Hydrogen Clouds as Direct Evidence of the Dynamics of the Universe

Nearly 100 years since Vesto Slipher first measured redshifts in distant galaxies (1912) and still no real direct evidence that it represents expansion.

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What does represent **Direct Physical** evidence of the dynamics of the universe?

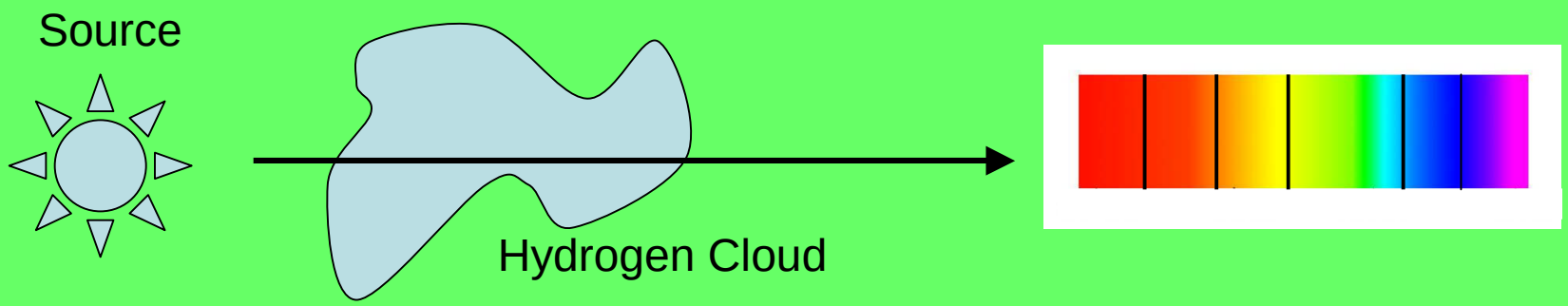
1. The average separation of Hydrogen Clouds?

2. The average separation of galaxies?

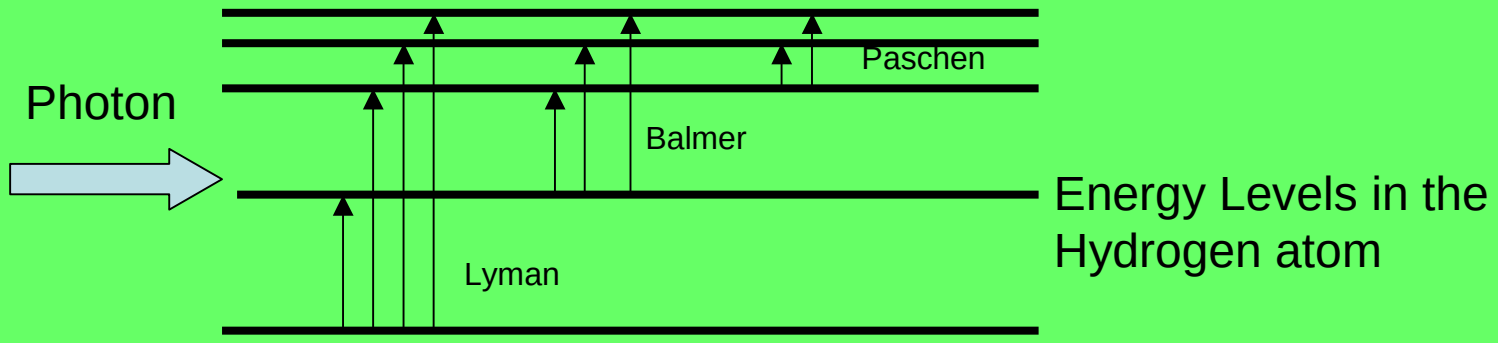
3. The average temperature. Is it increasing, decreasing or staying the same?

Points 1 & 3 can be determined from the Lyman Alpha forest.

When a continuous spectrum of light passes through a Hydrogen cloud, the Hydrogen atoms in that cloud absorb photons of certain frequencies (and hence energies) and thus the spectrum of the emerging light has a pattern of black lines ‘etched’ upon it.



The Lyman Alpha series represents interactions between incoming photons and an electron in the lowest energy level of the Hydrogen atom.



Since these interactions involve the highest energies, the photons are in the Ultra Violet range.

Light from quasars passes through several Hydrogen clouds before arriving here on Earth and each time, these particular frequencies are absorbed.

However, after passing through each Hydrogen cloud, the light is redshifted and so the absorption line moves towards the red end of the spectrum - before the next cloud absorbs those same frequencies.

In this way a whole ‘forest’ of lines is formed

In mainstream cosmology quasars are at huge redshifts indicating that the light from them has been travelling from the ‘beginning’ of the Universe.

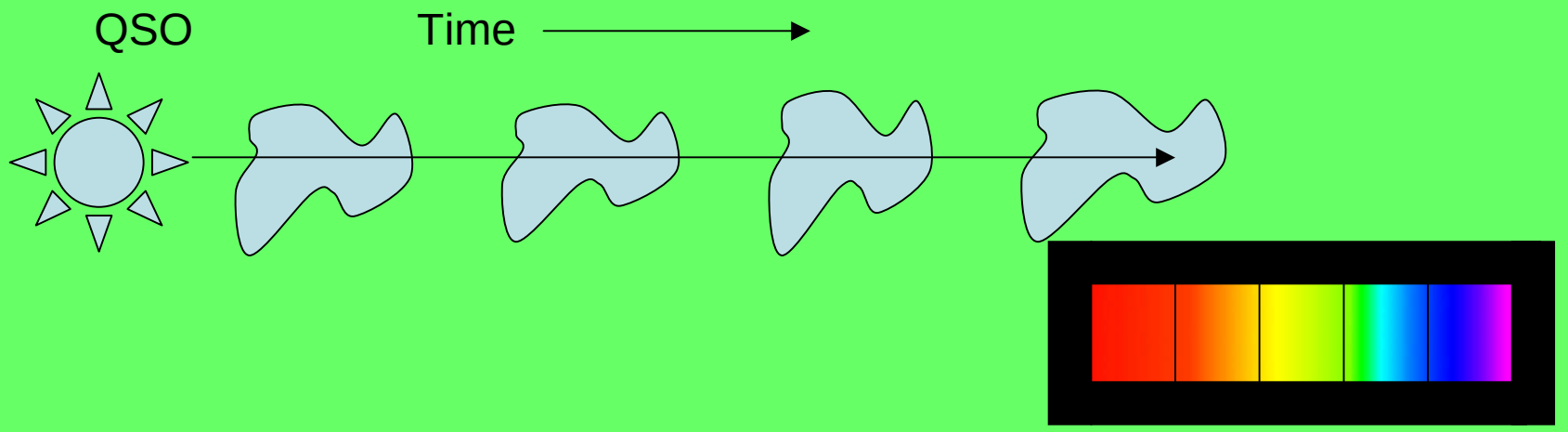
Hydrogen clouds too have been there for the lifespan of the Universe and so the Lyman Alpha forest provides a historical record of the dynamics of the universe.

The cosmological principle tells us that:
basically, on the large scale and at any instant in time,
the universe is the same everywhere!

