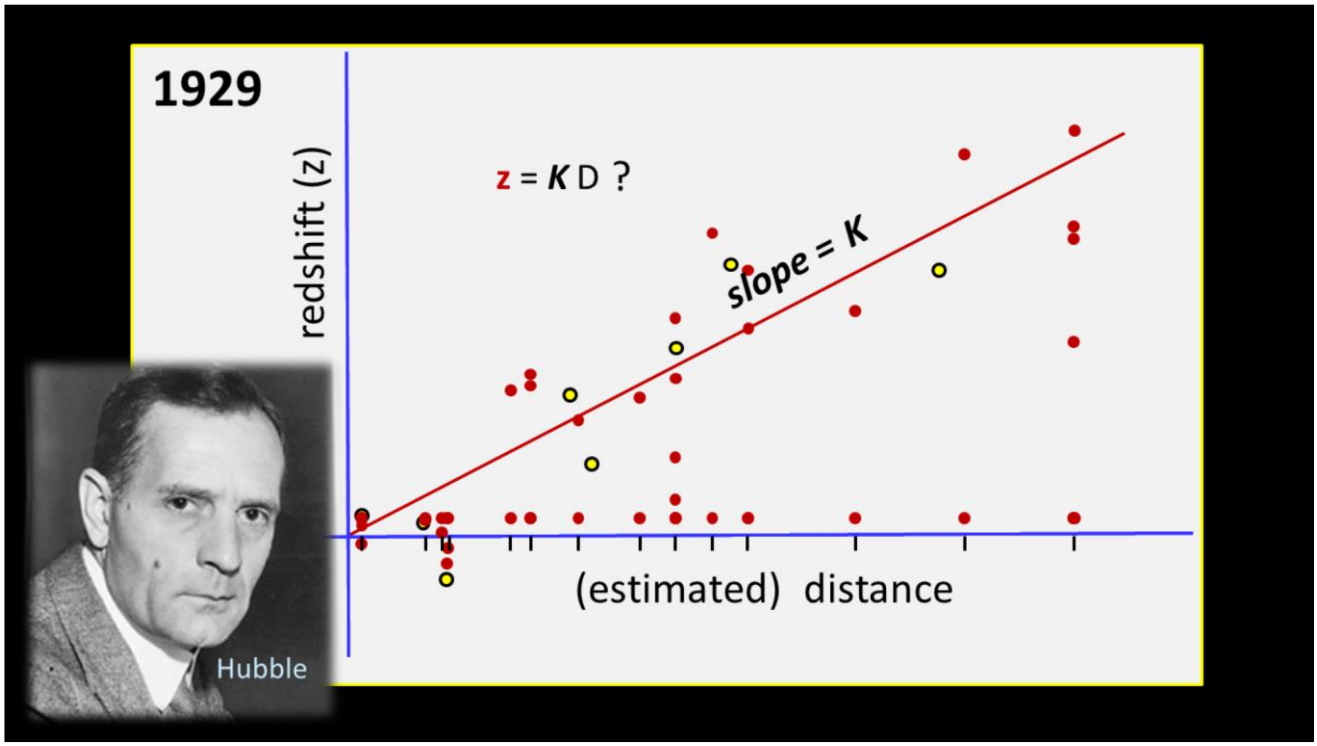
Mainstream cosmology currently sits on a few simple assumptions:

- about "**Hubble's Law**",
- about "**redshift**", and
- about the universe beginning with a hot "**Big Bang**".

Taken together, these ideas lead to models (like "**Λ-CDM**"),
and to predictions about the age and history of the universe.

So where did all this come from: the idea of a "Big Bang", these finely-tuned models, these estimates of universe age?



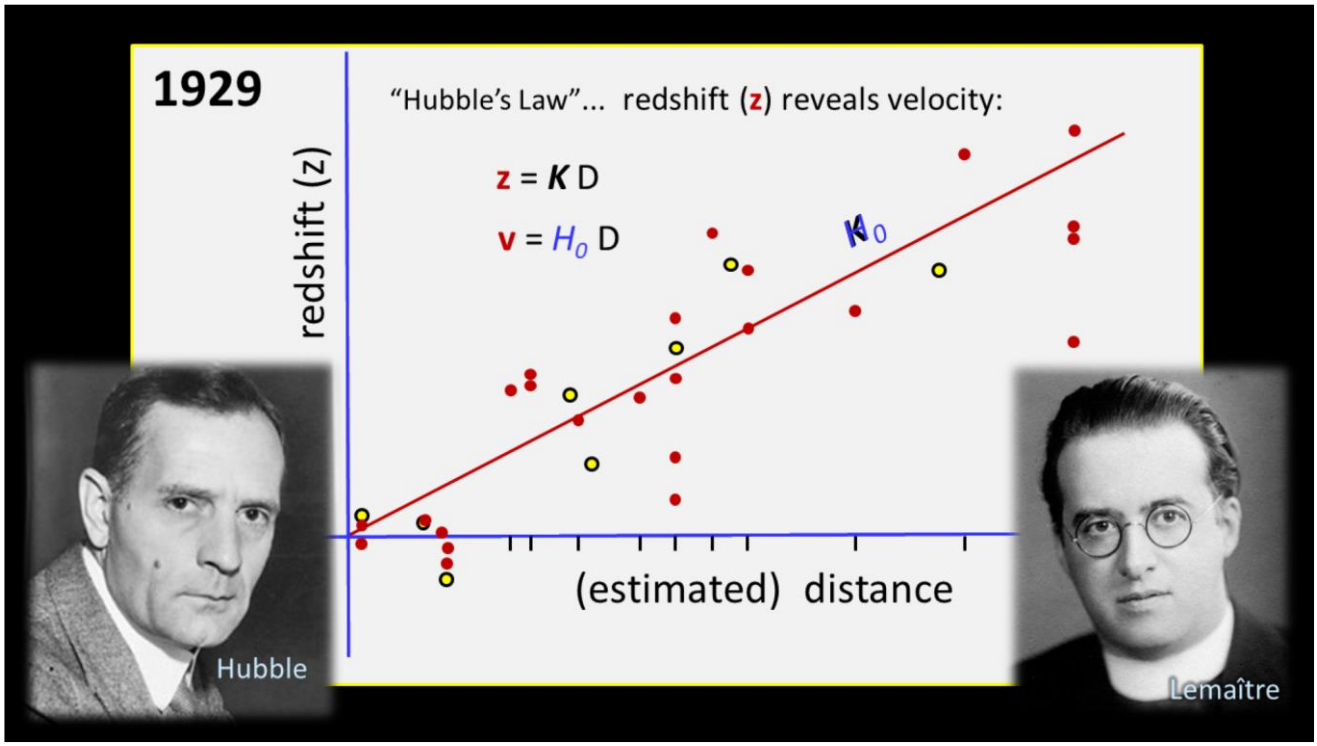
It began with the **slope** of this line.

By **1929**, astronomer Edwin Hubble had worked out rough estimates of distance to 24 nearby spiral galaxies.

When he plotted these distances against redshift, he noticed… that the distances to these spirals might be **proportional** to their redshift.

Which for astronomers, would be **HUGE** – they could find the **distance** to a galaxy just by reading its **redshift** !

As to what was **causing** these redshifts, Hubble remained non-committal.

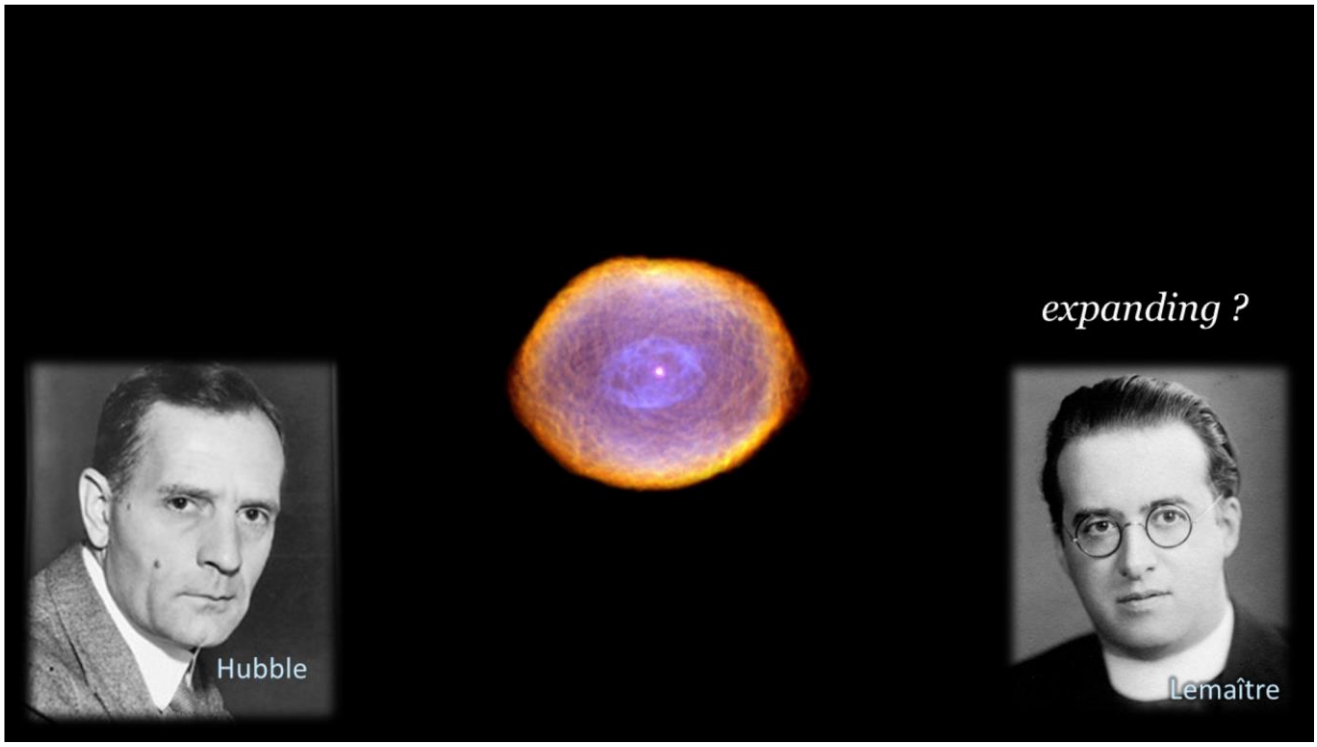


Not so, Georges Lemaître.

Lemaître, another astronomer, jumped on Hubble's data as evidence that these spirals were all racing away; that their redshifts were a simple Doppler shift, caused by their "**speed of recession**".

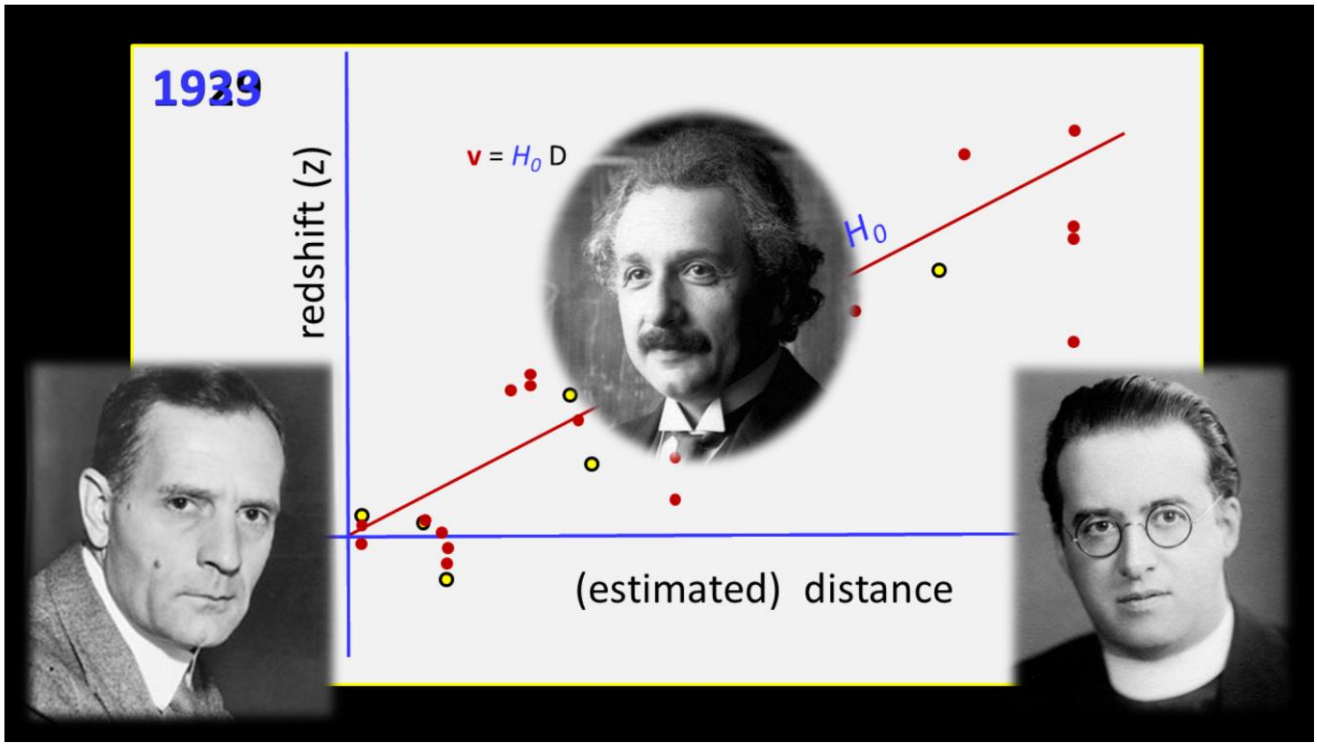
In fact, it was Lemaître who wrote down "Hubble's Law", that redshift reveals **velocity**; and that velocity – the apparent "**speed of recession**" of spiral galaxies – is directly proportional to their distance;

This **constant of proportion** ("Hubble's constant", or H_0)
is given by the slope of this line.



Lemaître's idea was that the entire universe must be **expanding**, as if **growing** from some original "**cosmic egg**".

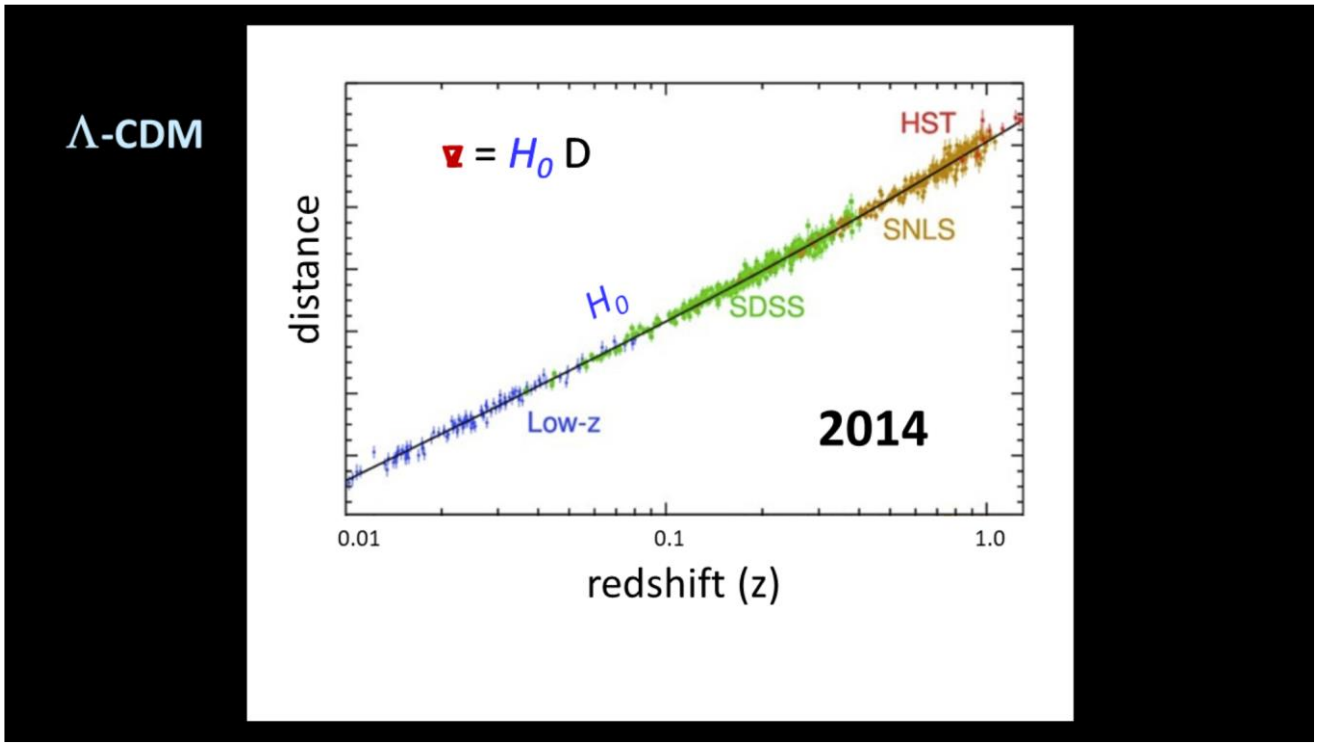
Now, given that Lemaître was a Catholic priest, and that his **cosmic egg** – this prototype "Big Bang" – was a bit like some "**creation myth**",



… and that Hubble's data "**was a bit rough**", many – including Einstein – thought that Hubble and Lemaître had jumped the gun; that Hubble's so-called Law was more "**leap of faith**" than "real science".

Nevertheless, by 1933 – **the very same time these Papers were being presented** – this idea about an expanding universe had caught on.

And that the **rate** of this expansion is given by H_0 ,
again, the slope of this line.

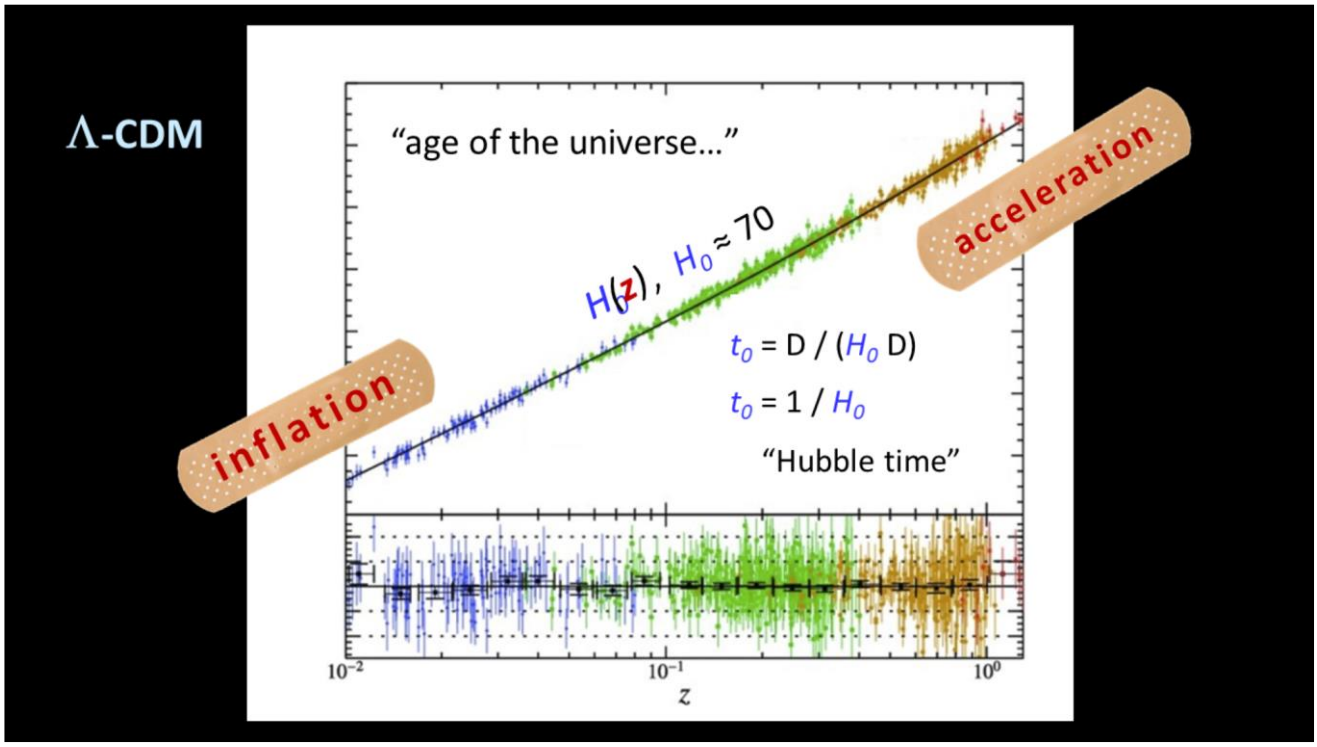


And sure enough, as the data improved, it really did look like Hubble and Lemaître had been on the right track. As we can see from this recent plot, the data **do** seem to fit nicely with **Hubble's** original idea:

that **redshift** might be proportional to **distance**.

