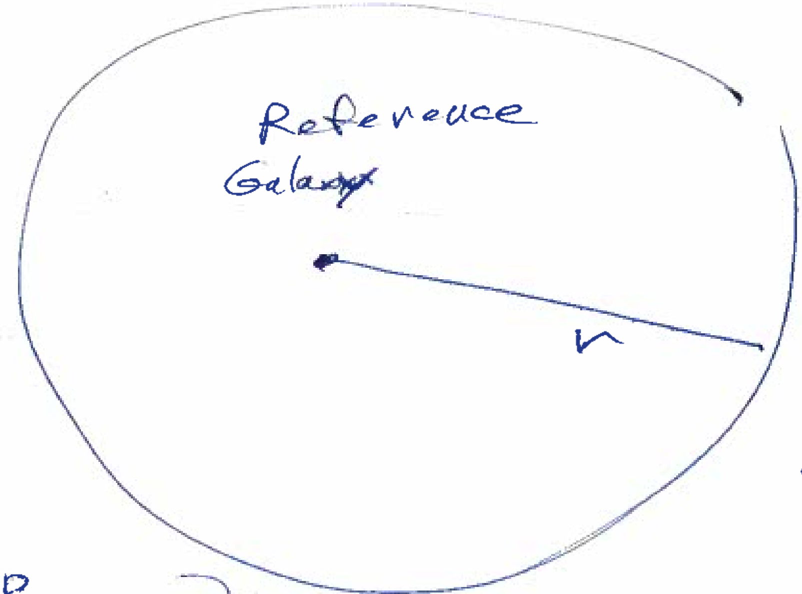
- There are many ways to study clustering or clumping of galaxies.

- We can only glance at a very simple analysis statistic - The 2-point correlation function

CL-188 is just a bit ~~too~~ abbreviated for understanding and

I used CL-340, see also CL-283, CL-344-

6073



2-Point correlation function

$$dN = n[1 + \xi(r)]\,dV$$

Number of galaxies in dV on average

Poisson moments $\langle x^2 \rangle =$

n is the mean number of galaxies per unit volume

$$n = \frac{N}{V}$$

If galaxies were strictly Poissonean — just randomly scattered in space ~~they'd~~ obey the Poisson distribution

Probability of N galaxies in volume V given n

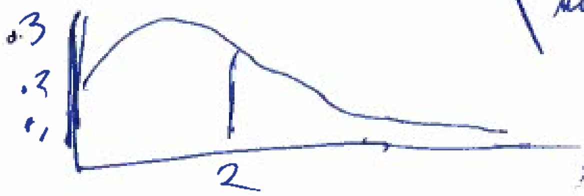
$$P(N) = \frac{\mu^N}{N!} e^{-\mu} \quad \text{where } \mu = nV$$

$\sigma = \sqrt{\mu}$

mean number in volume V

Bev-53

Poisson distribution is a limiting asymmetric Gaussian distribution



for $\mu = 1.67$

$\sigma = 1.29$

Bev -4

6074

However the mean number with a two-point correlation function for galaxies ~~within~~ at radius r from the reference galaxy

$$dM = d\langle N \rangle = n[1 + \xi(r)]dV$$

has an excess and it is ~~negative~~ ~~if $\xi(r) <$~~

positive $\xi > 0$

negative $\xi < 0$

Corresponding probability density not obvious in my textbooks

$$\langle N(r) \rangle = n\left[\frac{4\pi}{3}r^3 + 4\pi\int_0^{r} \xi(r)\, r^2 dr\right]$$

$$= n\, 4\pi r_c^3 \left[\frac{x^3}{3} + \frac{x^{3-\gamma}}{3-\gamma}\right]$$

$$\frac{r_0^{\gamma}\, r^{3-\gamma}}{3-\gamma}\Big|_0^{r} \quad \text{for } r \lesssim 10\,\mathrm{Mpc}$$

$x \lesssim 2$

However for small r $\xi > 0$

0 $x=0$

$\frac{1}{3} + \frac{1}{3-\gamma}$ $x=1$

$\frac{8}{3} + \frac{2^{1.2}}{1.2}$ $\approx 7 + 2$ ~~$\approx 2.6 + 2$~~

as $r \Rightarrow \infty$ this excess goes to zero.

i.e. the galaxies do cluster rather ~~than~~ avoid each other

For $r \lesssim 10\,\mathrm{Mpc}$

$$\xi = \left(\frac{r}{r_s}\right)^{-\gamma} = \left(\frac{r_s}{r}\right)^{\gamma} = x^{-\gamma}$$

$x = r/r_s$

where $r_s = 5\,\mathrm{Mpc}$, $\gamma = 1{,}8$ } Fiducial value

ξ ~~$\lesssim$~~ $[30 \to 50\,\mathrm{Mpc}$ $\xi > 0$

at $\xi > 30 \to 50\,\mathrm{Mpc}$ ξ oscillates arround 0.

at $r \sim 100\,h^{-1} = \frac{100}{.7}\,h_{70}^{-1} = 130\,h_{70}^{-1}\,\mathrm{Mpc}$ 6079

$$h = \frac{H_0}{100} = \frac{H_0}{70}\frac{70}{100} = h_{70}(.7)$$

there is a positive excess again.

the BAO scale

or maybe more like 150 Mpc

BAO scale
DESI has just presented ~~the~~ April ~~their~~ first results
but no where in all the papers, blurbs, videos
can I find any place where ~~they~~ just spit out ~~their~~ value for the BAO scale.

Two-point correlation function is just one statistic.
There are many others and people keep inventing new ones trying to capture ~~more~~ more of features of large scale structure and use ~~to~~ judge the fitness of LSS simulations
TNG, ~~Eagle~~, Simba etc.