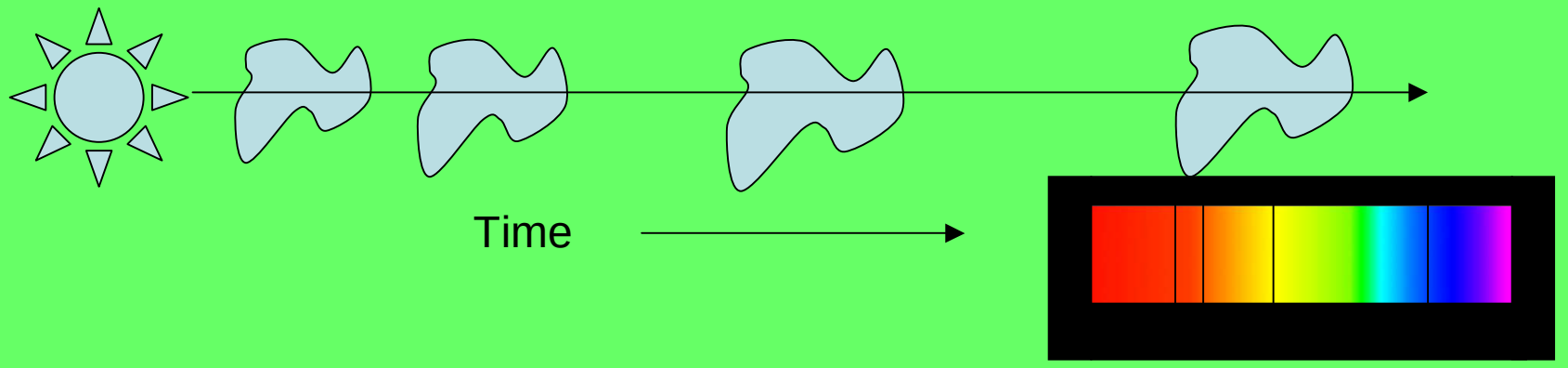
In a static Universe, on average, the Hydrogen clouds should be evenly spaced and thus the Lyman Alpha lines too, on average, must be evenly spaced (in redshift) on the spectra from distant quasars

In an expanding universe, on average, the Hydrogen clouds should become further and further apart as the Universe expands and thus the Lyman Alpha lines too, on average, must become further and further apart (in redshift) on the spectra from distant quasars.

In a static Universe, Hydrogen clouds, galaxies should, on average, be equally spaced and the overall temperature should be constant.



In an expanding Universe, Hydrogen clouds, galaxies should, on average, be getting further and further apart and the overall temperature should be dropping.



Lyman Alpha line counting

Usually, what is found is the number of lines per unit redshift (dN/dz)

Pick a redshift interval (dz) and find how many Lyman Alpha lines (dN) lie within that interval.

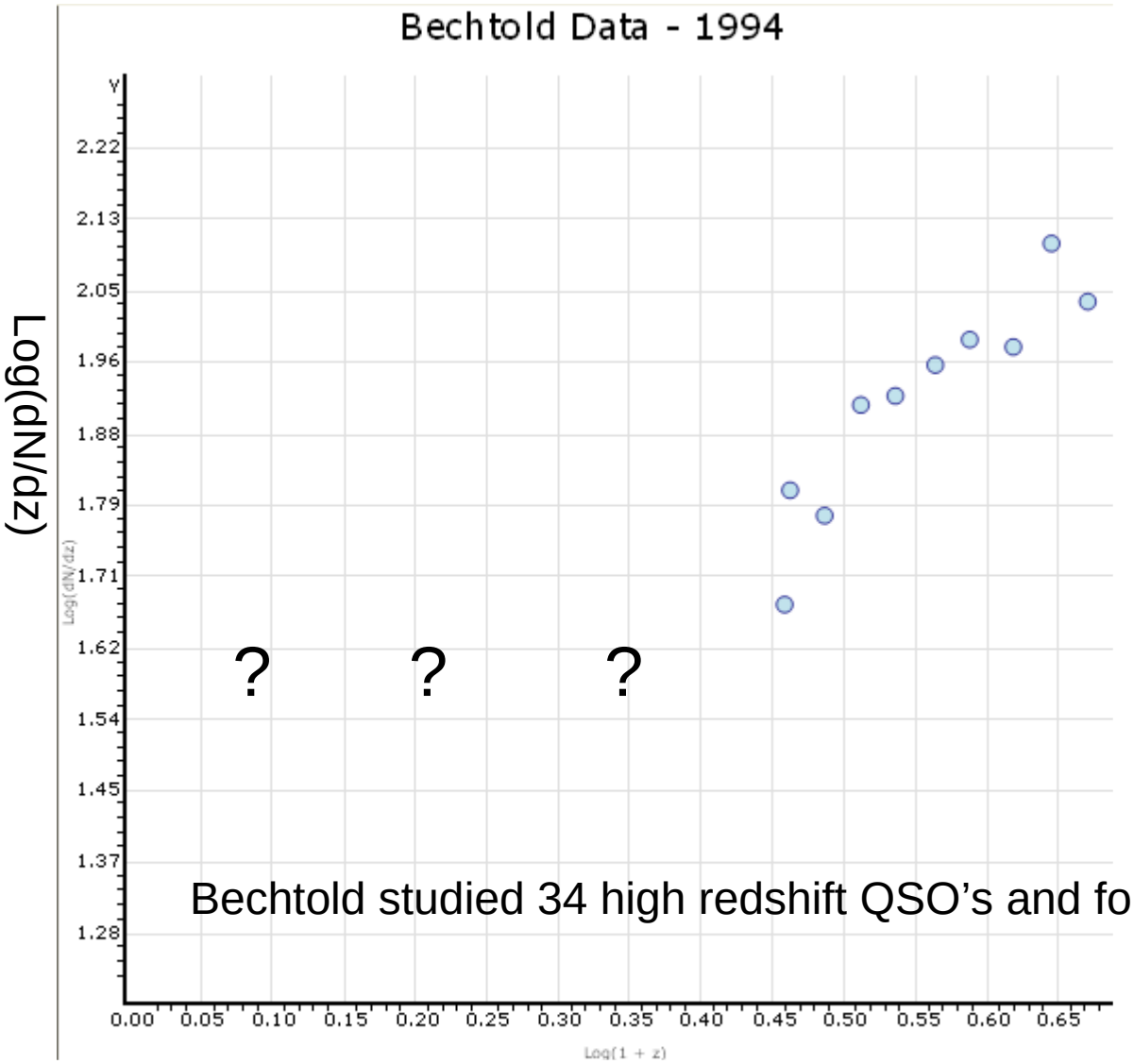
"The number of lines per unit redshift stronger than a fixed rest equivalent width limit is often written as:

$$dN/dz = A_0(1 + z)^{\gamma}$$

$$dN/dz = (dN/dz)_0(1 + z)^{\gamma}$$

QUOTE "For $0 \leq q_0 \leq 0.5$ if $\gamma > 1$ then there is intrinsic evolution in the observed number density of absorbers (i.e. in their space density, cross-section for absorption or both)"

Bechtold,J. 1994. ApJS, 91,1.