But notice: this is a plot of **redshift** vs. **distance**.
There's no mention of **velocity**.

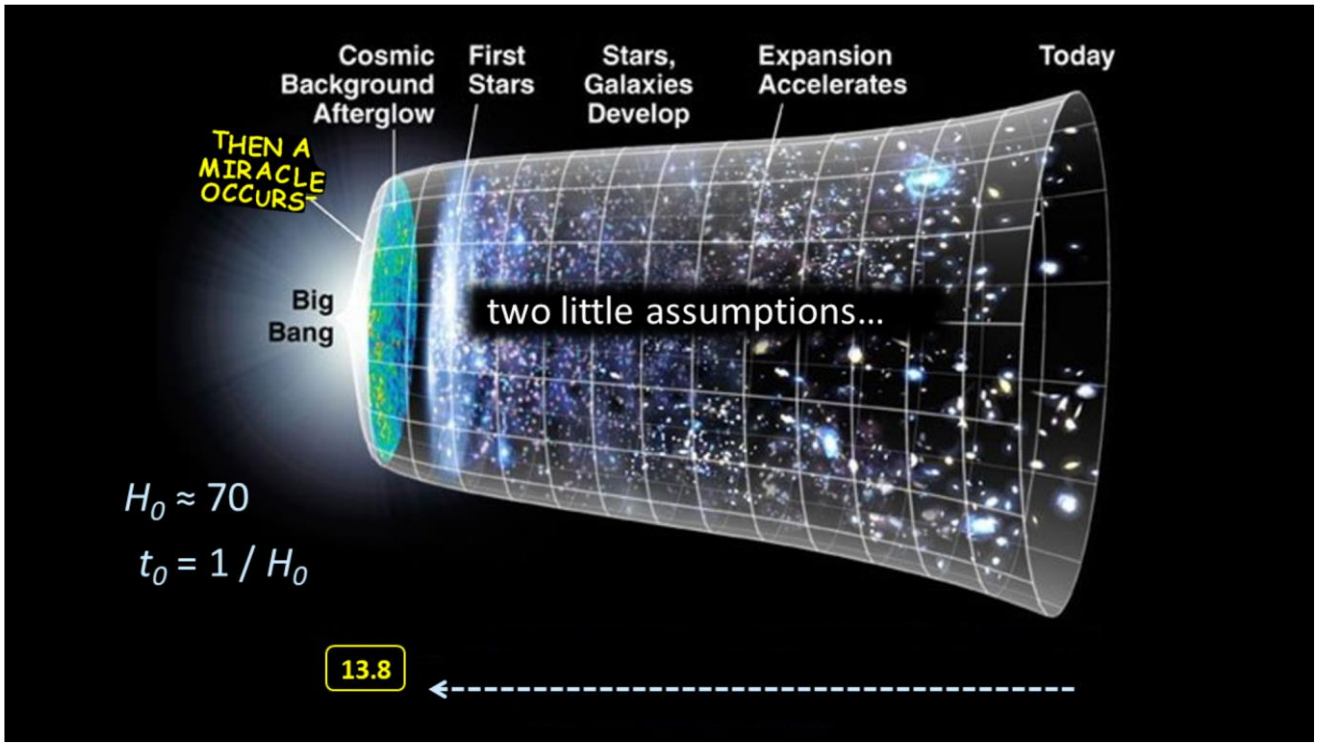
The idea that **redshift** is proportional to **speed of recession**
(or **rate of separation**) is an **assumption in a model**, an assumption that cosmologists (like **Lemaître**) have to add.



But once we accept these assumptions,

- and add a little fix near the start,
- and another little fix near the end,
- and calculate a so-called "Hubble time"…

.



… we get this story that **cosmologists** currently like to tell.

Which goes something like this:

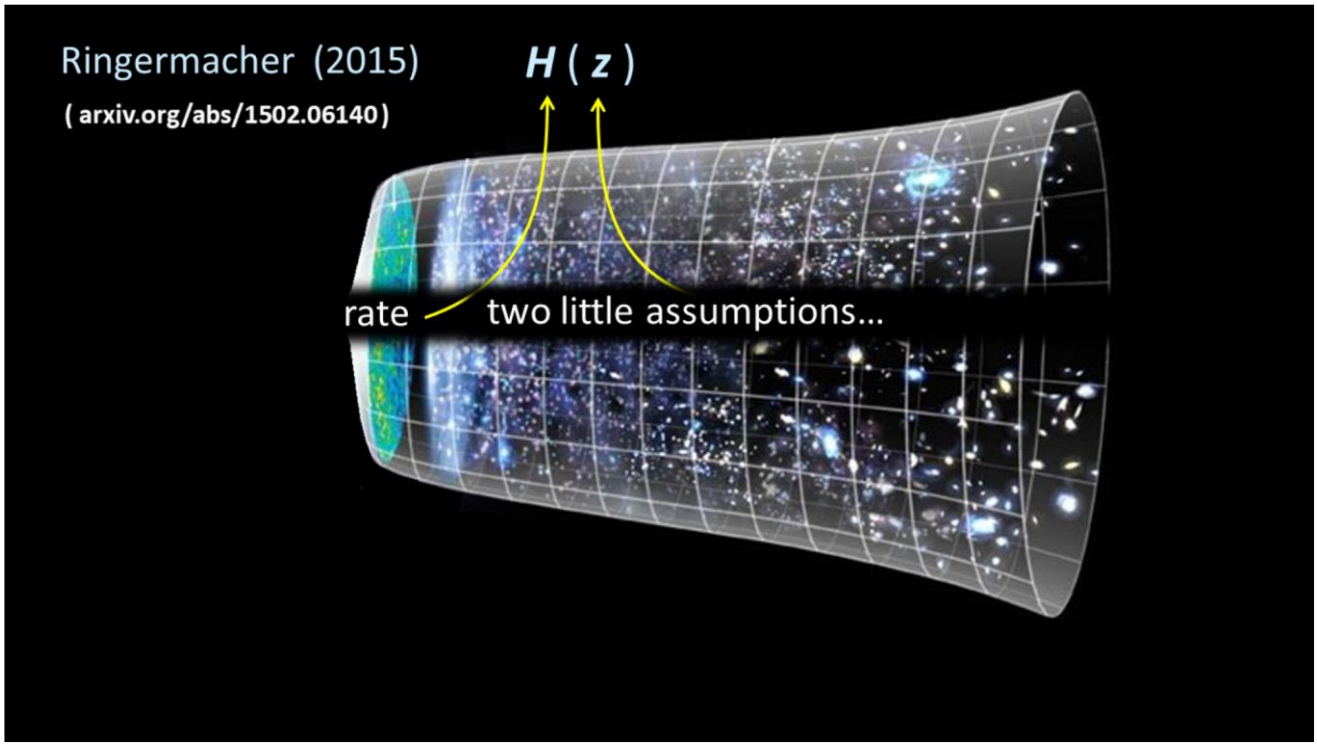
> Given one miracle (one **miraculous moment** of "cosmic inflation") and **two little assumptions**, we can predict that the universe began to expand about 13.8 billion years ago.

About this story, there's a joke that ***physicists*** like to tell:

["Cosmologists are **always** wrong, but never in doubt."]

* * *

So, two little assumptions…

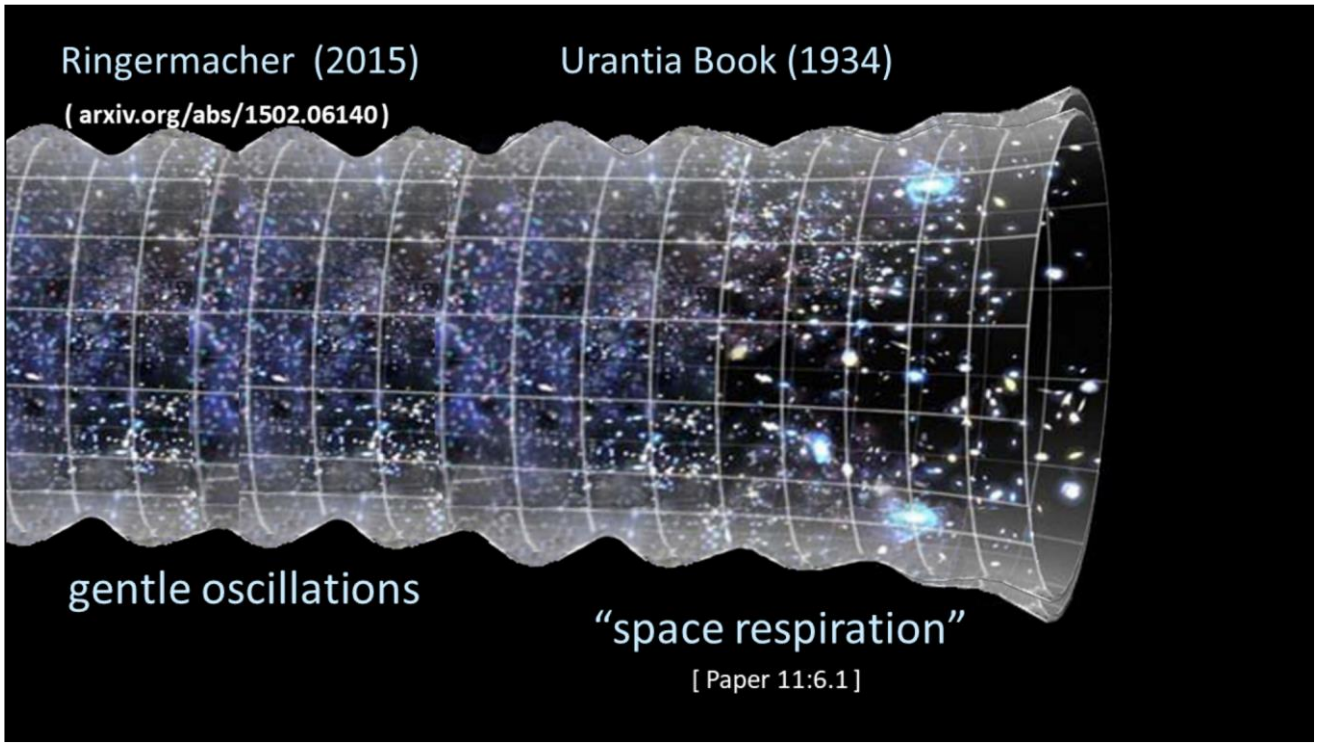


Two little assumptions,
… about [**redshift**] and [**rate of expansion**]; assumptions which nowadays seem so ***obviously*** true, that some cosmologists no longer see them as *"assumptions"*, but rather, as **hard facts** which their models must obey.

It's no exaggeration to say that this story, this proposed expansion history of the universe, sits on these two assumptions. So in 2015, two physicists (not cosmologists!) Harry **Ringermacher** and Lawrence **Mead**, took a close look at these assumptions, and this story, and the best data of the day.

And they noticed… something subtle in the supernova data:
that "the rate of change of the rate of change" (of the expansion)
has been changing… **every 2 billion years or so**.

[*] University of Southern Mississippi.
https://astronomynow.com/2015/07/01/is-the-universe-ringing-like-a-crystal-glass/

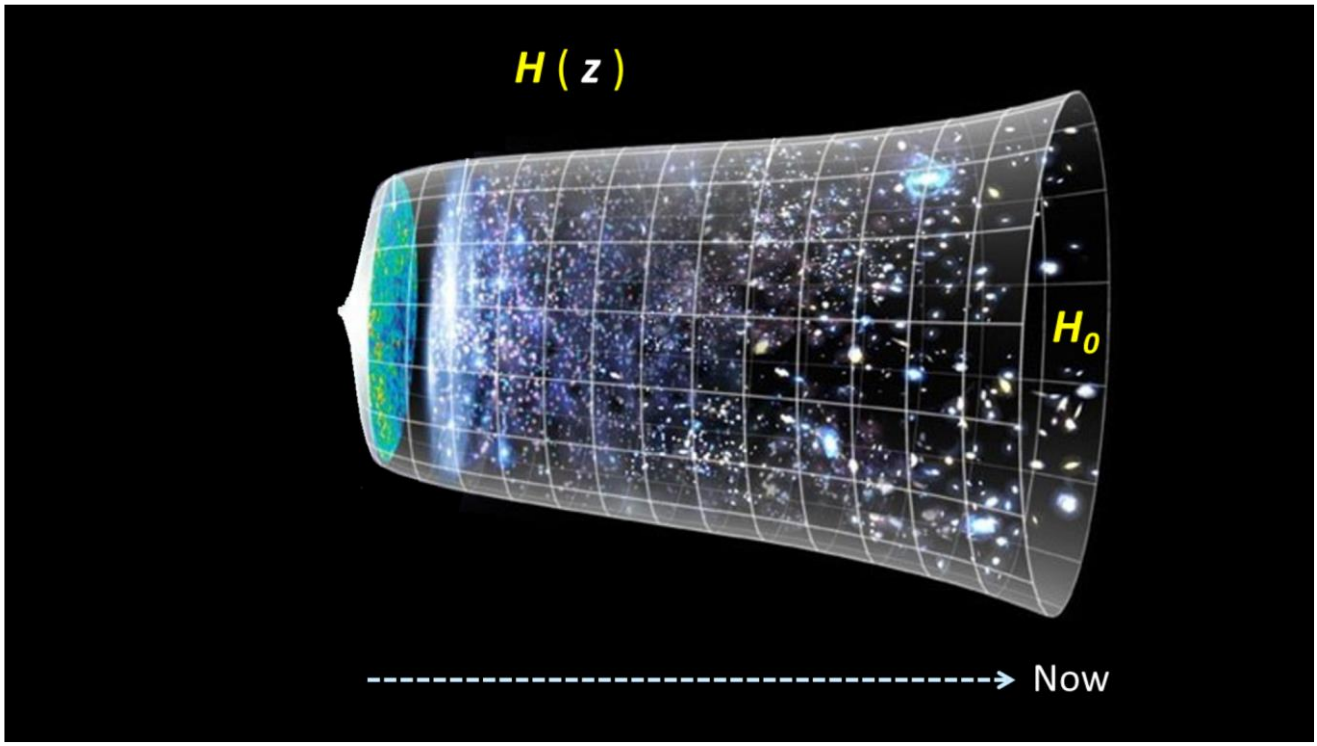


[…], they proposed that a simple, “Big Banged” universe was in some sense “ringing” or oscillating as it expanded; that over the last 13 or 14 billion years, the rate of expansion of the universe has **sped up** and **slowed down** 6 or 7 times.

The Urantia Book takes this unorthodox idea one more step: it proposes **cycles**, two billion years long, of gentle oscillation; of so-called “**space respiration**”.

(Paper 11 section 6 is all about “Space Respiration”)

[** https://arxiv.org/abs/1502.06140]



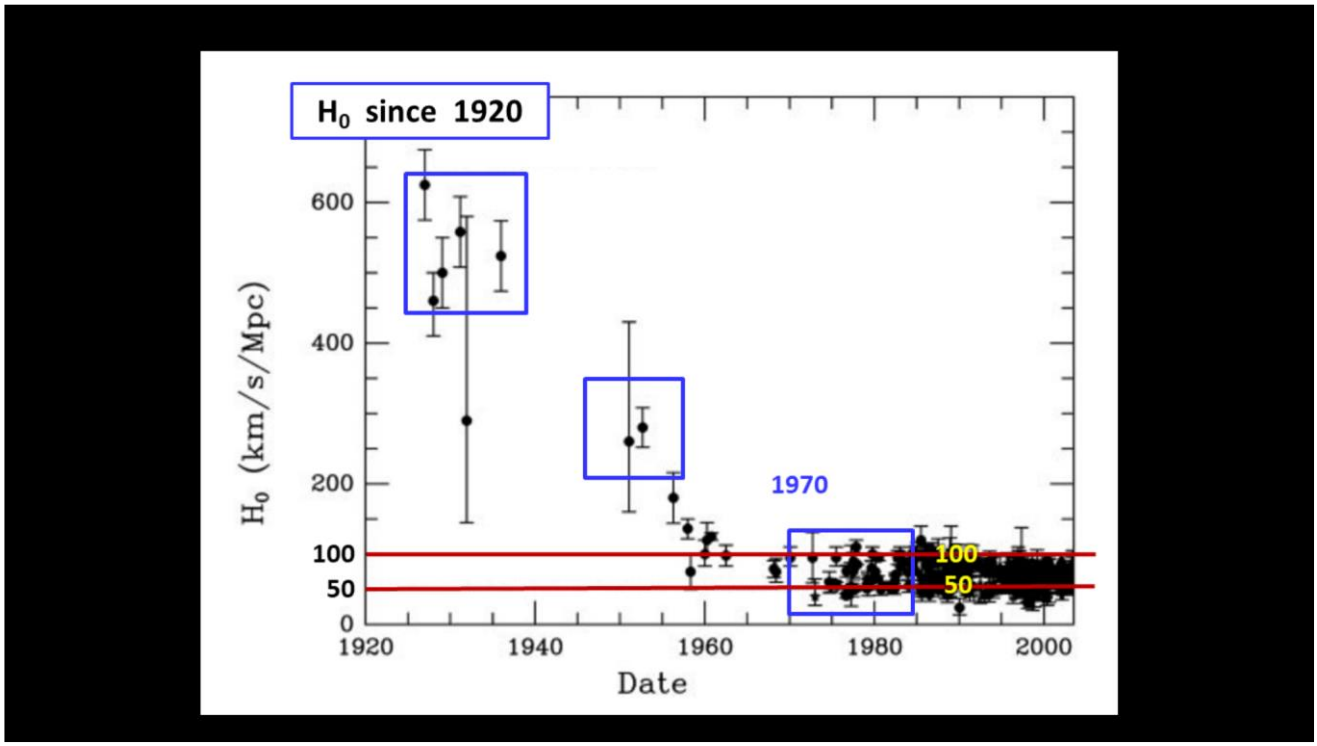
But getting back to the main stream…

This current consensus model, this assumed "expansion history of the universe" is, in effect, **defined** by that… "Hubble parameter",

H (as a function of redshift or age **)**.