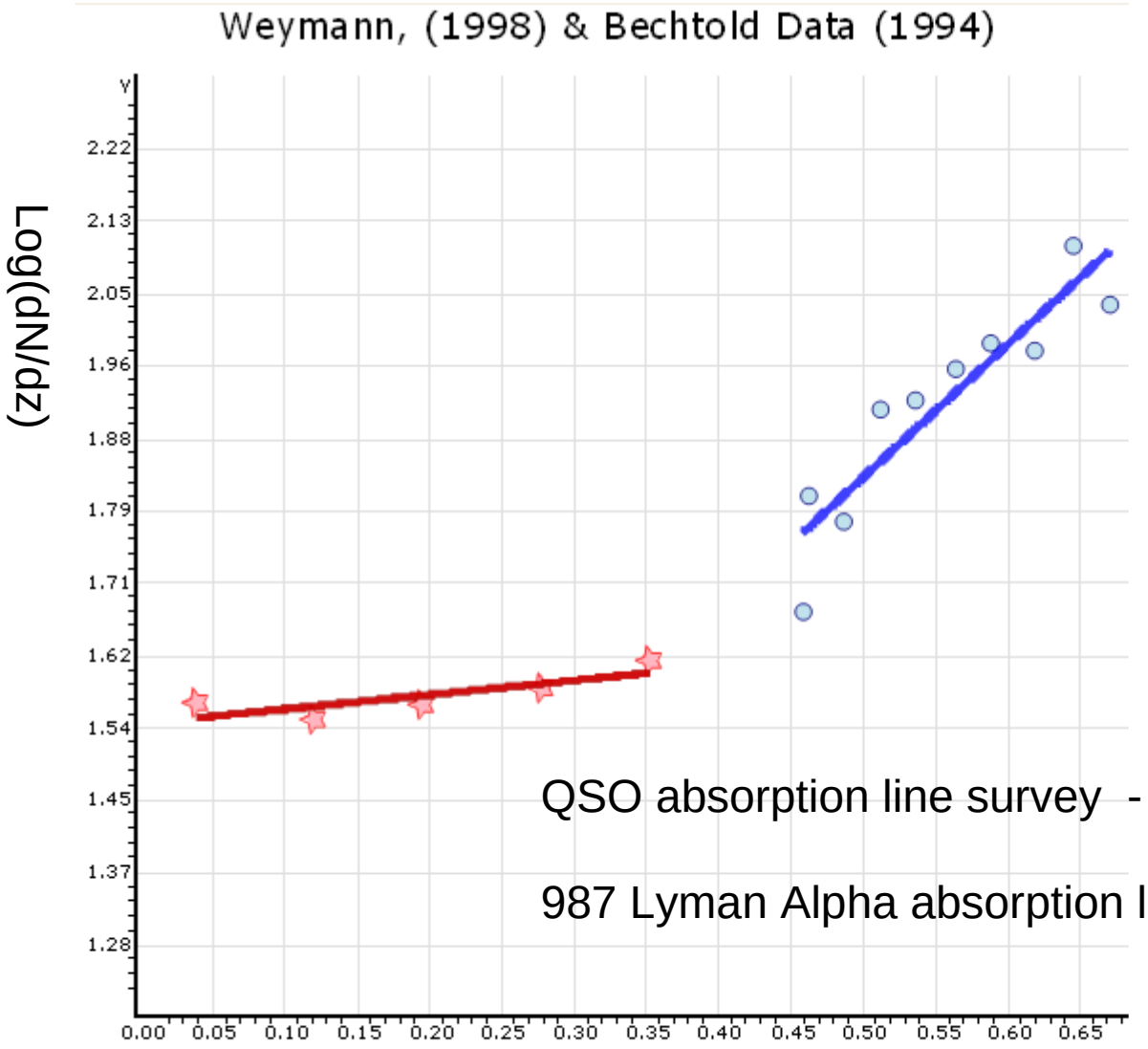
Bechtold studied 34 high redshift QSO's and found γ = 1.89±0.28

Since γ was greater than unity, there ‘must’ be ‘evolution’ in the Hydrogen clouds as they were disappearing faster than expected – i.e., the results did not fit those predicted by an expanding Universe theory.

This ‘evolution’ was said to be caused partly by:

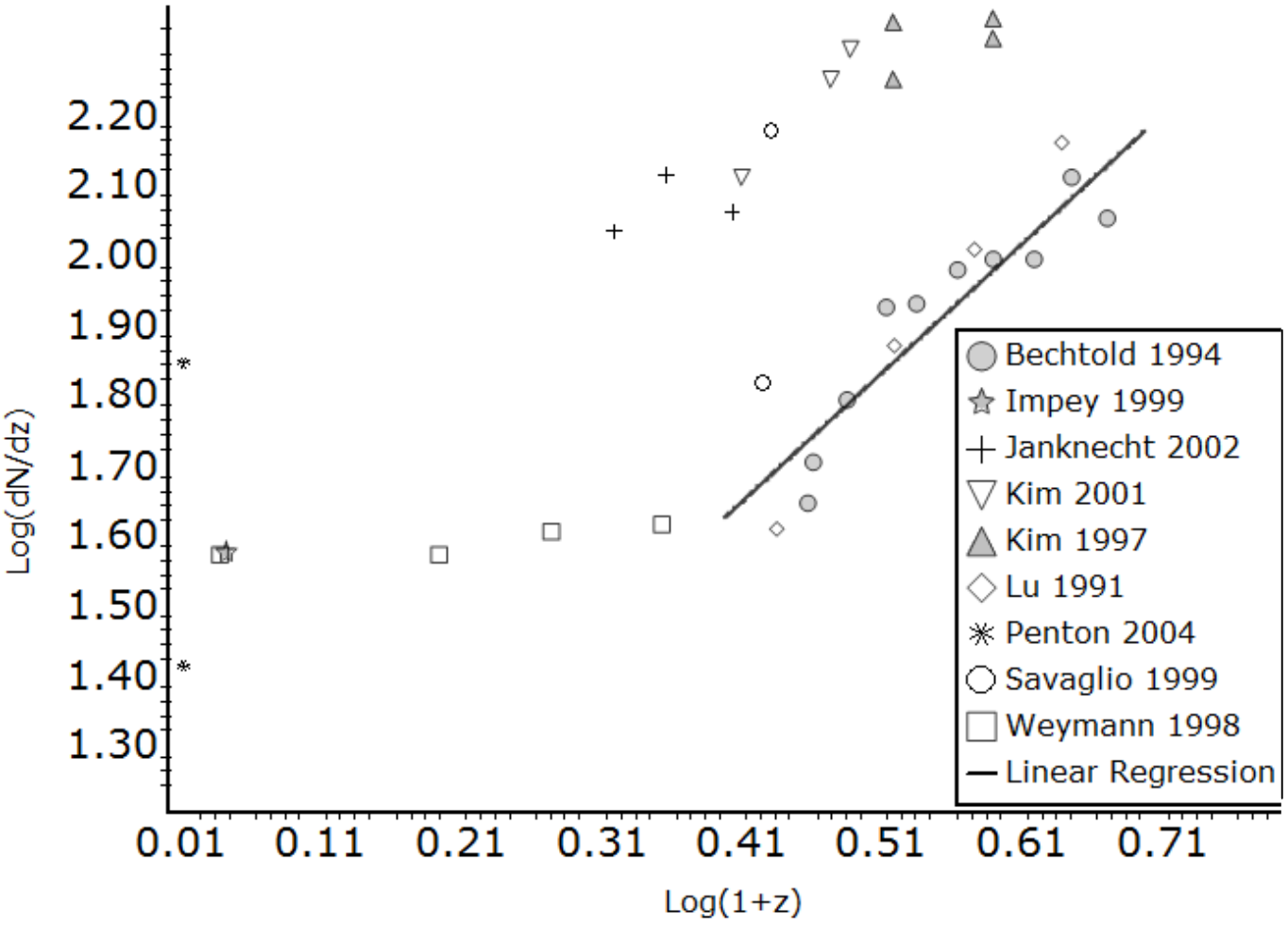
- the expansion of space;
- by Hydrogen clouds ‘thinning out’ due to galaxy formation - so that they dipped under the preset size/density threshold;
- thinning out of the clouds by UV radiation from quasars ionizing the Hydrogen atoms within the clouds;

In the low z region, the Lyman Alpha lines are still in the UV region as they have not been redshifted enough to appear in the visible region and be observable by ground based instruments. For these lines, we had to wait until the Faint Object Spectrograph (FOS) on the Hubble Space Telescope came into operation.



QSO absorption line survey - HST Key Project

987 Lyman Alpha absorption lines. $\gamma = 0.1 - 0.3$


2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
Log(dN/dz)
0.01
0.11
0.21
0.31
0.41
0.51
0.61
0.71
Log(1+z)
Bechtold 1994
Impey 1999
Janknecht 2002
Kim 2001
Kim 1997
Lu 1991
Penton 2004
Savaglio 1999
Weymann 1998
Linear Regression

Recent results.

Lehner et al ApJ658:680-709. 2007. looked at results for the range $z > 0$ and $z \leq 0.4$
Quote: "dN/dz is very similar for either column density range implying no redshift evolution of dN/dz between $z > 0$ and $z \leq 0.4$"

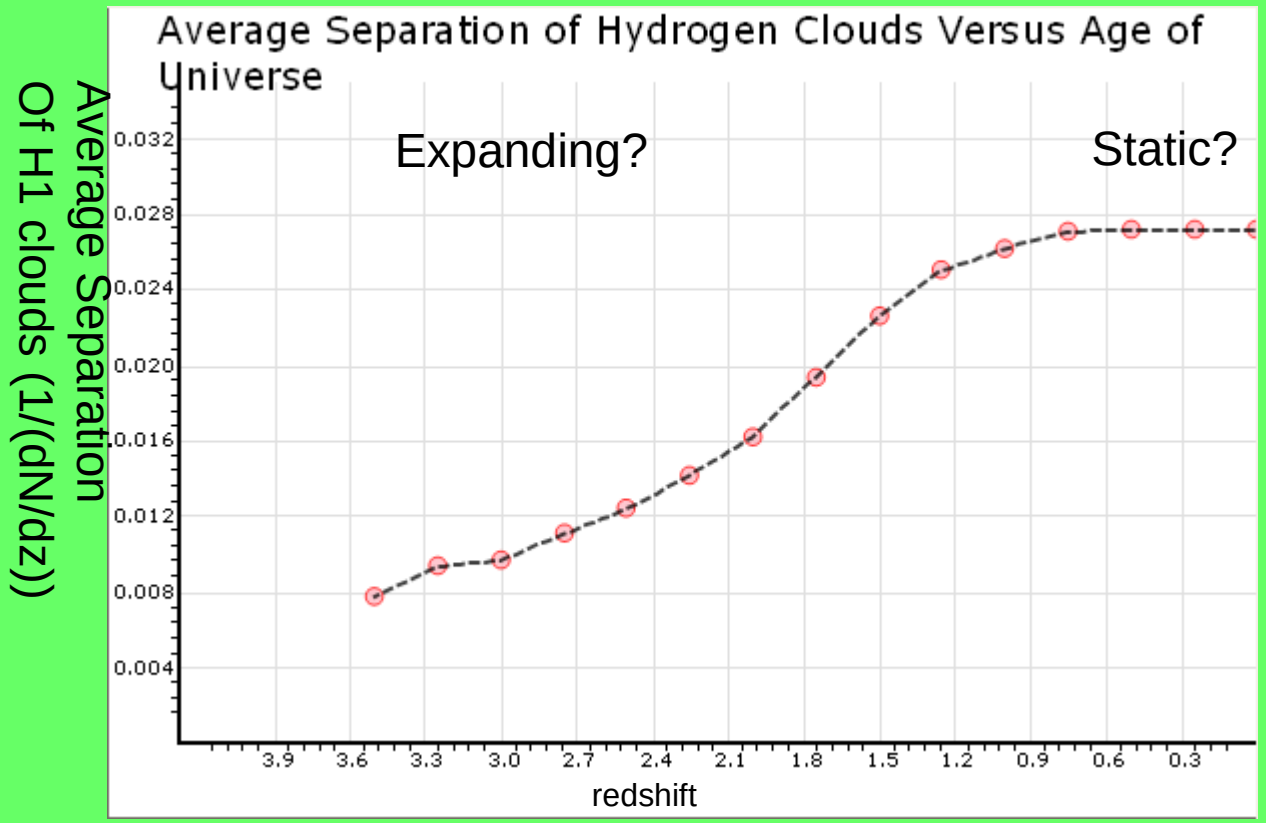
Janknecht,E et al. A & A458, 427-439. 2006 looked at the range $0.5 < z \leq 1.9$
Quote: "A comparison with results at higher redshifts shows that it (dN/dz) is decelerated in the explored redshift range and turns into a flat evolution for $z \rightarrow 0$"

Kirkman et al. MNRAS 376, 1227-1237, 2007. Looked at 74 QSO's in the range $0 < z \leq 1.6$ using the HST FOS.
Quote: "no change in the number of lines per unit redshift "

That is, on average, the Hydrogen clouds are evenly spaced for at least the last billion years or so!

But how can these clouds be, on average, equally spaced, and yet have totally different redshifts? It reminds one of the earlier steady state theories, where the universe expands, new matter forms to fill the voids,
- so that the universe remains, overall, uniform

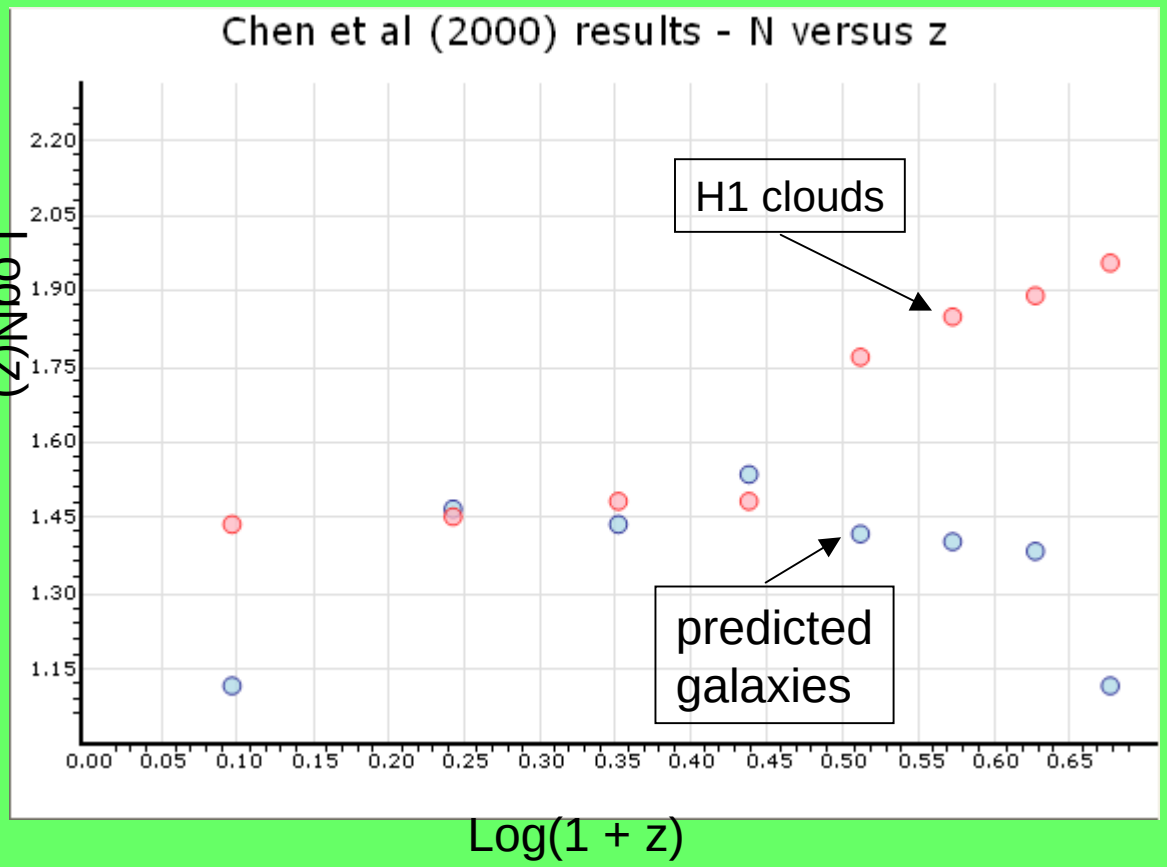
Taking these comments along with the other results we can ‘smooth’ the data and Plot 1/(dN/dz) - the average separation of Hydrogen clouds.