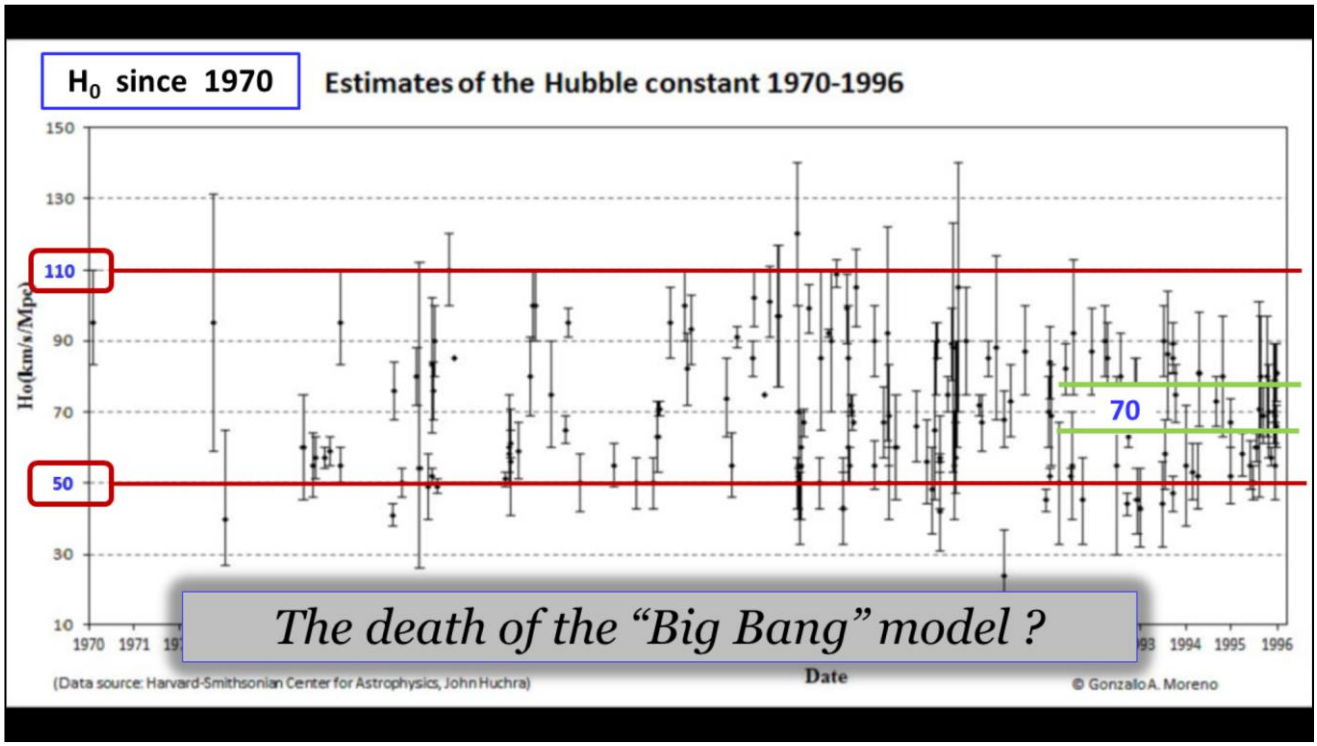
So **predicting** its **current** value – H_0 , the rate of expansion **now** – has become a crucial test: does this model **really** capture the highlights of universe history?

[**Or in a few short years, will our children's children look back, and wonder: "How could they have missed so much?"**]



This is the reason so much **effort** has

been spent trying to pin down a value for H_0 …



… and over the years, estimates have been converging; towards about **70** of these… let's call them "Hubble units" (**km/s/Mpc**).

But cosmology can be a *tricky* business.

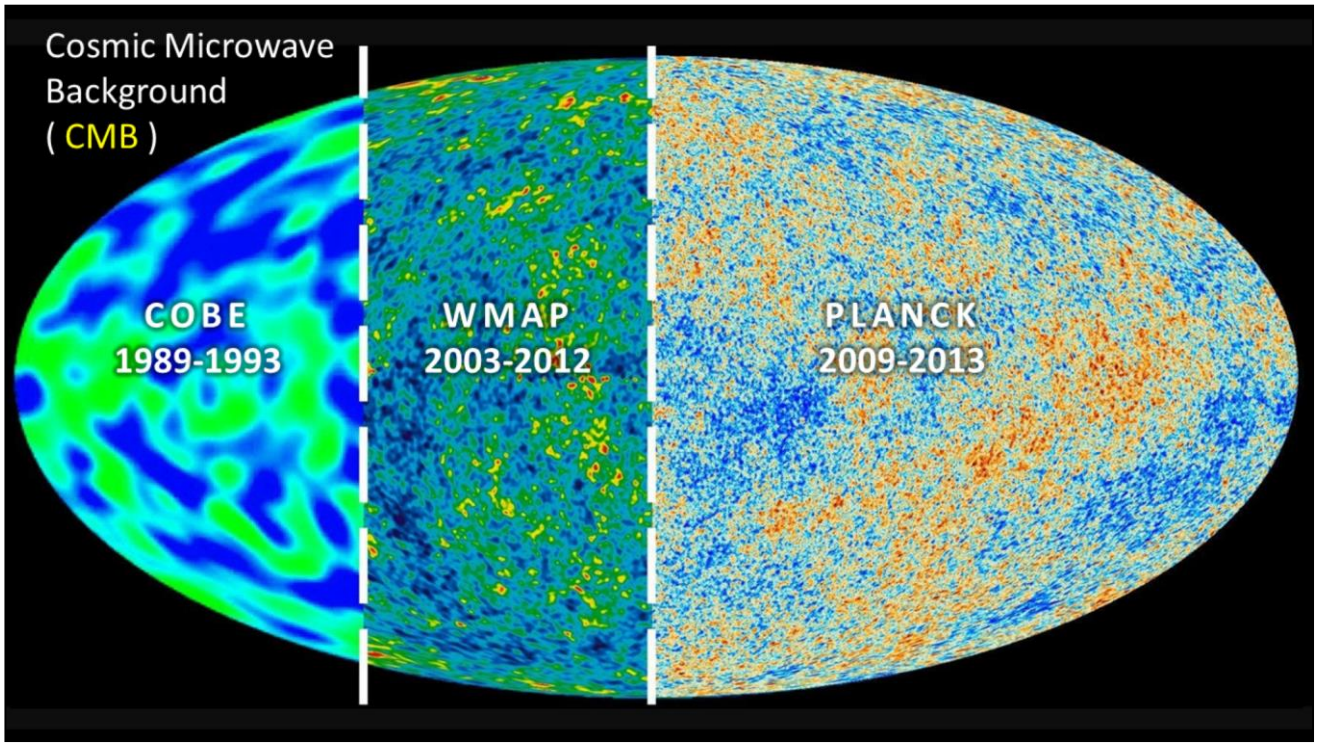
By the 1980's, the simple idea of an "expanding universe" had become a "**Big Bang model**", finely-tuned, and **fragile**.

And inconsistencies had appeared. Like galaxies seeming to be older than the universe.

In fact, by 1992, rumours were going 'round about…

*"**the death of the Big Bang** (model)."*

But then cosmologists…

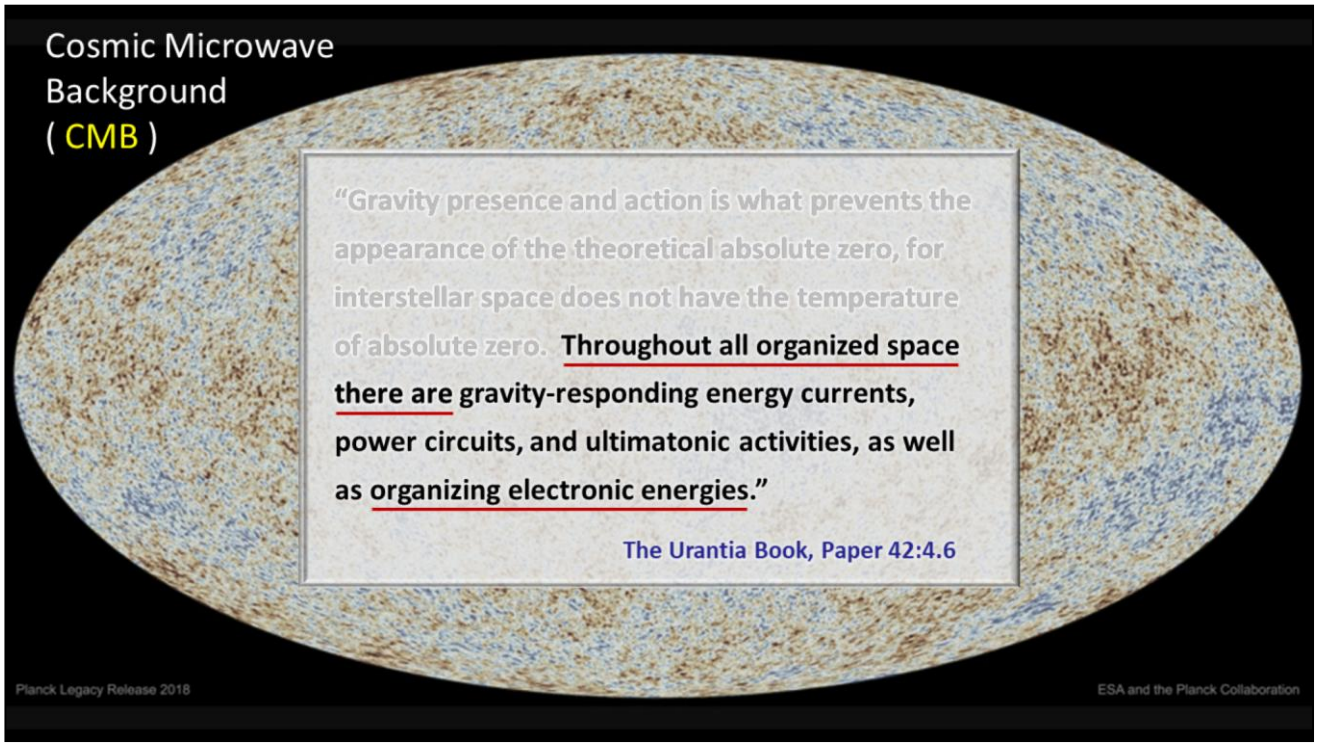


… got their first real taste of this: the "Cosmic Microwave Background" (or **CMB**); the signal that saved the Big Bang.

Almost every feature [in this… **extremely filtered plot**] – could be made to fit so well with Big Bang expectations, that this Cosmic Microwave Background is now seen as "**a smoking gun**", actual **proof** that the universe began with a hot big bang.

After all, if the CMB is **not** a "**redshifted surface of last scattering**", what else could it be… ? (!)

[See: "the temperature of empty space", 42:4.6]



Well, Paper 42 section 4 makes a suggestion:

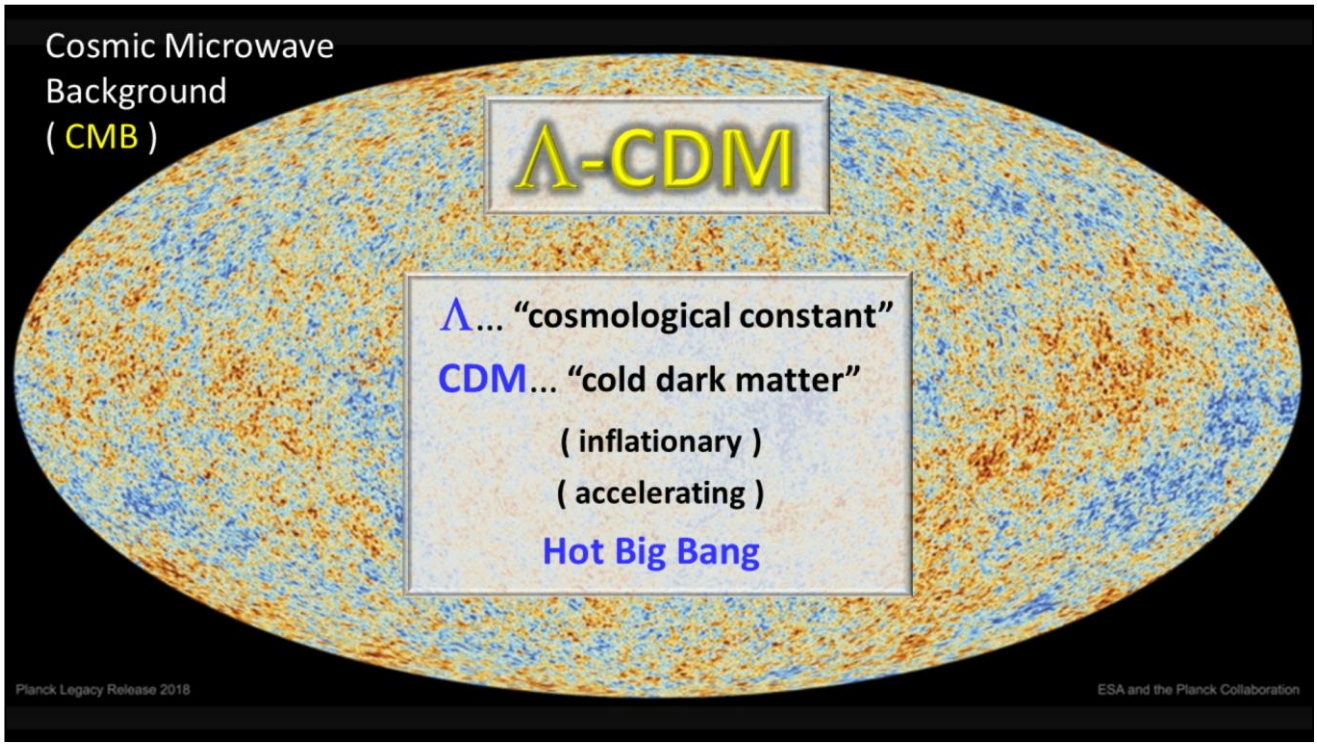
> [… … …]
> Throughout all organized space there are […]
> **organizing electronic energies**." (42:4.6) [**2.725 Kelvin**]

This paragraph, presented in 1934, raises a possibility: that the microwave background is **not** a "surface of last scattering" (from some Big Bang), but simply… one of many interesting properties of "**pervaded space**".

But hang on. If the Cosmic Microwave Background – this non-zero temperature of space – is **not** a "redshifted surface of last scattering", then what happens to that "**smoking gun**", that "**signal which saved the Big Bang**" ?

Hmm. Again, hold that thought.

For now, putting aside this [**unorthodox, ambiguous**] alternative, …



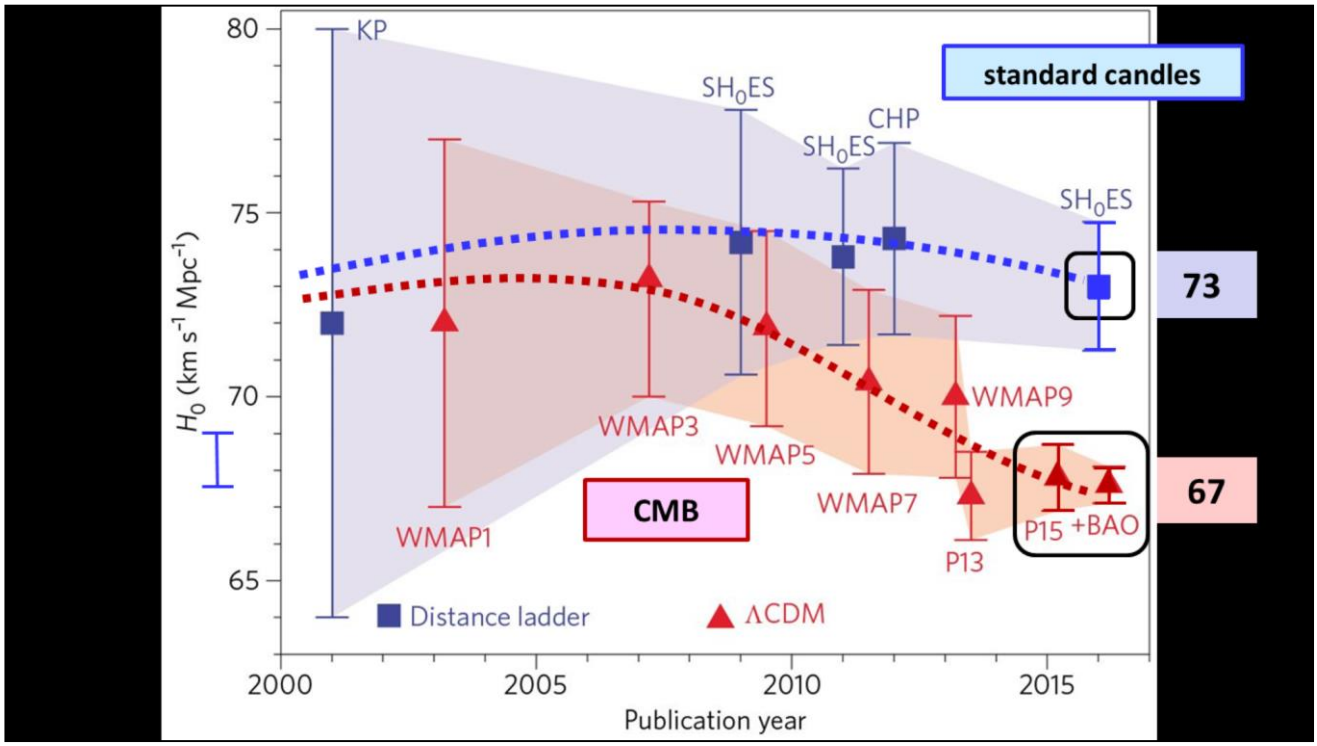
… this cosmic microwave background has allowed cosmologists to build, and to polish up, a consensus model for "native" cosmology, so-called "**Λ-CDM**".

Here:

- **Lambda** means something like Einstein's "**cosmological constant**",
- **CDM** is "**cold dark matter**",
- and adding a few more bells and whistles,

we get this… "Standard Model".

But just when cosmologists thought they could relax, …



We got this:

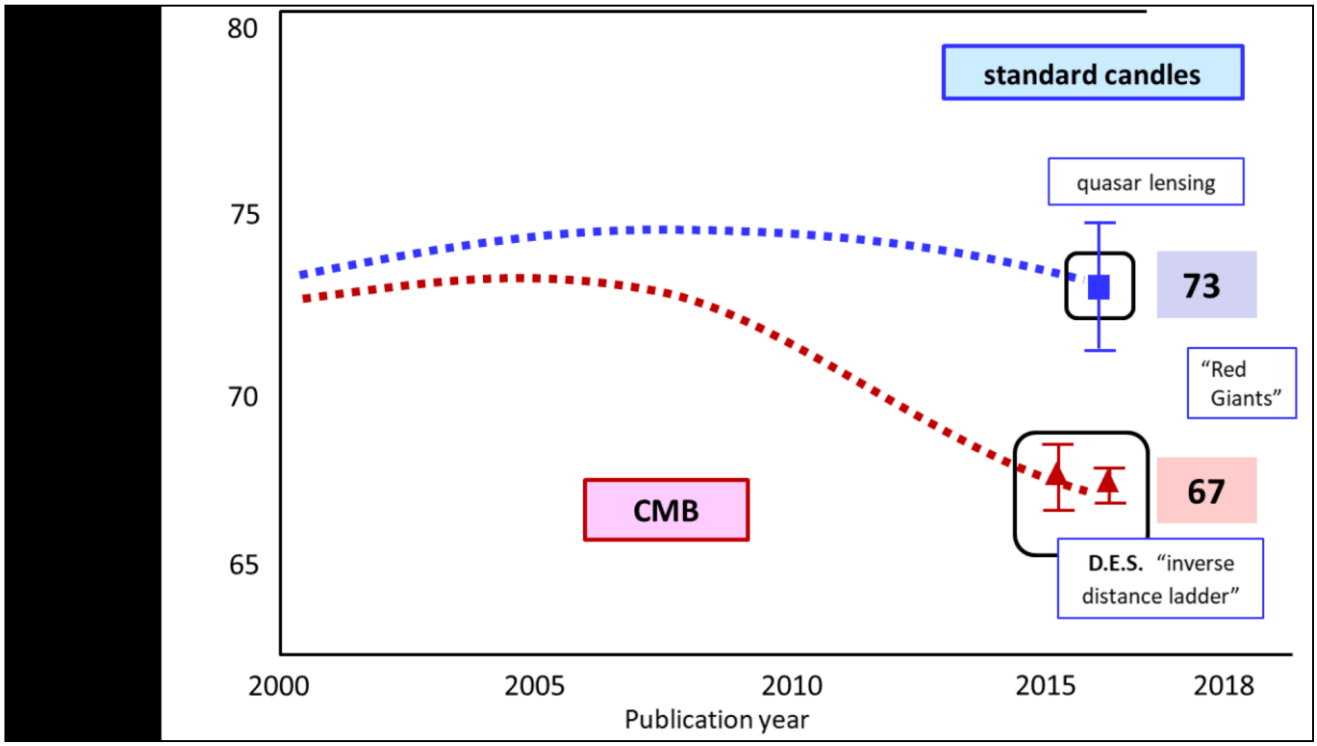
Using direct measurements of **standard candles**, like Cepheid variables and supernovae, estimates of H_0 have converged to a value somewhere **above** 73.