Age of Universe

Average Galaxy Separation.

HDF Galaxy catalogue Published by Fernández-Soto et al 1999, contains Coordinates, photometry and photometric redshifts of 1067 galaxies for 0<z<6. Nearly 120 of these photometric redshifts have been shown to be in good agreement with spectroscopic ones from the Keck telescope.



Chen et al used this data to predict how many galaxies with extended gaseous envelopes there are along any particular line of sight. They concluded that: “known galaxies of known gaseous extent must produce a significant fraction and perhaps all of the Lyα absorption systems over a large redshift range.”

BUT….
This means that not only are H1 clouds evenly spaced then so too are the galaxies – even though they all have totally different redshifts!

The average temperature.

Is it increasing, decreasing or staying the same?

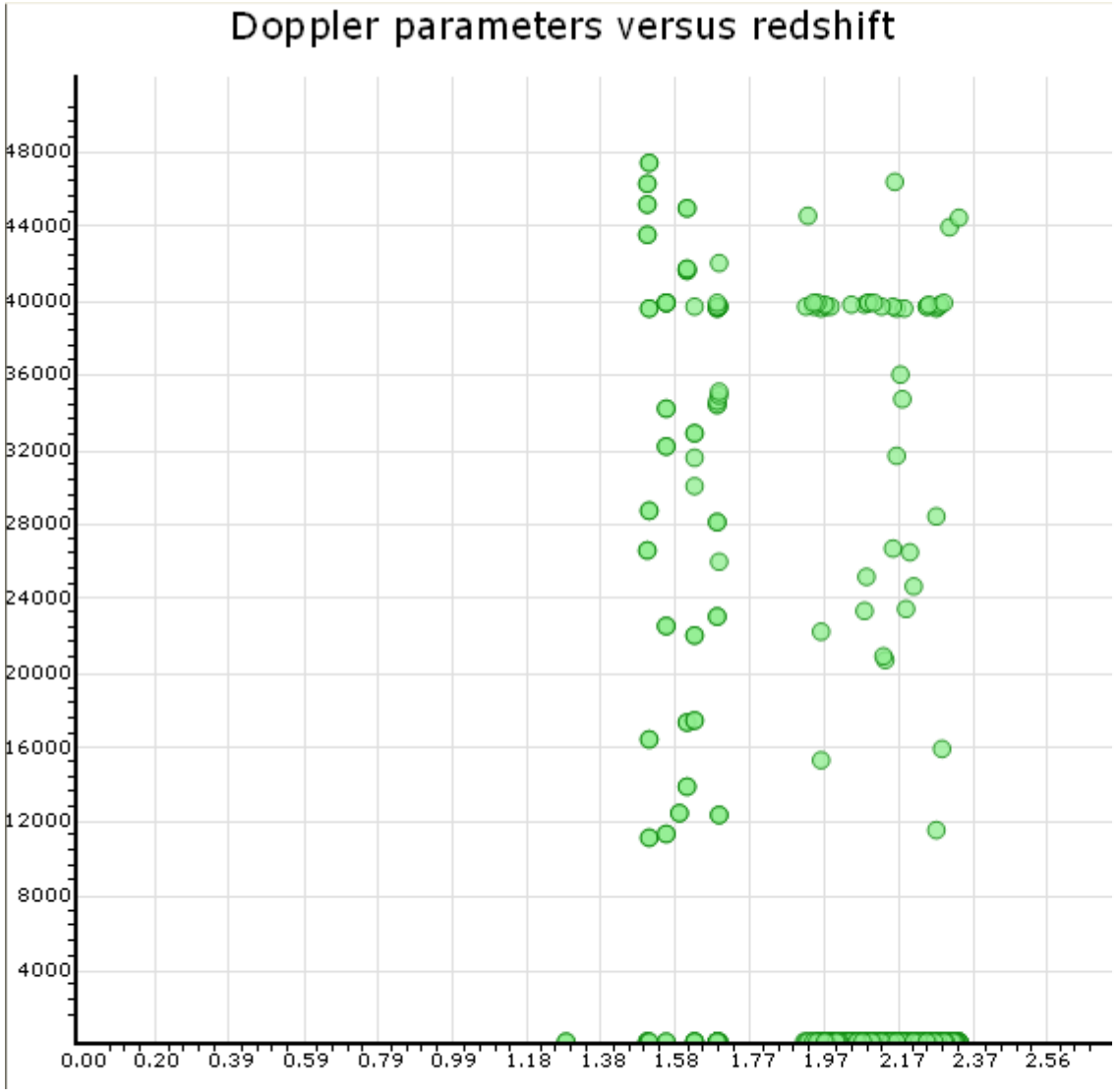
The Doppler Parameter (b) is related to the temperature of the gas by:

$$b^2 = b_{th}^2 + b_{nt}^2$$

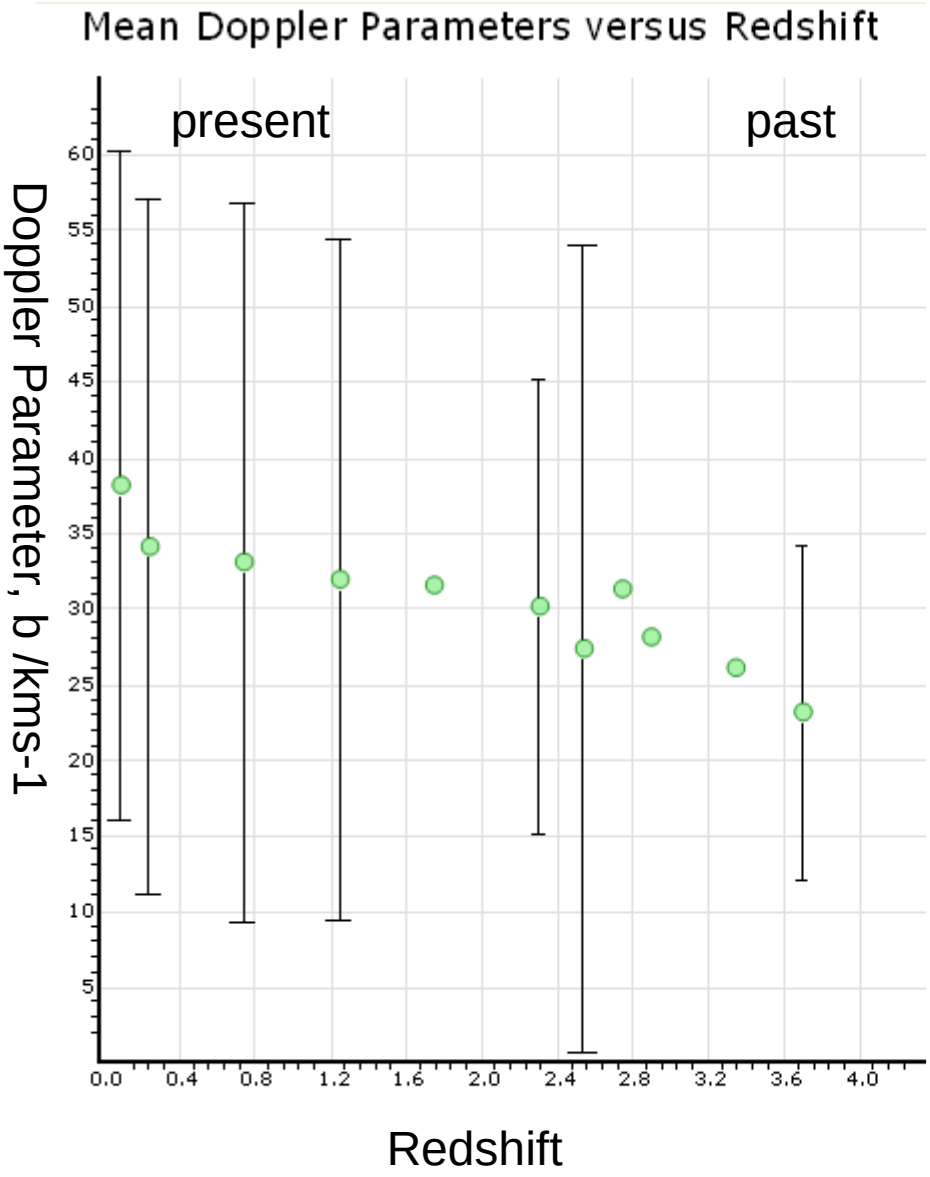
Where b_{th} and b_{nt} are the thermal and non thermal broadening of the line

The measured b directly provides an upper limit to the temperature of the observed gas.

> "This cut off envelope provides a probe of the gas temperature of the IGM at a given *z*, thus giving a powerful constraint on the thermal history of the IGM"
> Lehner et al ApJ658:680-709. 2007



The Lyman Alpha forest
at 1.5 < z < 4
Kim et al
2001A&A...373..757K
VizieR Catalogue Service



From the literature

z	mean b(km/s)	±	authors	year
0.1	38	16	Penton et al	2000
0.25	34	16.9	Lehner et al	2007
0.75	32.9	17.8	Janknet et al	2006
1.25	31.8	17	Janknet et al	2006
1.75	31.4	14.5	Janknet et al	2006
2.31	30		Kim et al	1997
2.55	27.2	13.5	Kim et al	2002
2.75	31.2	16.2	Kirkman et al	1997
2.9	28		HU et al	1995
3.35	26		Kim et al	1997
3.7	23	8	Lu et al	1996

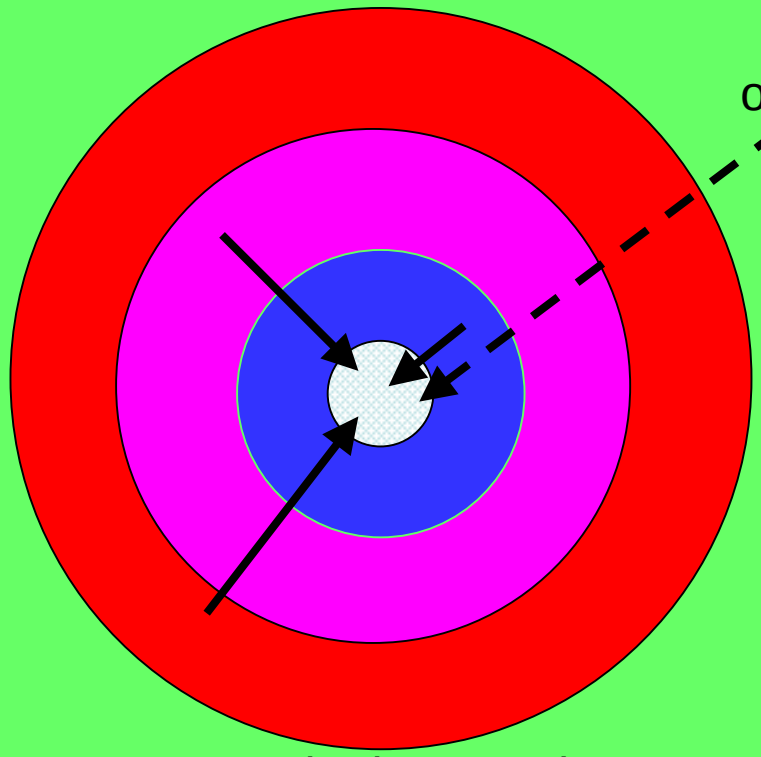
Lehner et al ApJ658:680-709. 2007 looked at the range $z > 0$ and $z \leq 0.4$
"..results in median and mean b-values 15% - 30% higher at low z than at high z"

Misawa et al arXiv0707.0006v1 for $2 < z < 4$ re:absorption line widths.
QUOTE: "Neither HDL's nor LDL show any evolution trends"

Lehner's results show:
QUOTE: "Doppler Parameters are monotonously increasing from
$z = 3.1$ to ≈ 0

Janknecht et al. A & A458, 427-439. 2006 looked at the range $0.5 < z \leq 1.9$
In conclusion, when discussing the Doppler parameter said:
Quote: "It does not change significantly with z."

This causes problems for Mainstream CMB –
and probably signifies that it must be local!