But as this lower red curve shows,

using Big Bang **models** (and the microwave background),

estimates have also converged… to a **different value**.

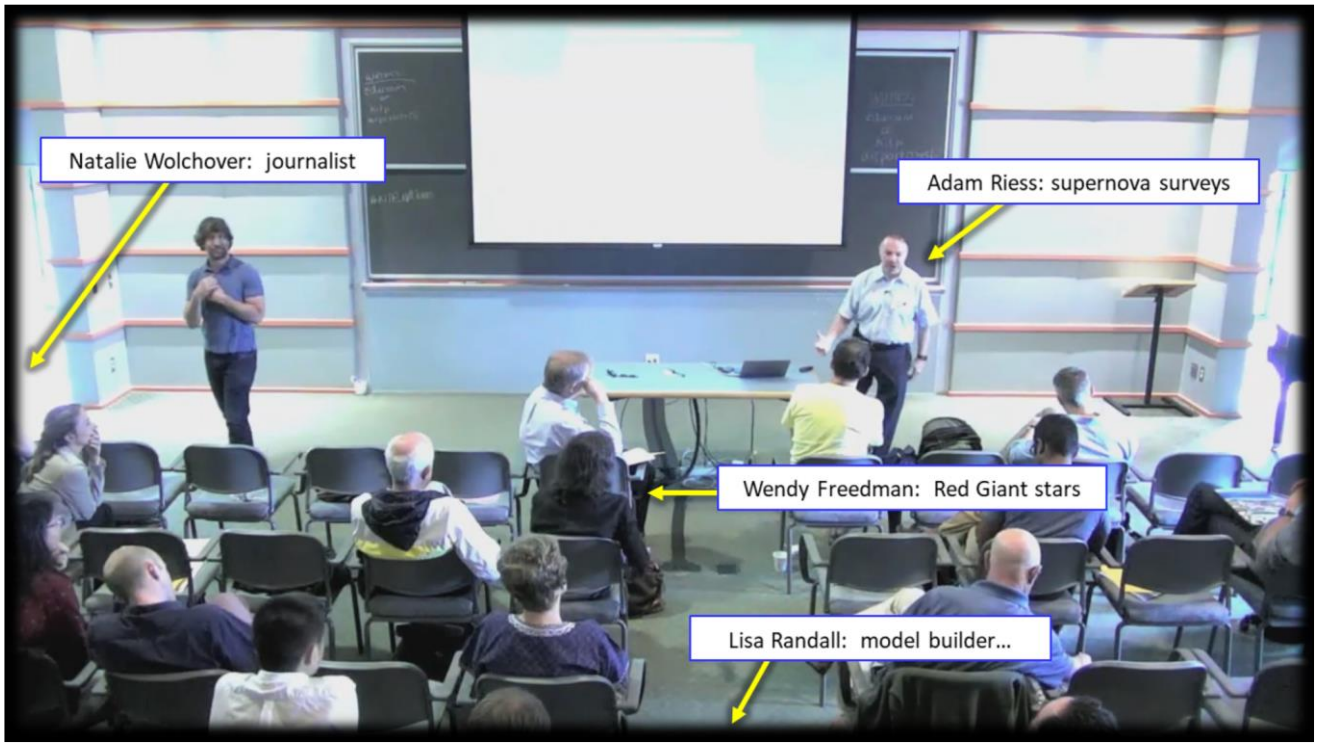
From observation, **astronomers** calculate that H_0 must be at least 73.
But **cosmologists** – using their best models – ***require*** about 67.



Two of the most sophisticated, carefully calibrated, checked and re-checked estimates – of the **central** prediction of current consensus cosmology – appear to have **diverged**.

Latest results only compound the problem.

For cosmologists, this divergence has become so unsettling, that earlier this year (July 15-17), the folks who run the surveys and write the papers which shape current cosmological ideas, ...

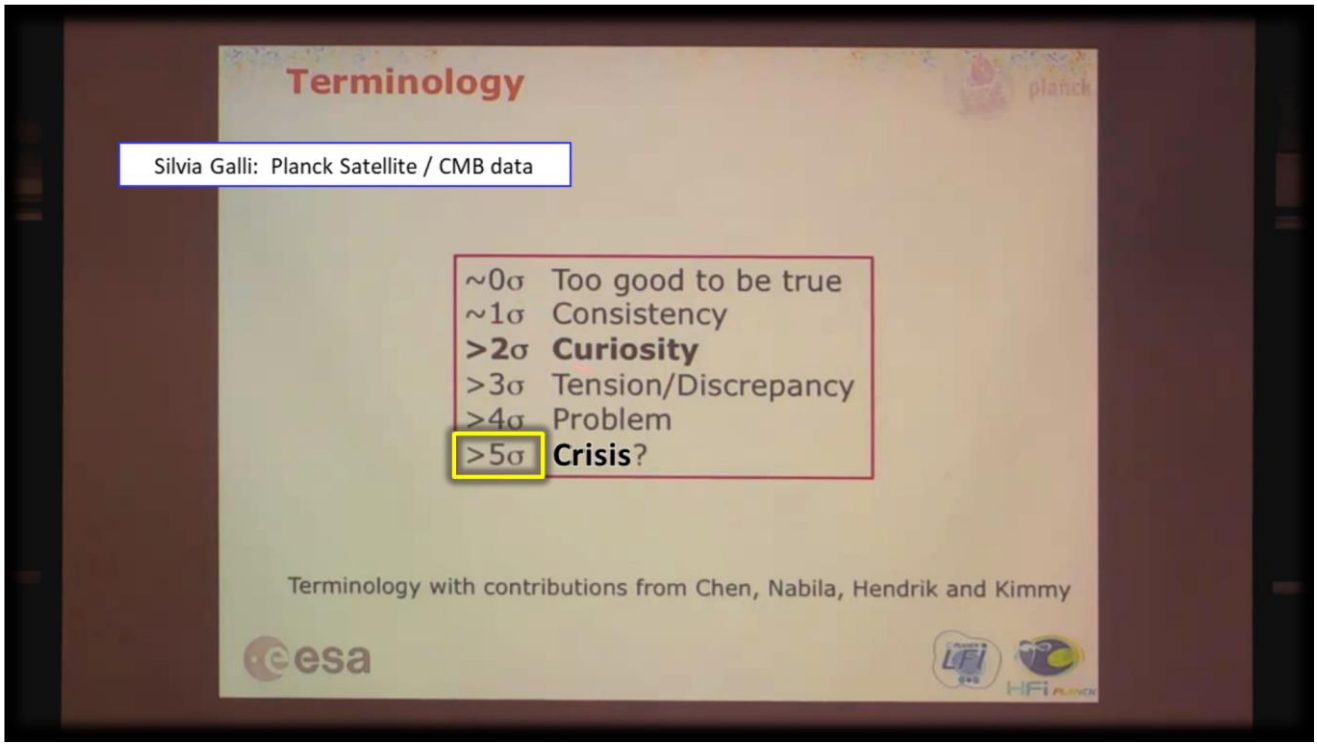


… got together in Santa Barbara [*] to try to sort things out.

Here's a snapshot from the conference;

Adam Riess: (supernova surveys) in full flight;
Wendy Freedman: (Red Giant stars) ready to pounce;
(apparently) **Lisa Randall** (model builder) was in the back row,
and **Natalie Wolchover** (favourite journalist) was over here.

[*] KITP – Kavli Institute for Theoretical Physics



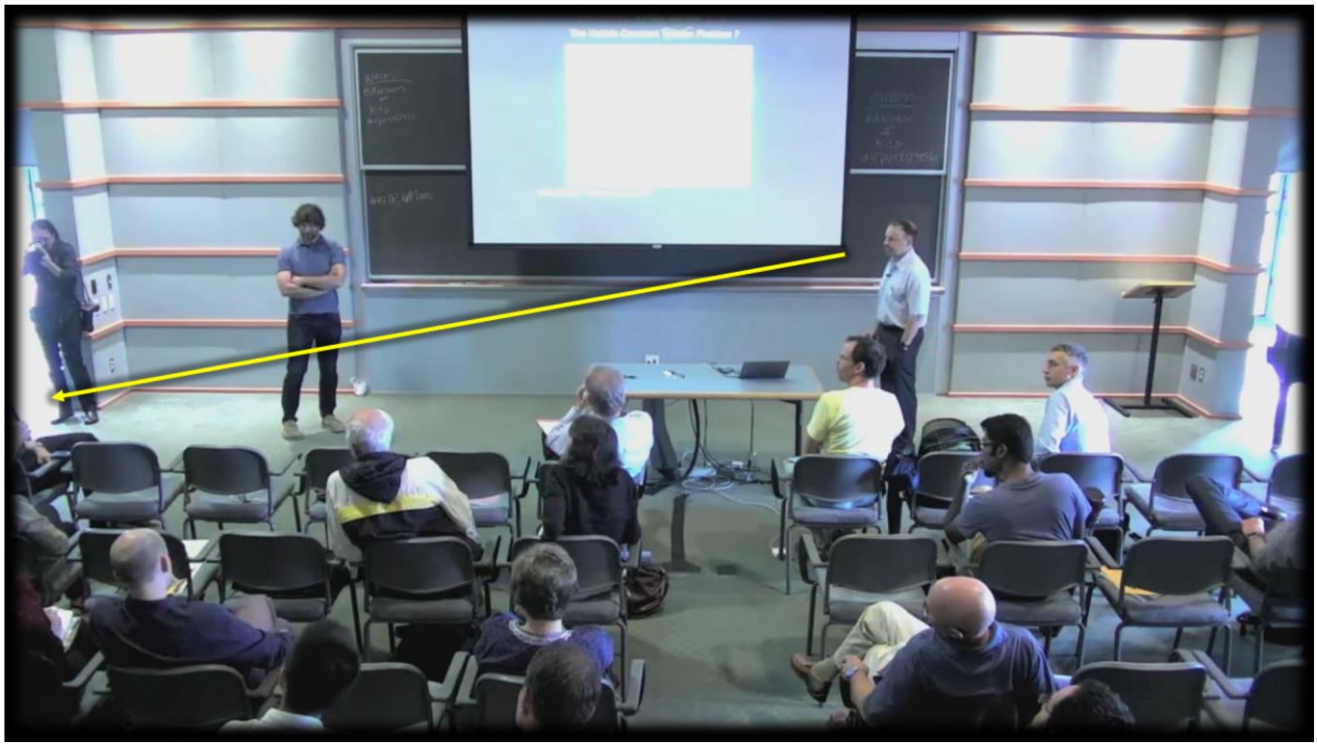
Over lunch on the first day, some of the attendees were talking about how to classify “levels of disagreement” between model predictions.

Silvia Galli (from the Planck satellite team) compiled this list:

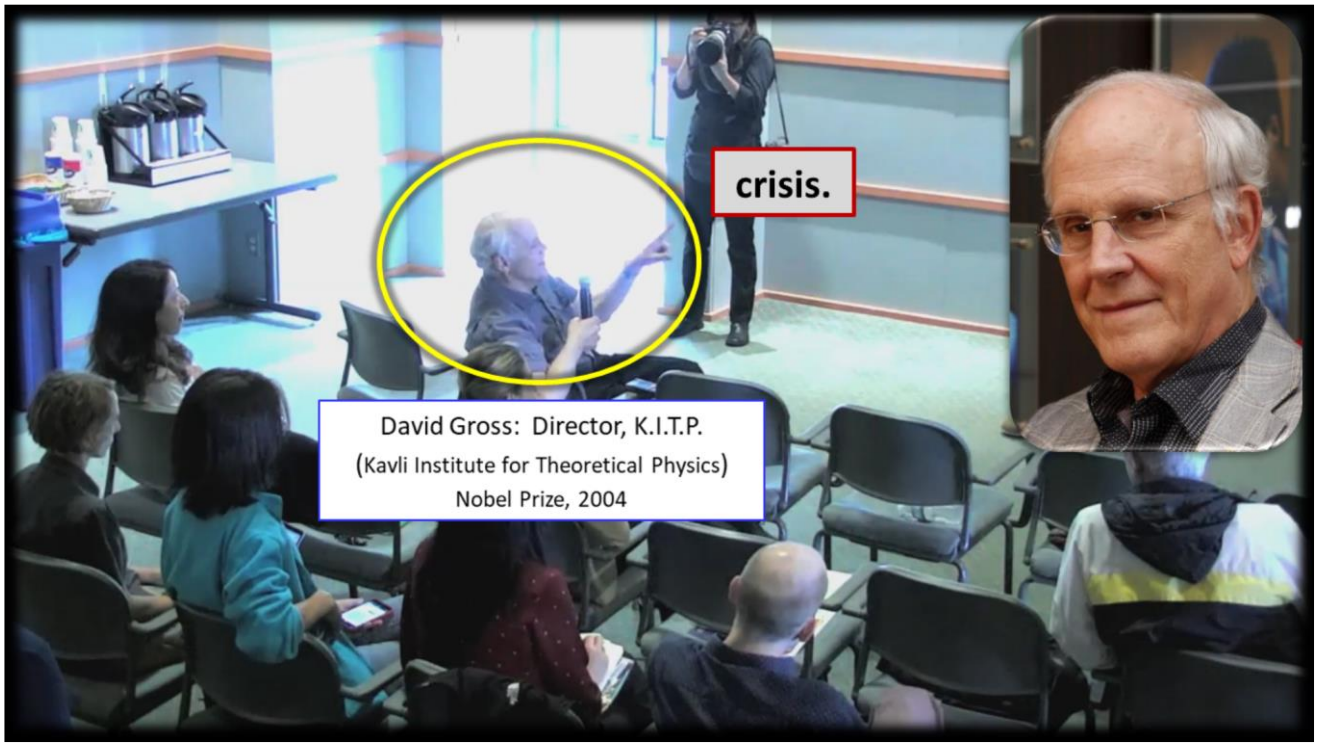
[…]

The point being that the disagreement between model predictions for (H_0) is now greater than 5 sigma.

Which brought to mind a moment from earlier in the day…



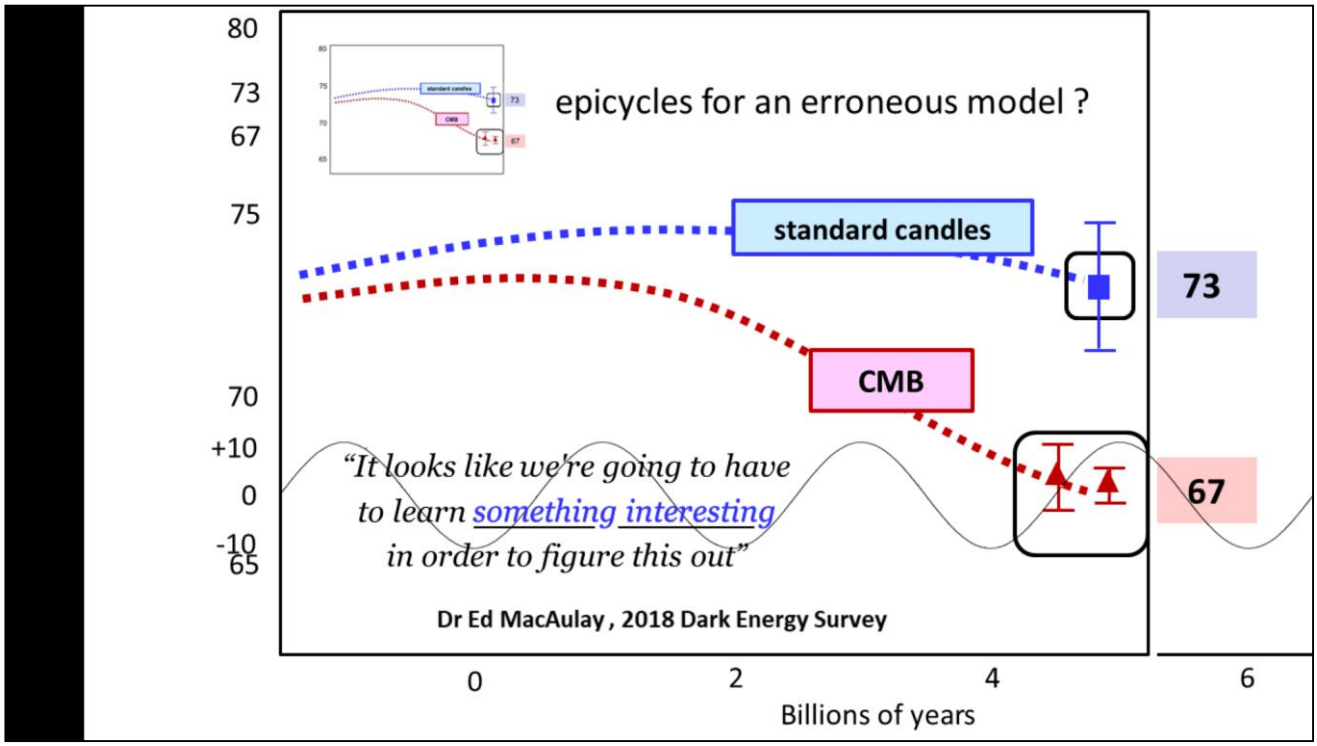
Things were proceeding as things do at cosmology conferences, when some guy over in the corner, front row, pointed out…



… that in his field (particle physics), when researchers have a discrepancy this big, they declare a "**crisis**".

This is David Gross, director of the Institute

(where the conference was held).