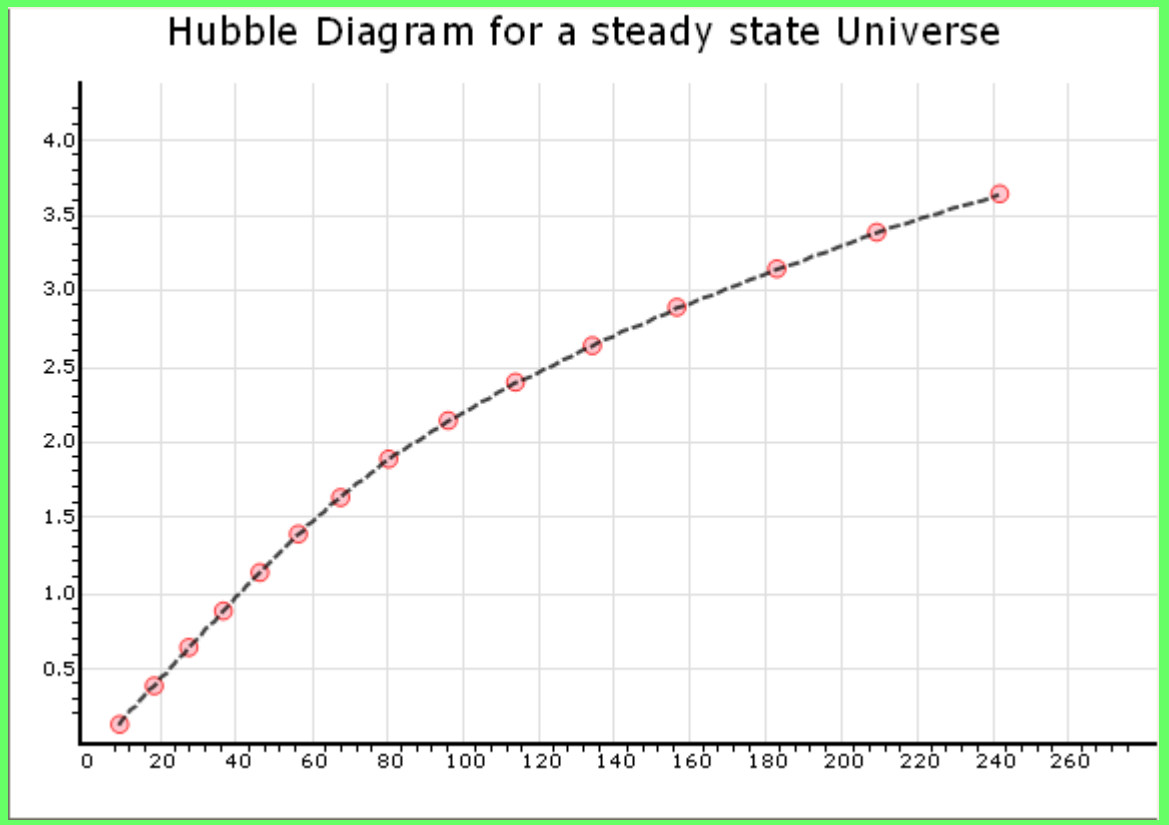
We can think of the CMB arriving at Earth as being from ‘shells’ at different distances away.
Since each shell is further and further away, the radiation was emitted further and further back in time and so, in an expanding Universe, each shell must be hotter than the one before it.

‘layers’ of CMB

In mainstream cosmology….

- Here, on Earth, the CMB is a superposition of that emitted from the rest of the universe
- The CMB is redshifted too.
- To get a ‘perfect’ black body spectrum, the further away the CMB came from, the hotter that region must have been.
- The hotter the region, the shorter the wavelengths emitted.
- As these travel towards us they get redshifted.
- The wavelengths increase until they match those from the local, cooler, regions.
- The black body curves match and superpose to give a perfect black body curve.
- But… If the temperature is constant, the local CMB consists of a series of increasingly redshifted Blackbody curves and so the final result will not be ‘perfect’
- CMB must be local!

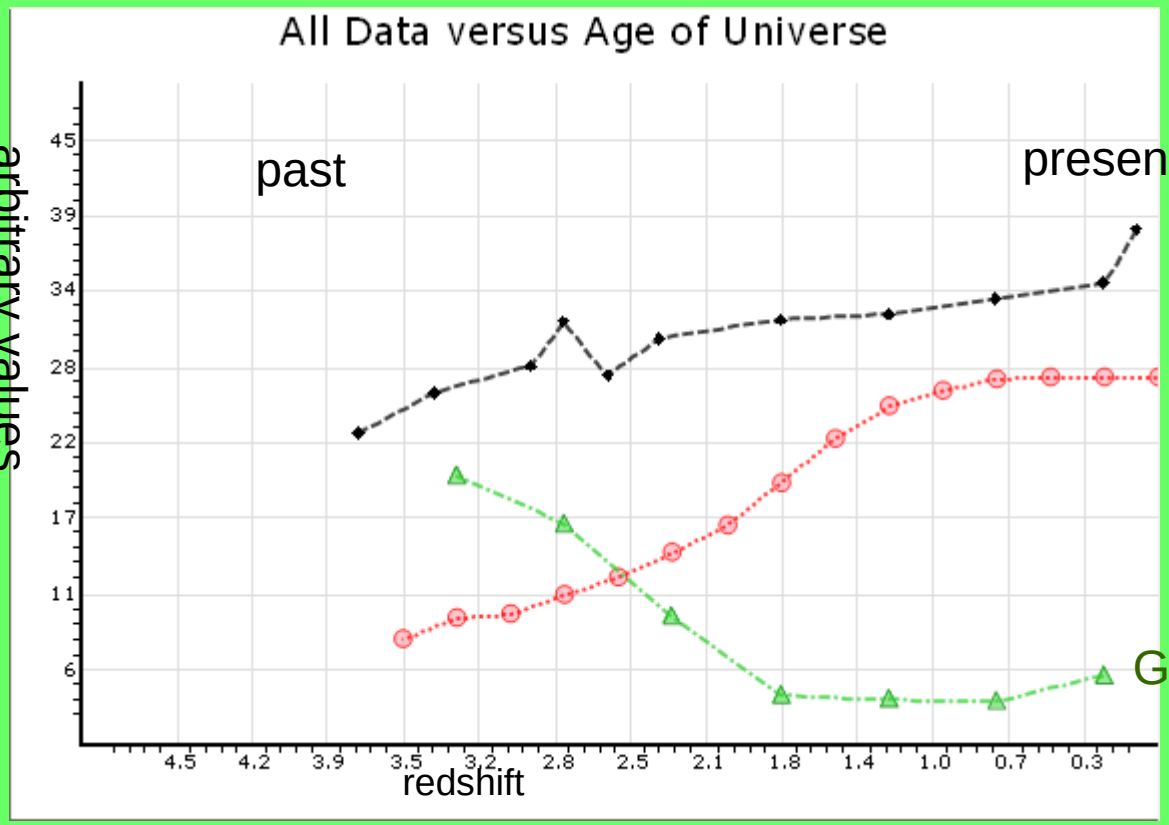
In a static Universe, the average separation of H1 clouds should be constant
And so we should be able to use it as a unit of distance.



However, in most alternative theories, the line should be straight or be exponential curving upwards!

Is the curve exponential – tending towards a limiting value? Z is a ratio of velocities (v/c), is expansion reaching the speed of light?

All Direct Physical Evidence versus age of Universe



past

present

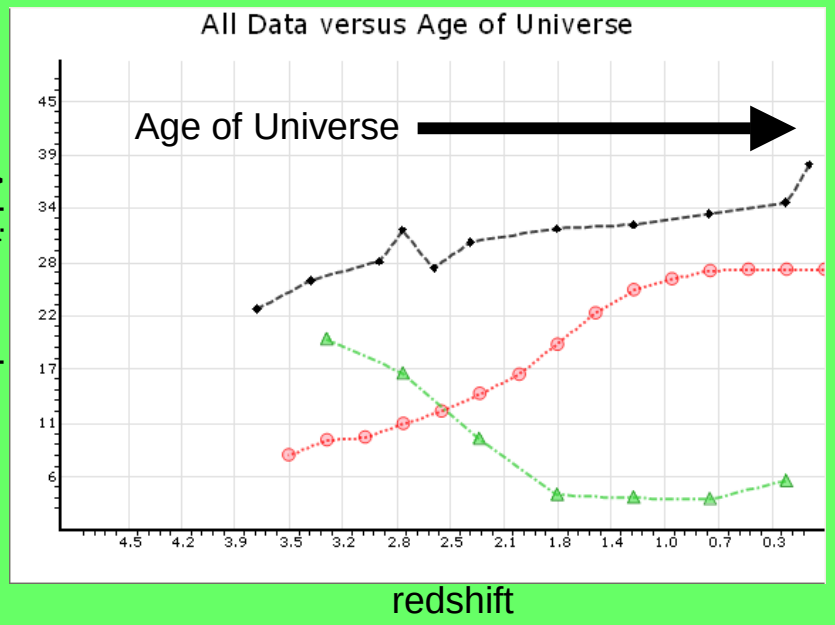
temperature

Hydrogen cloud separation

Galaxy separation

Age of Universe

All Direct Physical Evidence versus age of Universe

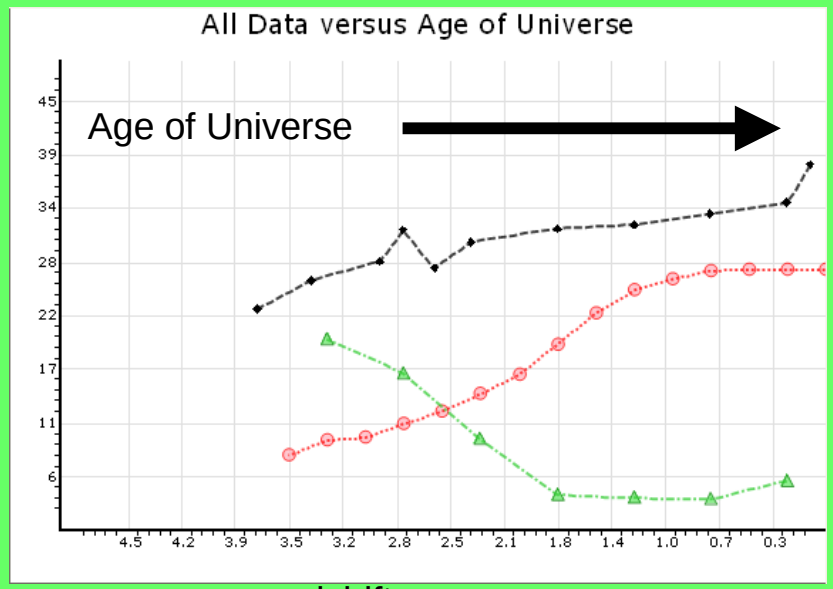


Is it possible that

- The Big Bang Happened?
- The elements formed as per mainstream?
- The Universe expanded?
- Einstein's equations hold?
- But – The density of the Universe is exactly equal to the critical density.
- So it stopped expanding?
- No need for inflation!
- Since the Universe did expand, high z supernovae will still exhibit time dilation

But….
The H1 clouds, though static, have different redshifts.
We need an alternative redshift mechanism – Tired light?
As photons travel through space they interact with the IGM and lose energy.
This reduces their energy and frequency and thus increases their wavelength ie redshift
Where does this energy go? - Eventually to warming space.
Notice that the temperature rises as the Universe ages!

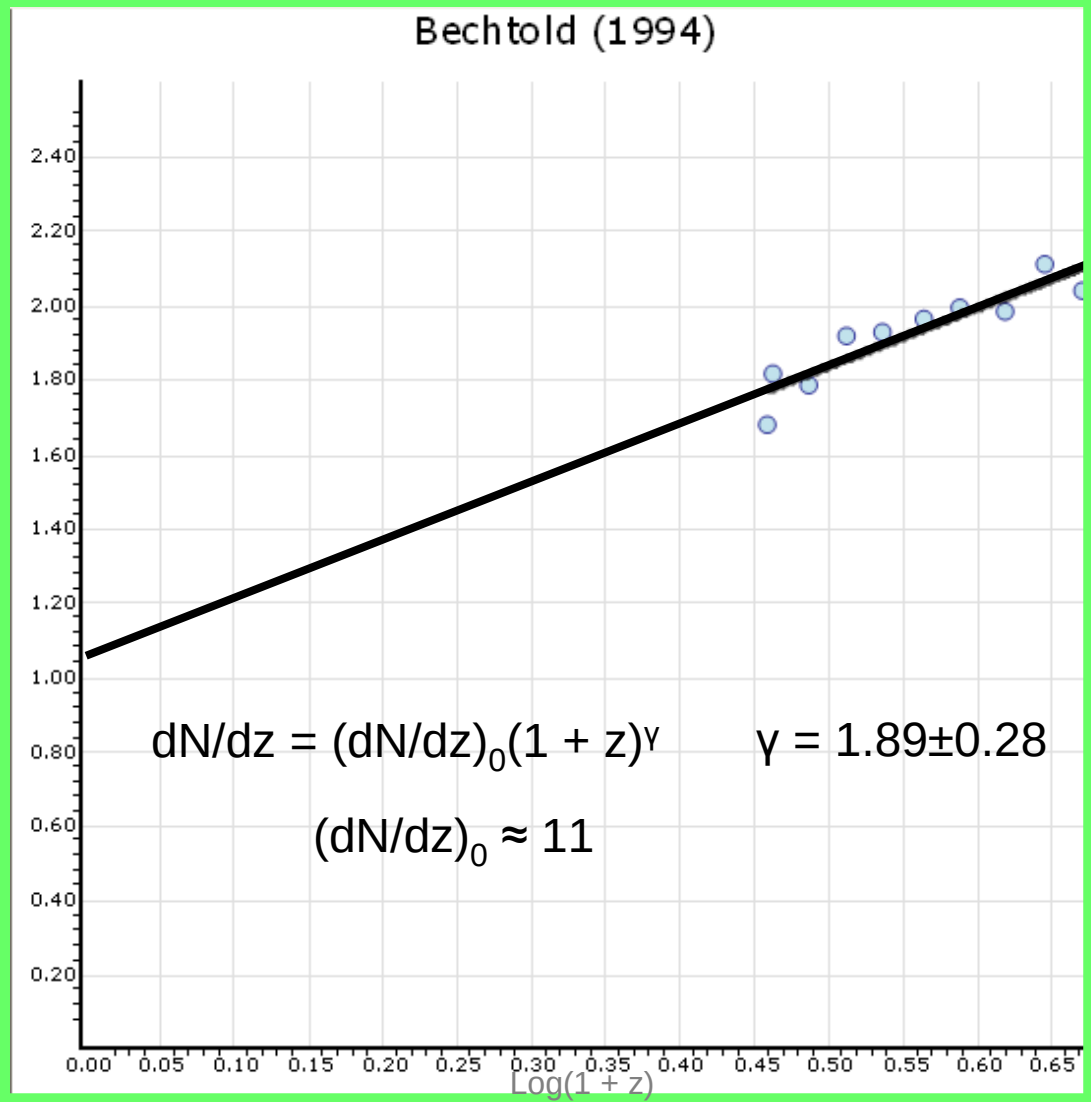
All Direct Physical Evidence versus age of Universe



But….
H1 clouds are evenly spaced in the locality (z<1?) and so we would expect these results to be reliable.
Where there is evidence for expansion, this is far away.
Remember that we started off with the original assumption that Quasars are located at huge redshifts and ……

Well, not everybody believes this!

A thought on the ‘age’ of the universe – about 13.6×10^9 years in the BB theory.



Using this mainstream data, we should be able to get an indication of the age of the Universe in terms of the redshift, z

That is, lets extrapolate The line backwards in time.

For instance, how long is it Since the Hydrogen clouds Were ’touching’?

i.e. H1 clouds are ≈ 70kpc in size

So, at what redshift were they ‘touching’ - assuming expansion?

dN/dZ = 6600 $Z = 29$

Or 46×10^9 years!

i.e. 3 times the BB age of the universe.

At what redshift did the clouds have ‘atomic separation’ of 10^{-10} m?

dN/dz = 1.5×10^{36} $Z = 4 \times 10^{18}$!!! Or…..

6×10^{27} years or 50,000,000,000,000,000,000 times older than the BB age!

Some might call the time associated with this redshift ‘infinite’!

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