So here we have a couple of – apparently incompatible – predictions from our current "best fit" model for the history of the universe, prompting one researcher to sum up the situation like this:

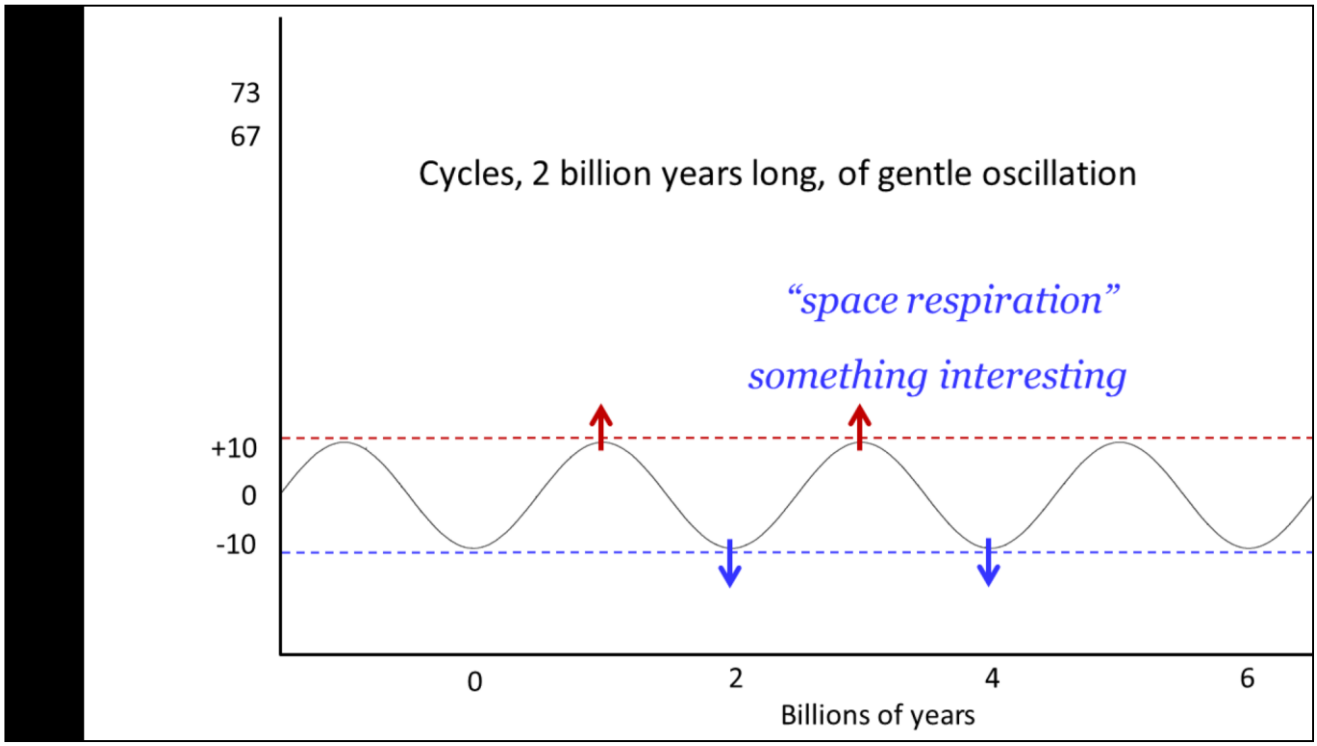
> "It looks like we're going to have to **learn something interesting** in order to figure this out."

As we're about to see, the Urantia Book suggests "**something interesting**". But first, a comment.

Each of these predictions comes from an attempt to fit data to a **ΛCDM** "hot Big Bang". But if the underlying model is **wrong**, or "not even wrong", then the finely tuned parameters of that model become like **epicycles**, helping to fit an erroneous model to increasingly inconvenient facts.

So what does the Urantia Book suggest?

It suggests… **two** large-scale motions of space.

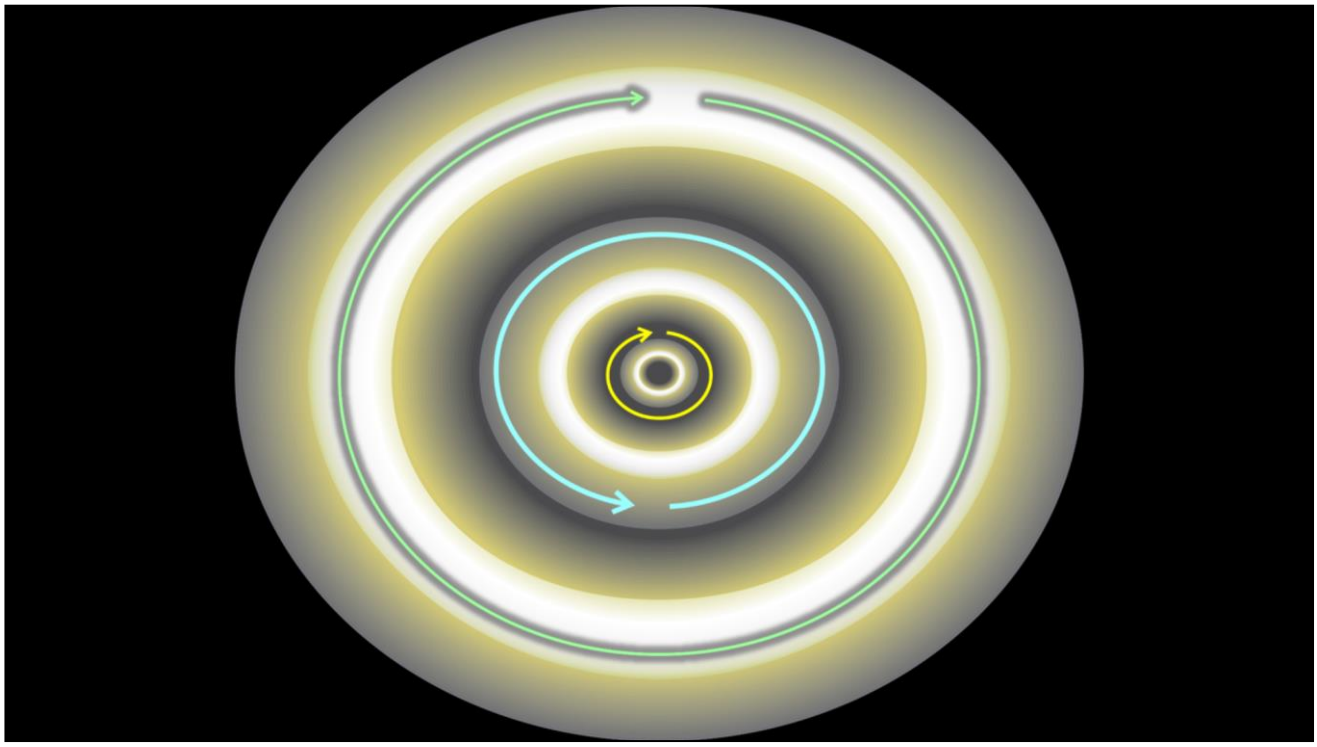


First:

Cycles, two billion years long, of gentle oscillation,

a periodic expansion and contraction of all space,

which the papers call "**space respiration**".



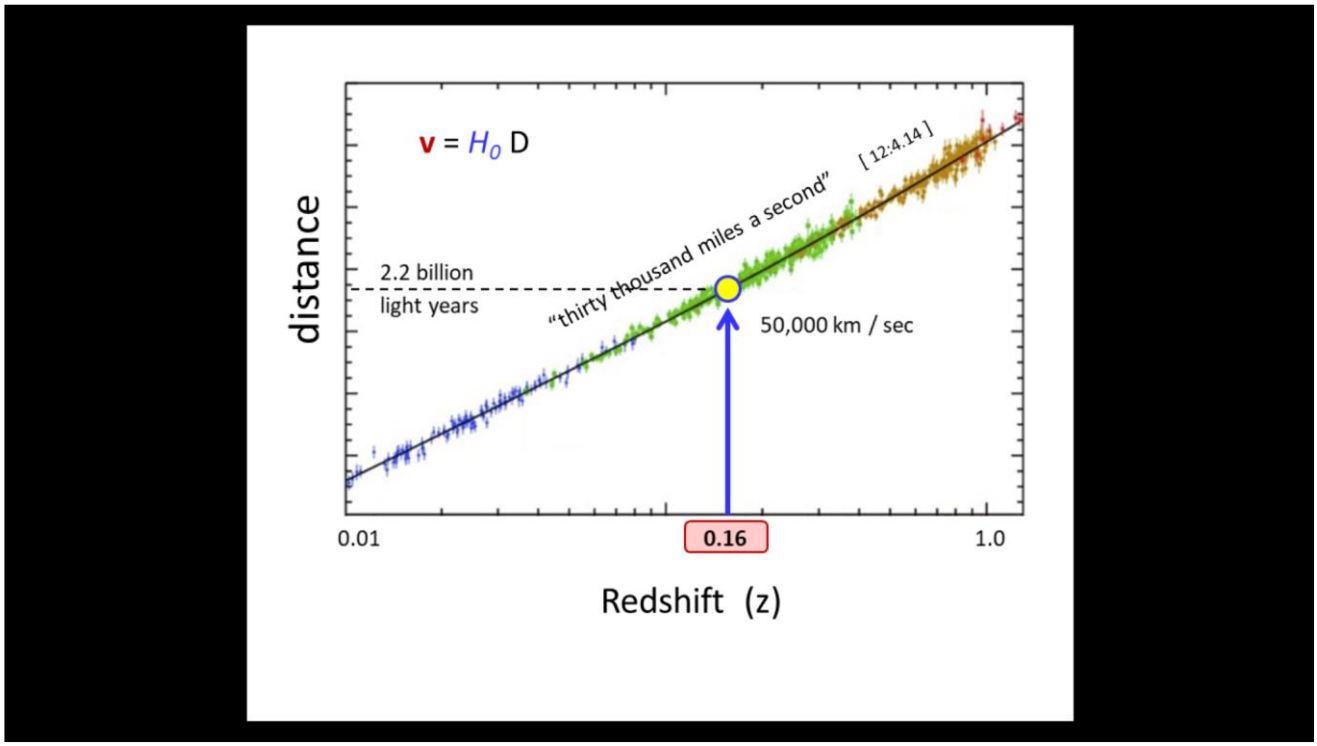
And **second**:
the counter-rotation of nested levels of outer space.

Ok but… can "**rotation**" and "**gentle oscillation**" explain the **systematic**, **distance-dependent** redshifts that astronomers actually observe?

And what about that microwave background… !?

Good questions. Let's see what the Urantia Book has to say.

We'll begin with "Hubble's Law".



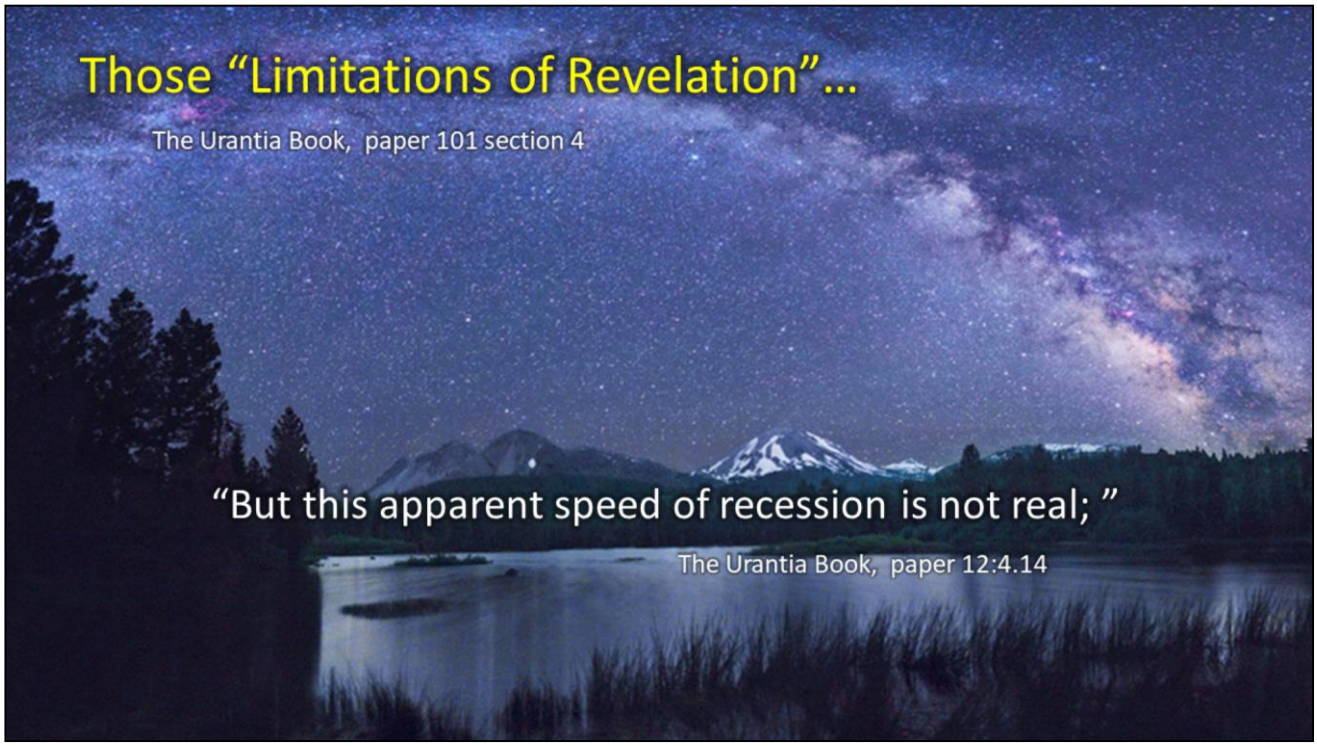
If Hubble's Law were true, then this plot says that, if we find a galaxy with a redshift of 0.16, then we can simply read a Hubble diagram to find that **that galaxy** must lie about 2.2 billion light years away, and be receding at about 50,000 km per second.

In other words, about… "**thirty thousand miles a second**", a speed which might sound familiar…

From 12:4.14, [quote]:

> "[…], it will appear that these far-distant systems are in flight from this part of the universe at the unbelievable rate of more than **thirty thousand miles a second**."

"**At the unbelievable rate.**" What does the Urantia Book say about this [quote] "**unbelievable rate**", this *apparent* "**speed of recession**" ?



…

" But this apparent speed of recession **is not real**; "

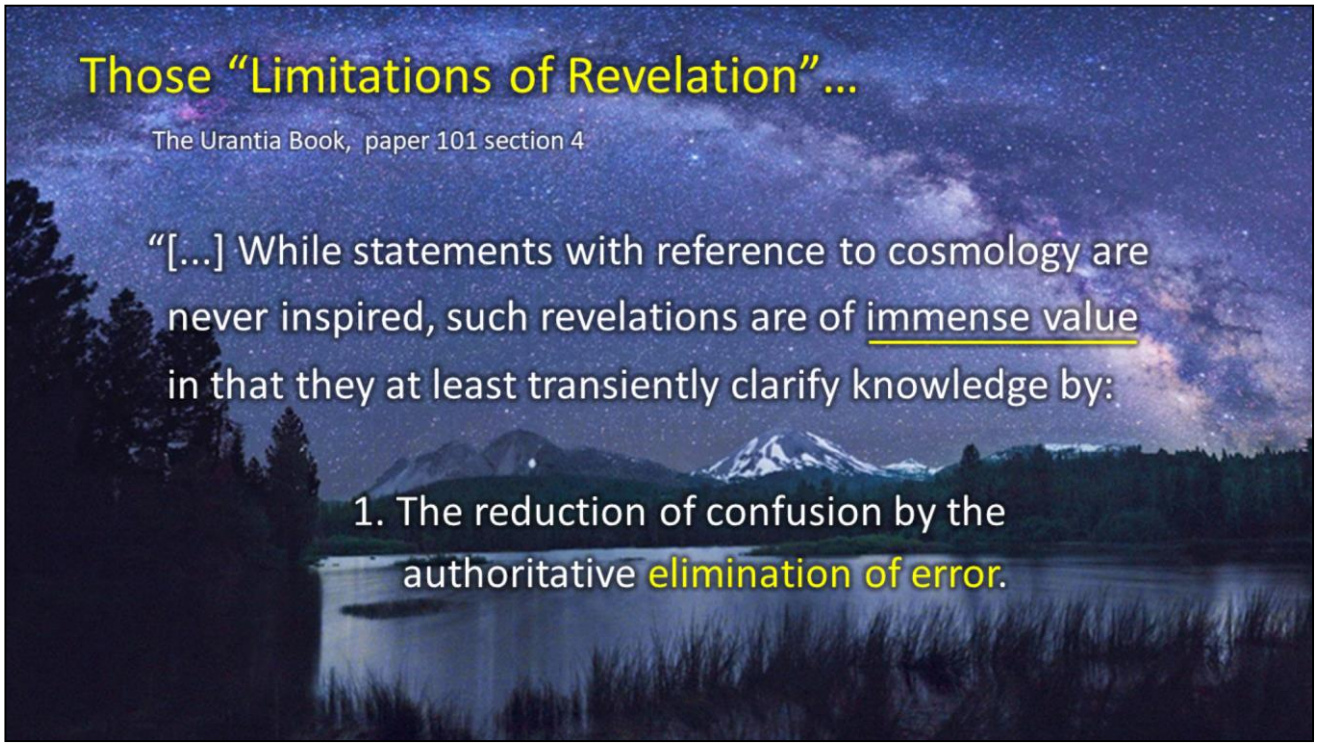
" **But this apparent speed of recession is not real;** " This statement is not presented as a **hypothesis** for us to test; it's presented as a **fact**, which the author is in a position to know.

They go on to explain that, beyond a certain distance, this red-shifting of spectral lines becomes [**quote**] "**wholly unreliable**" (12:4.14) as a method for estimating distance or speed.

Which brings us to those "**limitations of revelation**" discussed in Paper 101. In section 4, the authors explain that, with regard to science and cosmology, they were not free to say too much.

Like that *prime directive* in *"Star Trek"*, galactic civilizations don't interfere with developing cultures.

However, they do say that, if we're "barking up the wrong tree", they **can** tell us: "**That's the wrong tree.**"



From Paper 101 section 4 [quote]: (1109.6, 101:4.5)

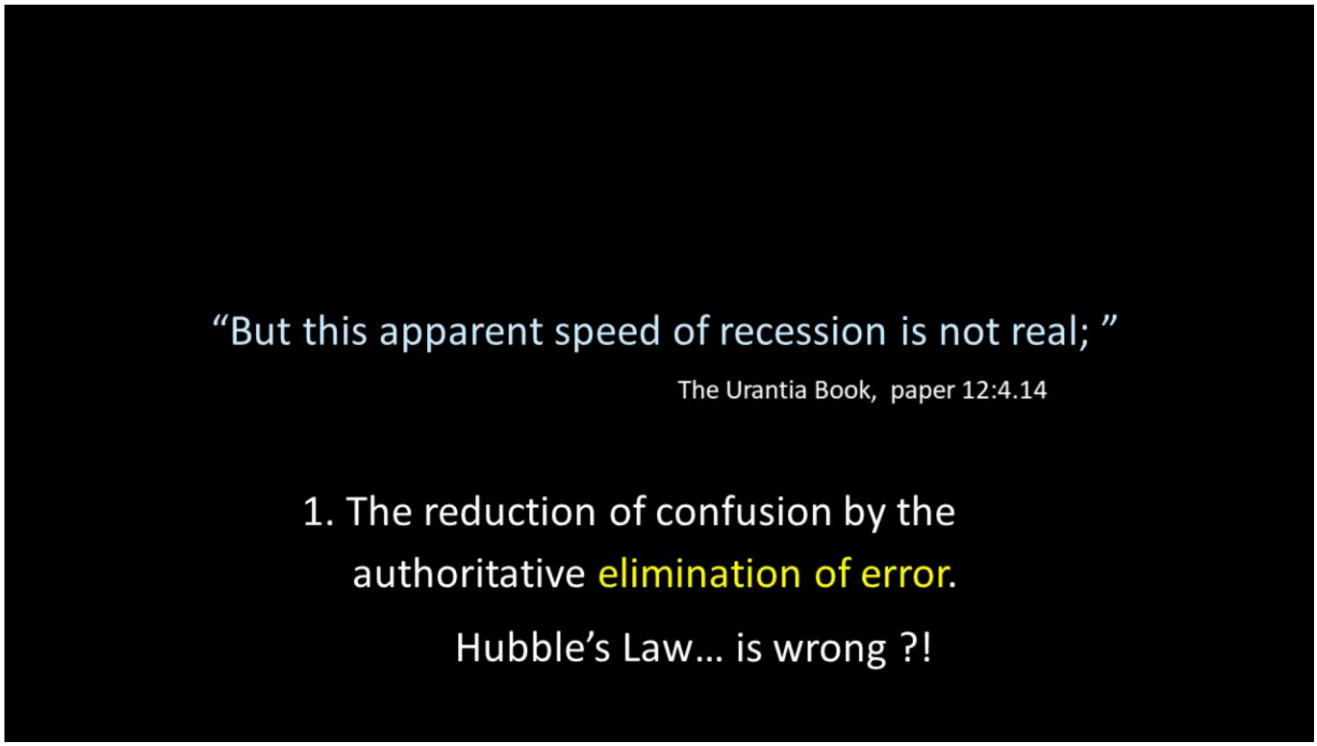
> "While statements with reference to cosmology are never inspired, such revelations **are** of **immense value** in that they at least transiently clarify knowledge by: […]

They then list 5 ways in which this sort of "limited revelation" can be of "**immense value**".

The **first** goes like this [quote 101:4.6]:

> "1. The reduction of confusion by the authoritative elimination of error."

"The authoritative elimination of error".



"But this apparent speed of recession **is not real**; " (12:4.14)

Is this a case of **#1**:

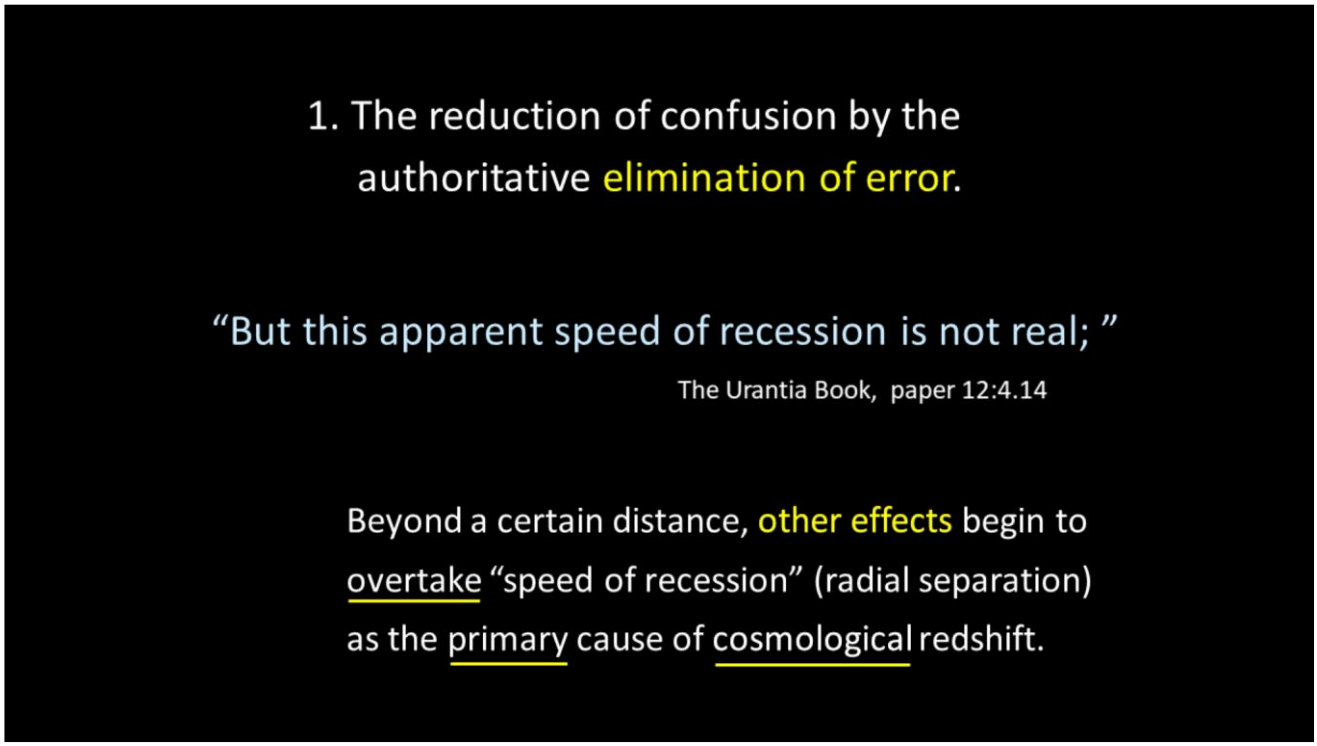
"The reduction of confusion by the authoritative elimination of error."?

As far as I can tell, this question of "**redshift**" and "**Hubble's Law**" is the **only** place in the papers where the authors tell us that one of our scientific assumptions is **wrong**.

Elsewhere, they either **echo** prevailing ideas (like that distance to Andromeda), or **reveal** things beyond human capacity to prove (like ultimatons).

But here, they point to a particular – and **critical** – assumption: about "**Hubble's Law**"; and tell us bluntly that it's **wrong**.

So what about those redshifts of distant galaxies?

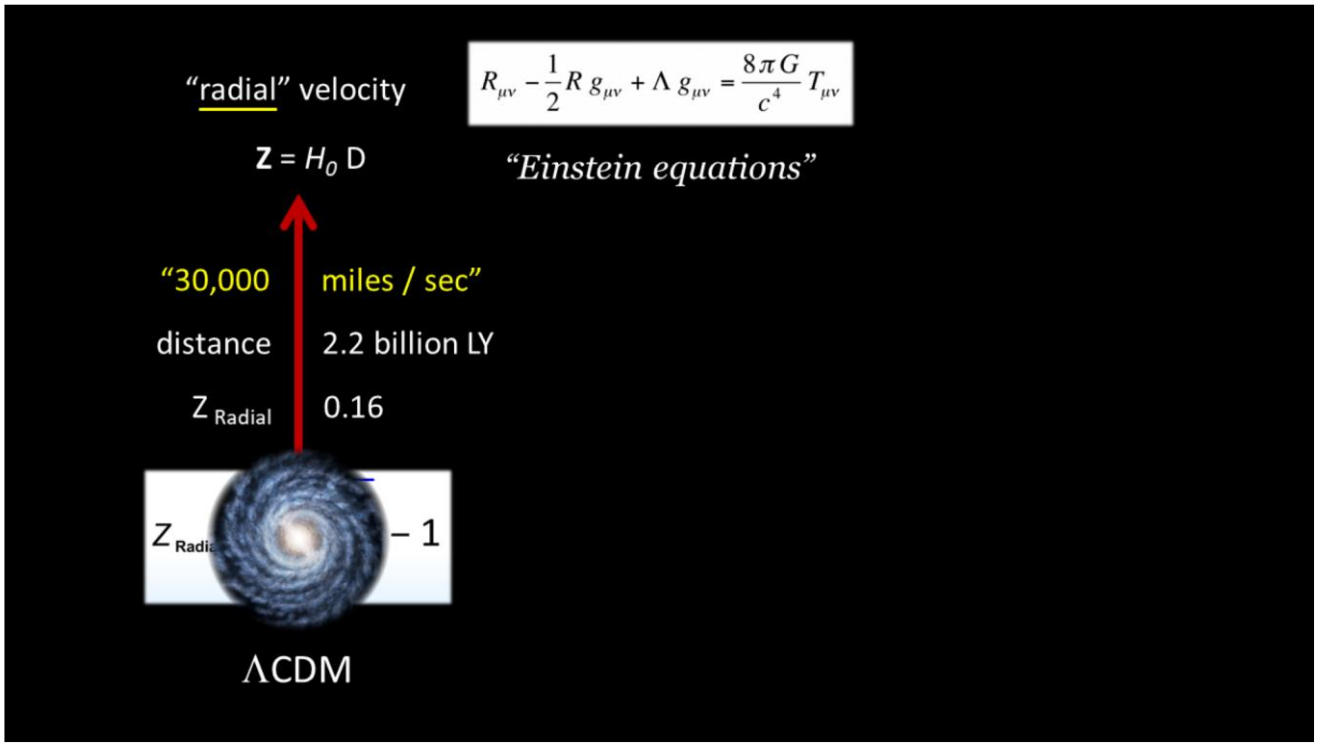


In paper 12 section 4.14, the author claims that, beyond a certain distance, **other effects** begin to overtake "**speed of recession**" (or radial separation) as the primary cause of cosmological redshift.

"Other effects"?

What else could be causing a systematic, distance-dependent redshifting of spectral lines?

Let's take a look.



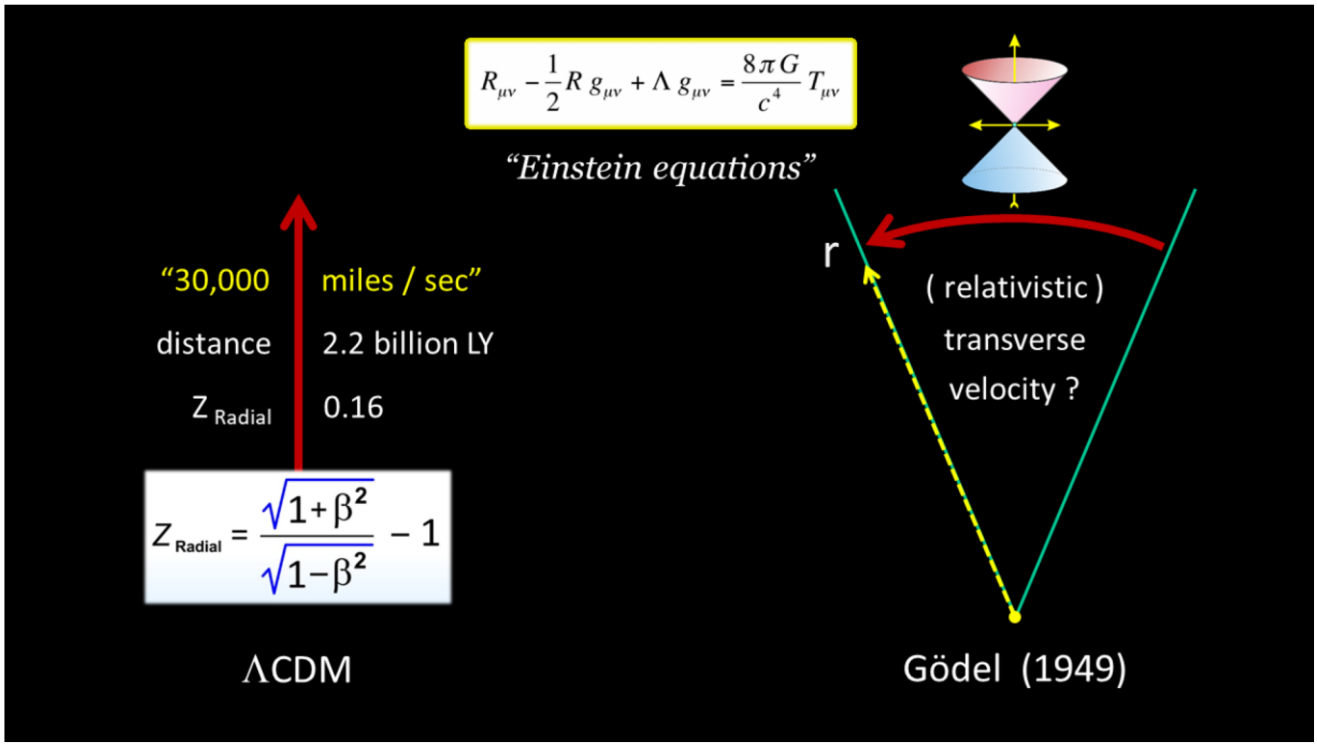
In "Big Bang" models, an assumption is that redshift is proportional both to **distance**, and to **velocity**; the further away a galaxy is, the greater its apparent "speed of recession". And thus the greater the redshifting of its spectral lines.

So for a galaxy with measured redshift of **0.16**, our current "Big Bang" model (**ΛCDM**) predicts that galaxy must be about 2.2 billion light years away, and be receding at a rate of "**30,000** miles a second".

But from Einstein, such a rate of recession implies…
a relativistic Doppler shift of **0.16** !

This convenient match is one of the features of **ΛCDM**: that with a few nips and tucks, it can be made compatible with Einstein's "faint glimpse", about space and time and gravity.

In this sense, this "**model**" is said to be "**a solution**" of Einstein's equations.



But in 1949, a curious character pointed to another, **very different solution**. The character was Kurt Gödel, and the occasion was Einstein's 70th birthday.

What Gödel had noticed was that, if the universe were not simply **expanding**, but also **rotating**, then funny things would happen to space and time.

For example, in a rotating universe, Einstein's equations appear to allow travel backwards in time, so-called "closed time-like curves".

[which cosmologists tend to dislike.]

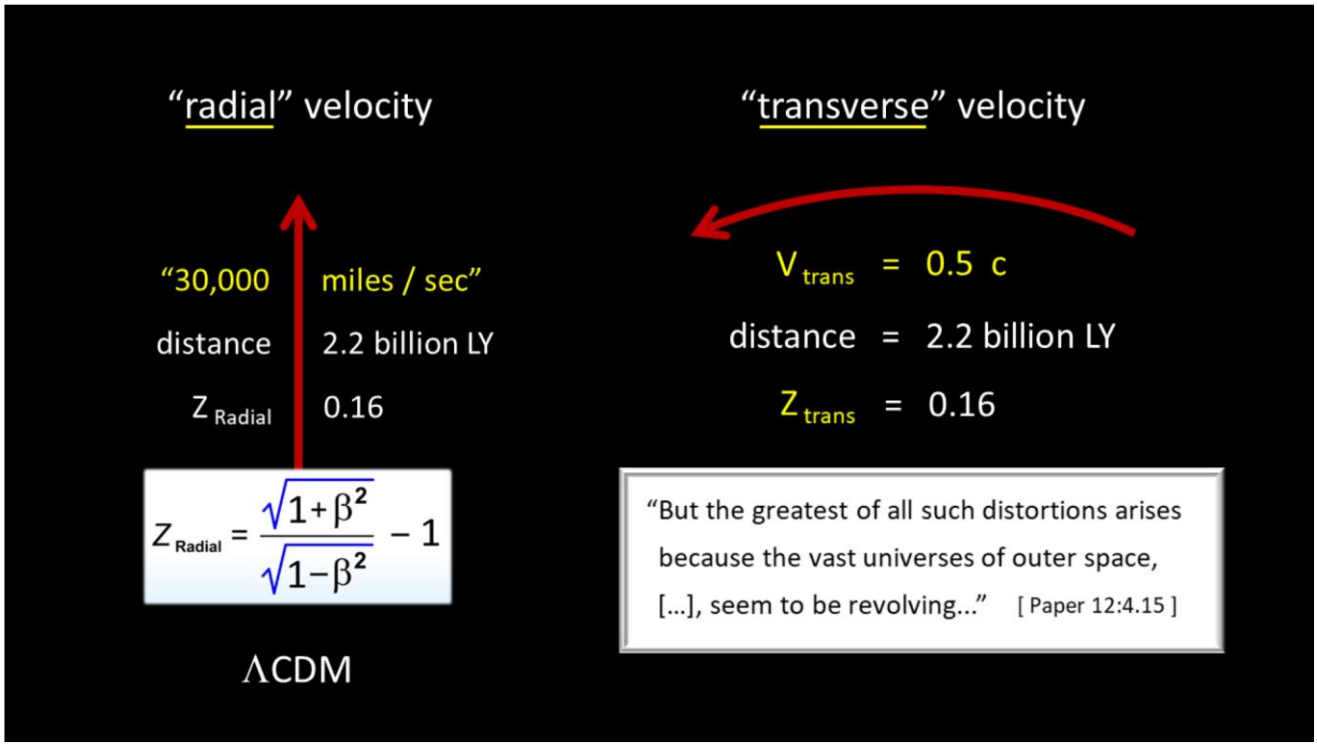
Also, a rotating universe implies some kind of **center of rotation**.

[which cosmologists really dislike!]

So Gödel's curious solution remained, like the man himself, a curiosity.

But it **did** get people thinking: *what if…* the universe were rotating? After all, absolutely everything in the universe either spins or rotates…

Why not the universe itself ?



But if the universe *were* rotating, and if we were near the center, then once again, Einstein has something to say:

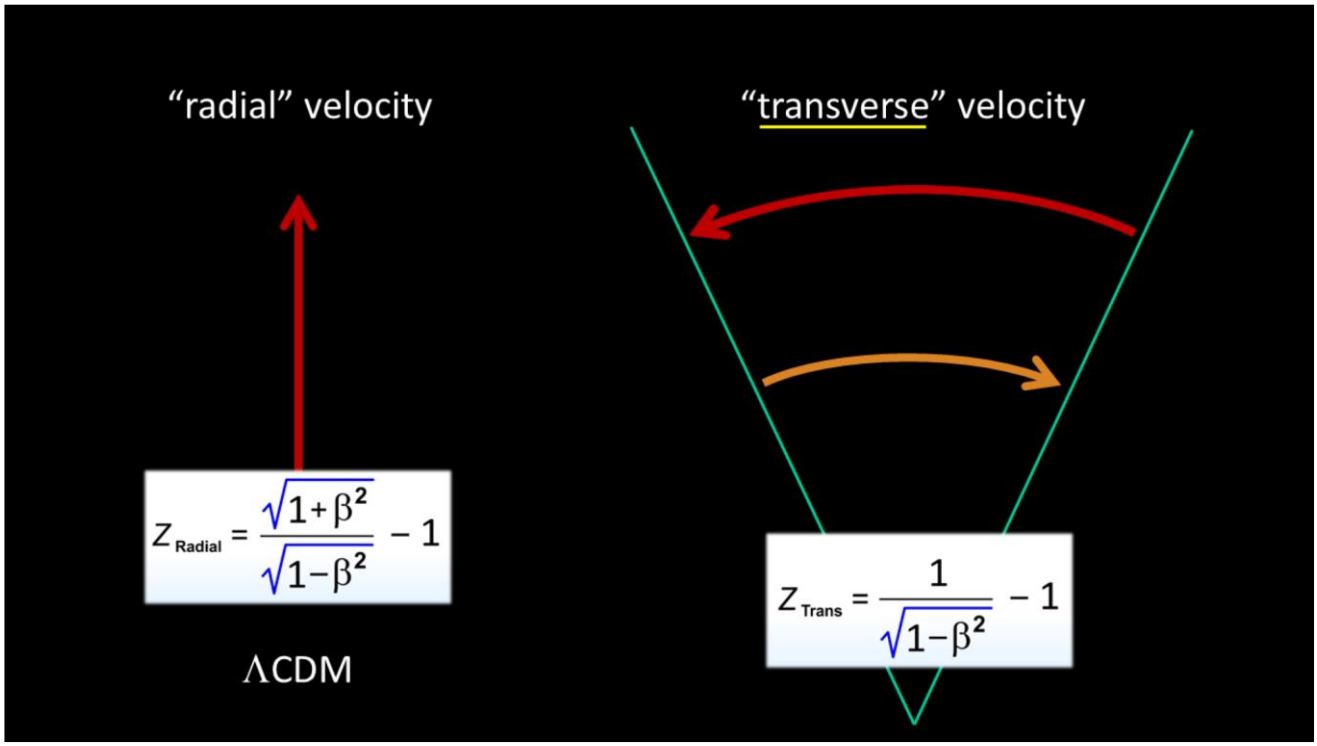
If that same galaxy, 2.2 billion light years away, were moving… not **away** from us, but **sideways** – across our line of sight – at a relative rate of half the speed of light, then Special Relativity predicts that we'd measure… a redshift of **0.16**.

Same redshift as predicted by **ΛCDM**.

Speaking about these redshifts – this **distortion** of spectral lines – the Urantia Book writes [quote]:

> "But the greatest of all such **distortions** arises because the vast universes of outer space, [...], seem to be revolving… " (12:4.15)

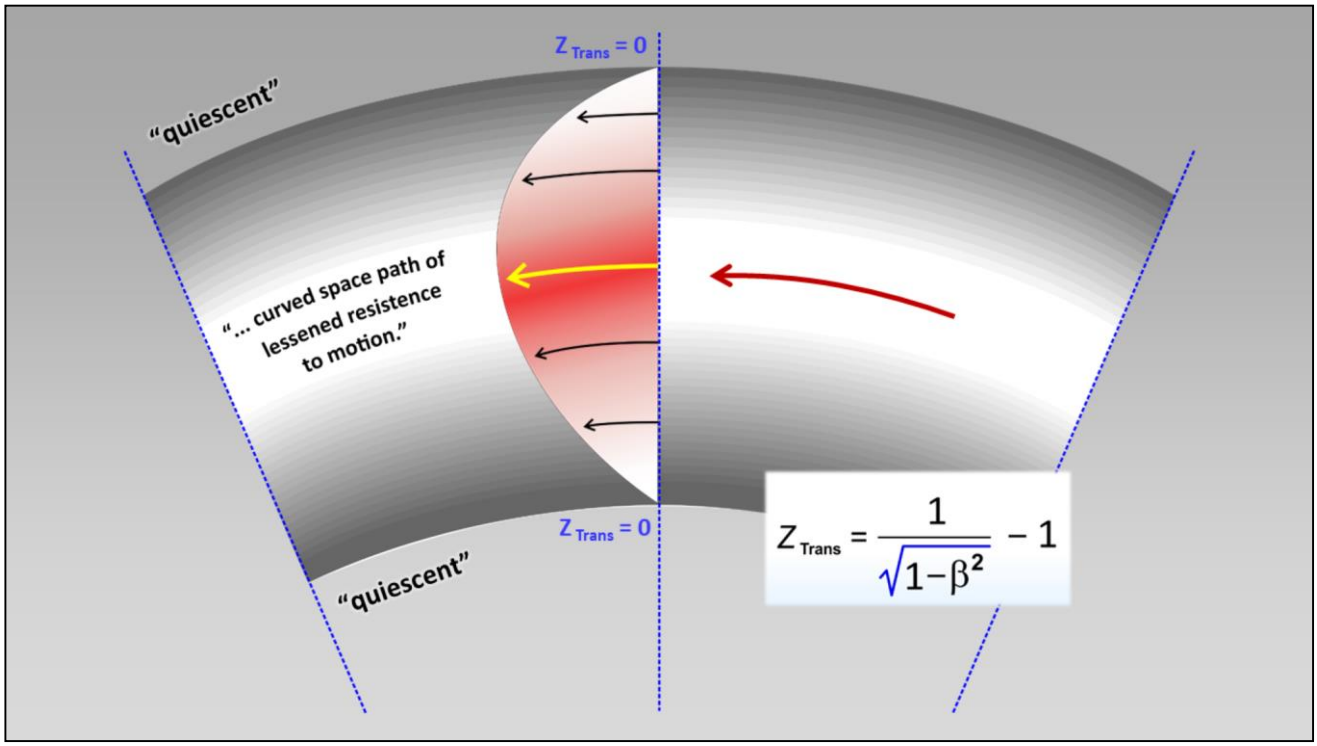
The claim in paper 12 section 4 is that the main component of the enormous redshifts of quasars and distant galaxies comes…



… **not** from a runaway expansion, but from **rotation**.

Which brings us to the Urantia Book's unique idea: of nested, counter-rotating levels of outer space.

The idea is that…



… entire "outer space levels" are rotating around our place in space,

thus appearing to move sideways, relative to us.

In paper 11:7, these "outer space levels" are described as [quote]

> "**curved space paths of lessened resistance to motion**" (11:7.8)
>
> "**… surrounded on all sides by relative motion-less-ness.**"

Notice, at the inner and outer margins, a space level is "relatively motionless"). So in each space level, we'd expect little or no sideways motion at the edges, rising to some maximum flow midstream.

Now, about motion along these curved space paths,

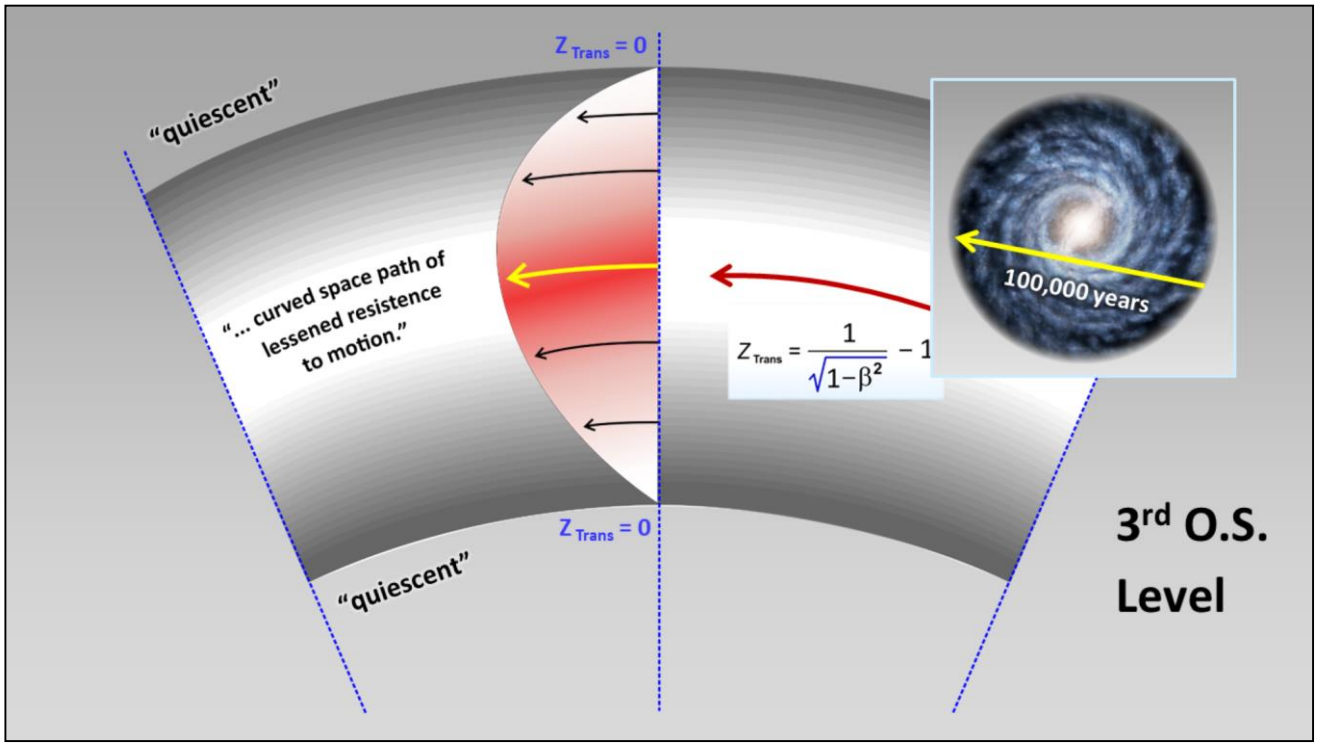
we're not talking about the motion of galaxies **through** space,
but rather, the transverse **motion of space itself**.

Which I'm going to assume is fast enough to be **interesting**.

Ok. Now here, let's remind ourselves how excruciatingly **SLOW**

the speed of light becomes… on this sort of **cosmic** scale.

For example…



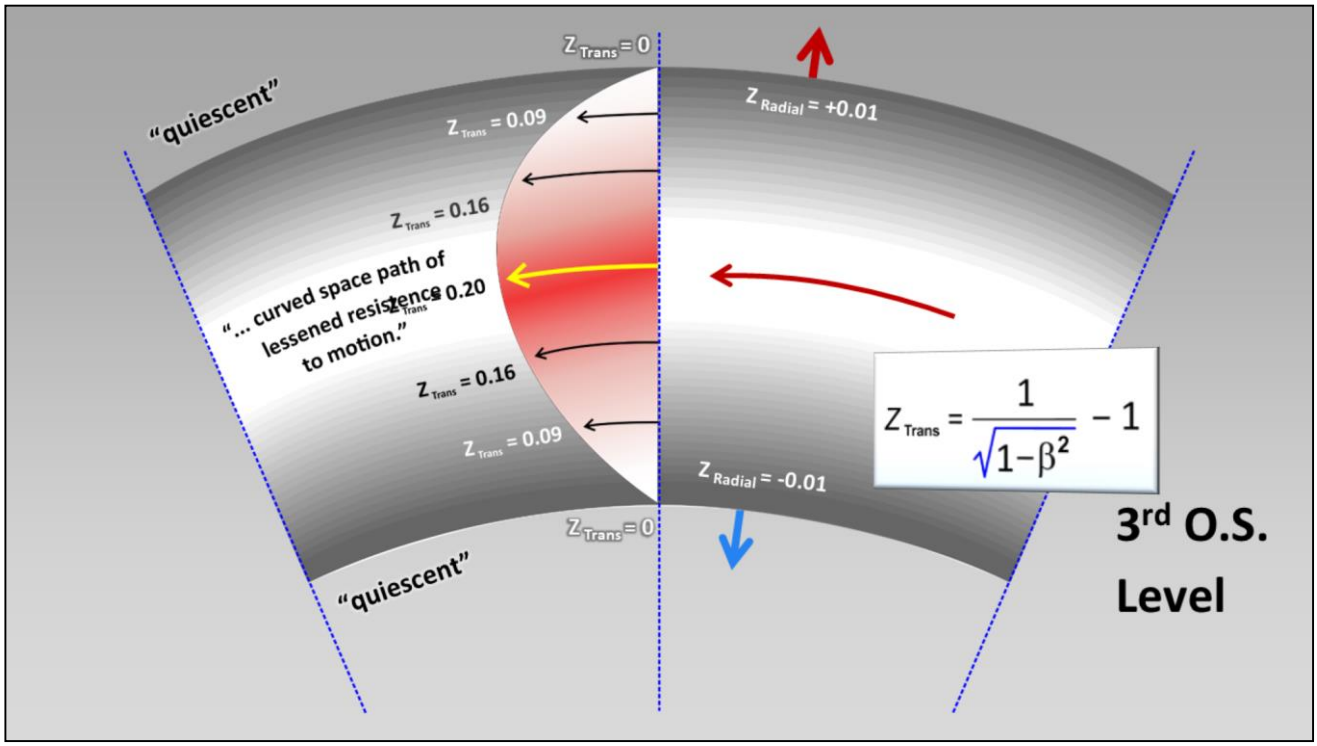
… imagine this is a segment of the **3rd outer space level**, and that this dot – *this tiny little dot* – marks the spot, 2 billion light years away, where a telescope finds a Milky Way-sized galaxy.

Now "**pause to consider**". It takes light – travelling at the **speed of light** – 100,000 years to cross that galaxy. **100,000** years to cross that "dot", those few pixels in our best telescope's field of view.

What this means is that, given current telescopes and techniques, there's no way for astronomers to detect sideways motion of a galaxy or quasar 2 billion light years away.

[but soon… "**nano-lensing of quasar caustic crossings**"? Watch this space !]

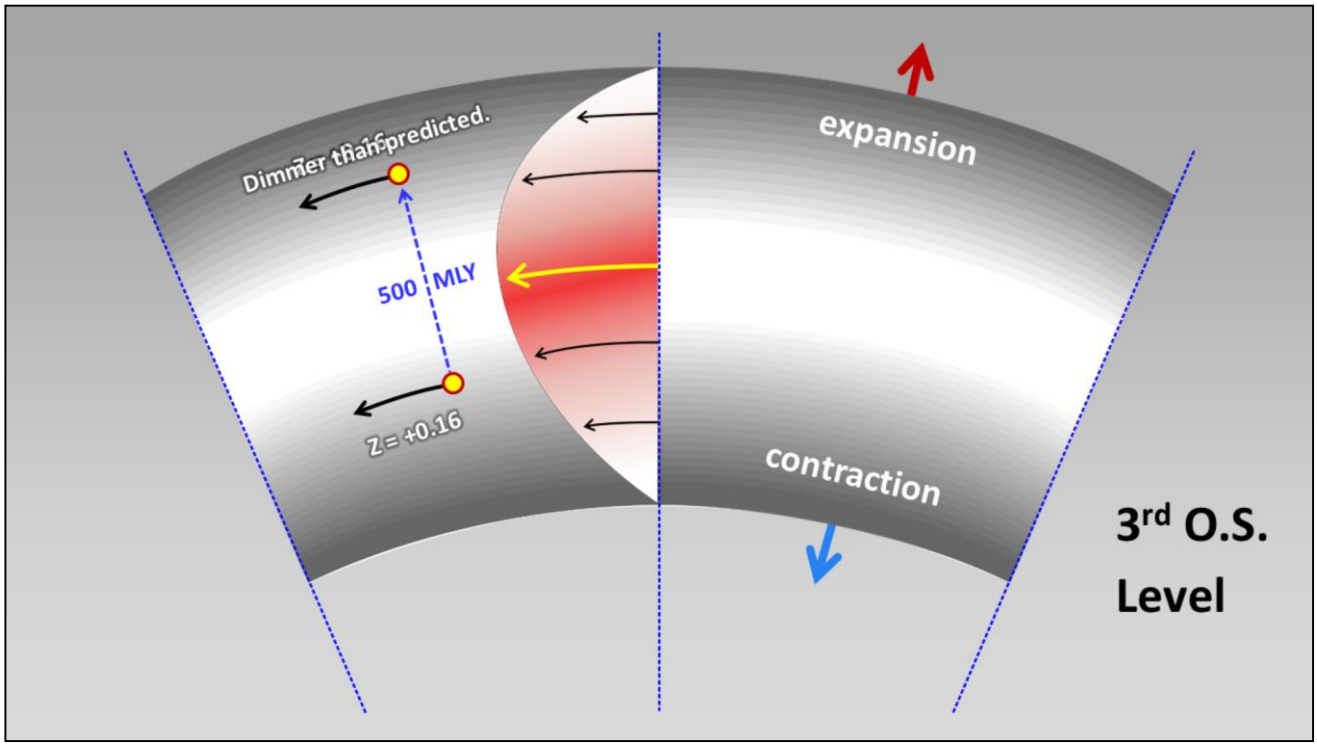
As we'll see in a moment, for this galaxy to be "going with the flow", cruising along this "**curved space path**", it must be moving across our line of sight at a **significant fraction** of the speed of light.



Given the possibility of significant sideways speed,
– of **relativistic**, **transverse** velocities –
plus cycles of space respiration,

Einstein gives us a simple explanation for the sort of systematic,
distance dependent redshifting that astronomers see…

This slide gives a hint of the idea…



… and here's an example of **how this might be interesting**:

Imagine astronomers find two identical Type 1a supernovae, one about here, and another out here, 500 million light years further out.

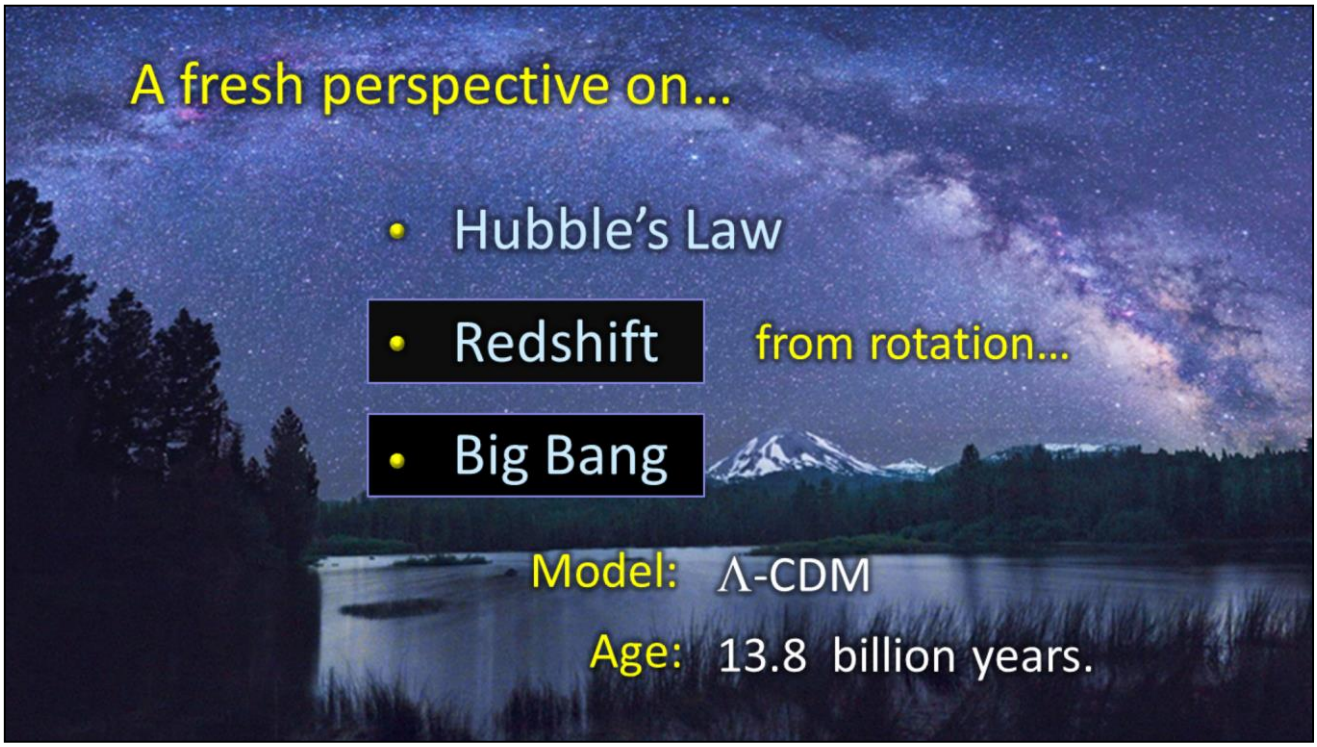
As before, let's say that, relative to us, both are "going with the flow", moving sideways at half the speed of light. From this sideways motion, both supernovae get a redshift of 0.16.

Each would also get an extra redshift (from expansion), or blueshift (from contraction), depending on the phase of space respiration.

But this second one is much more distant than the first, and so would appear… dimmer than expected. Or rather, dimmer than predicted by simple Big Bang models.

Which might **LEAD** cosmologists to propose something like, well, an… **accelerating expansion due to dark energy** ?

In other words, **Λ-CDM**. For example.

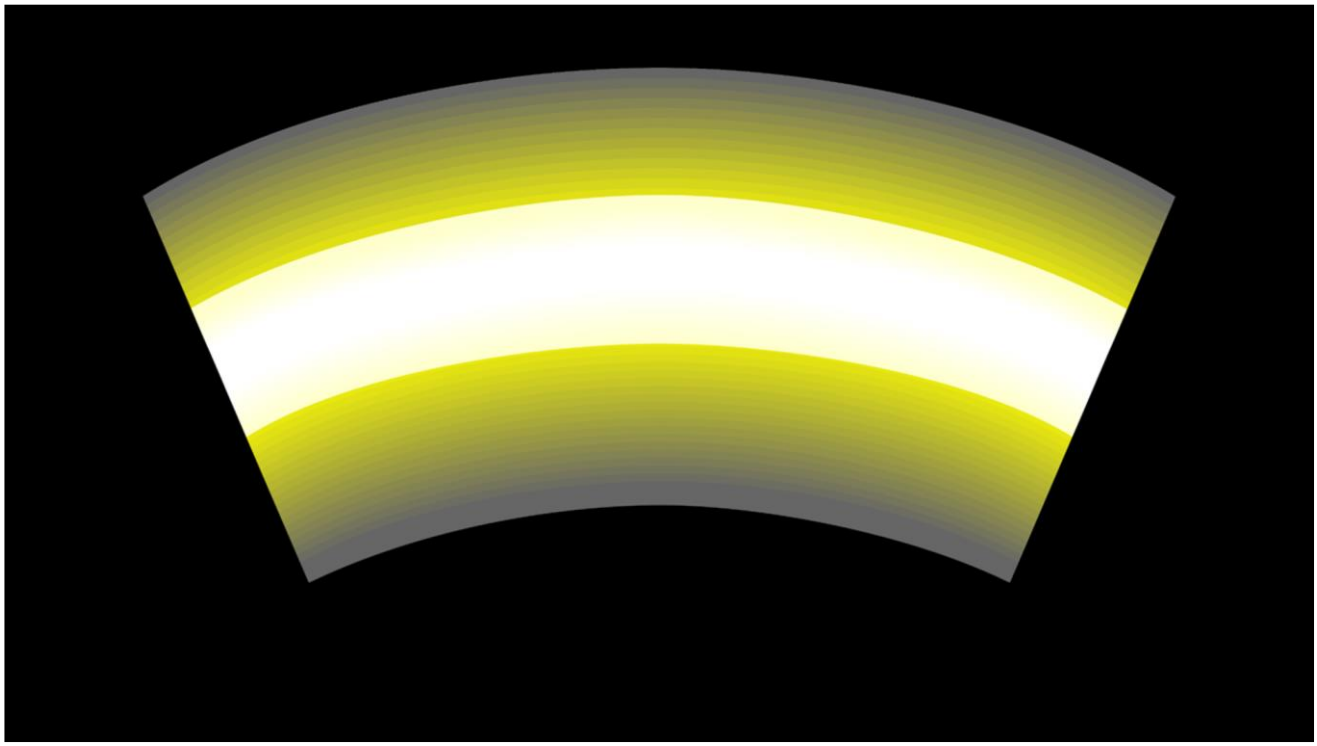


So, given that we **<u>CAN</u>** get **systematic, cosmological** redshift from **<u>relativistic</u>** rotation,

then the Urantia Book shows how we might replace the old idea of a "Big Bang"…

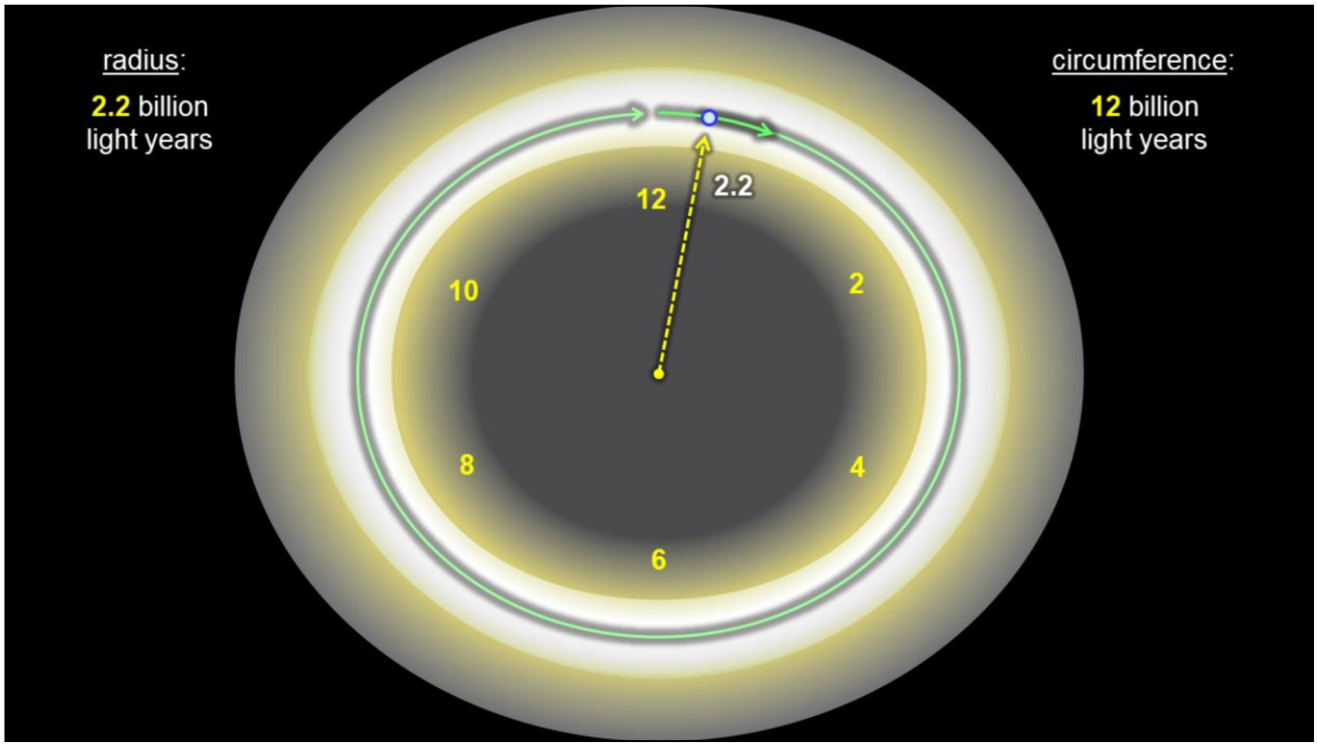
… with “space respiration”,

and counter-rotating “levels of space”.



[**transition**]

First, to get a feel for such **relativistic** transverse velocities, …

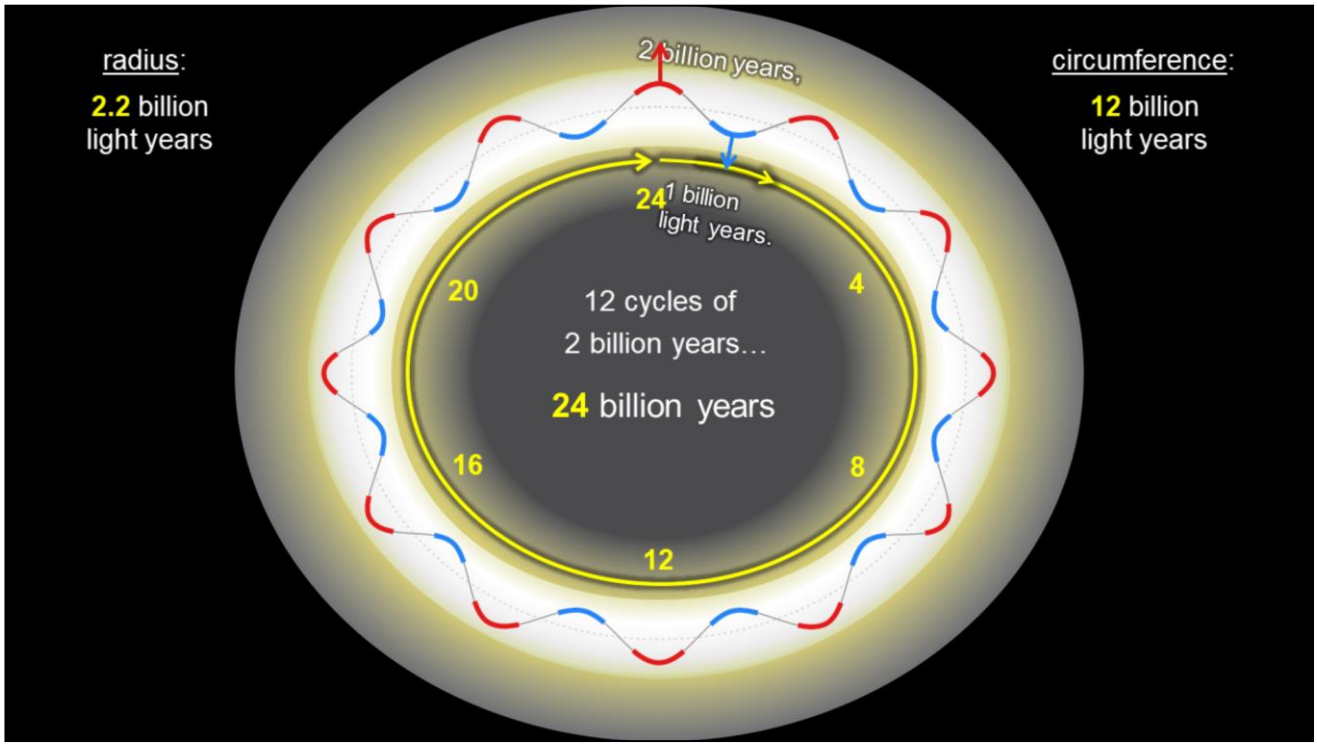


… let's think about a single cycle of "**space respiration**",
2-billion years long.

For a billion years, this entire space level expands;
for the next billion years, it contracts.

Now consider our target galaxy, 2.2 billion light years away,
say, somewhere near the midstream flow of this "curved space path".

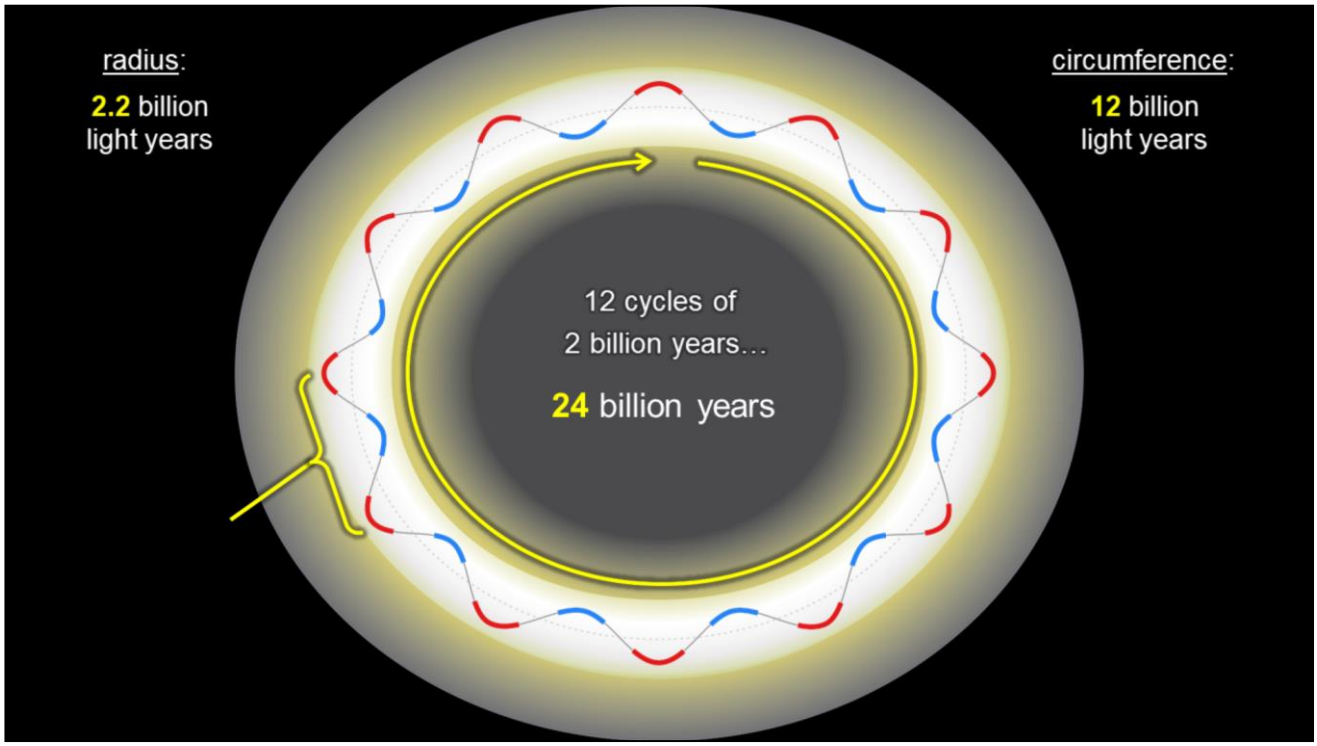
At a radius of about two billion light years, we'd have a circumference
(once around this ellipse) of about 12 billion light years, more or less.



So if our target galaxy were “going with the flow”,
2.2 billion light years away, at half the speed of light,
then in two billion years – a entire cycle of space respiration –
it would move… only about **one** billion light-years.

so it would take **12** of these 2-billion-year cycles,
or **24 billion years**, to go all the way around.

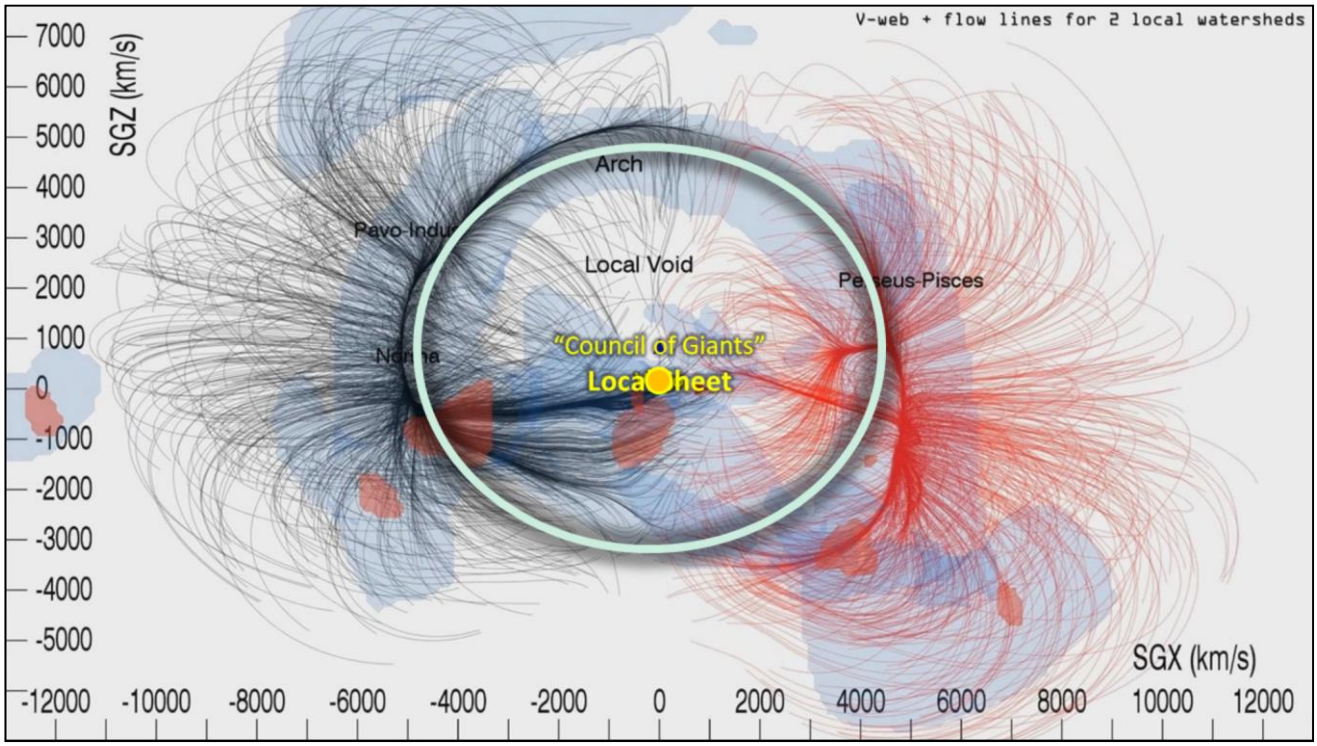
Average measured redshift: **0.16**,
periodically perturbed by the expansion and contraction of all space.



Once again I should emphasise: this is **not** the scientific method.

This is simply an exploration of unorthodox and ambiguous ideas.

So we have to wonder… has astronomy revealed any support for a model like this?



Well, there is this:

Our place in space appears to be ringed by a flow of galaxies.

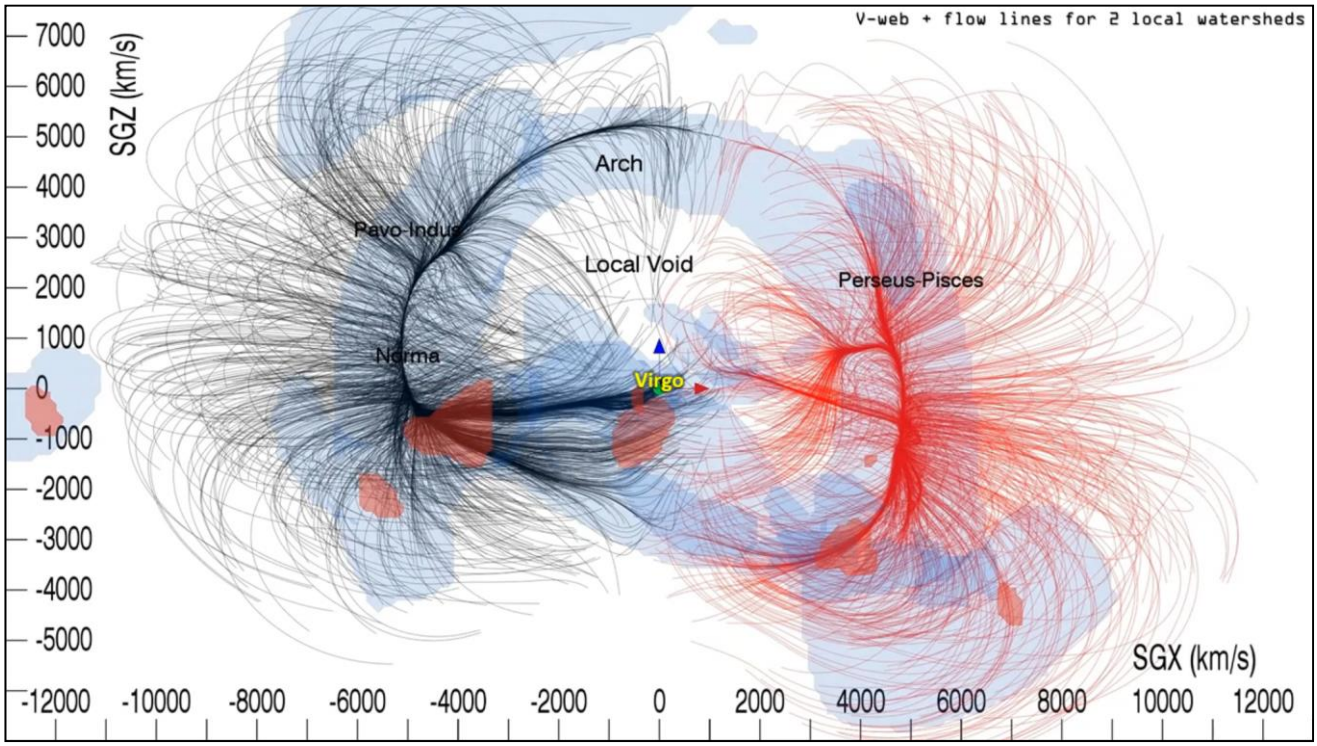
This is a snapshot of work from 2014, by Brent Tully's group,

showing "supercluster watersheds", surrounding the Local Sheet.

Which surrounds McCall's "Council of Giants".

Which surround us.

We're in here, near **Virgo**, our local cluster.



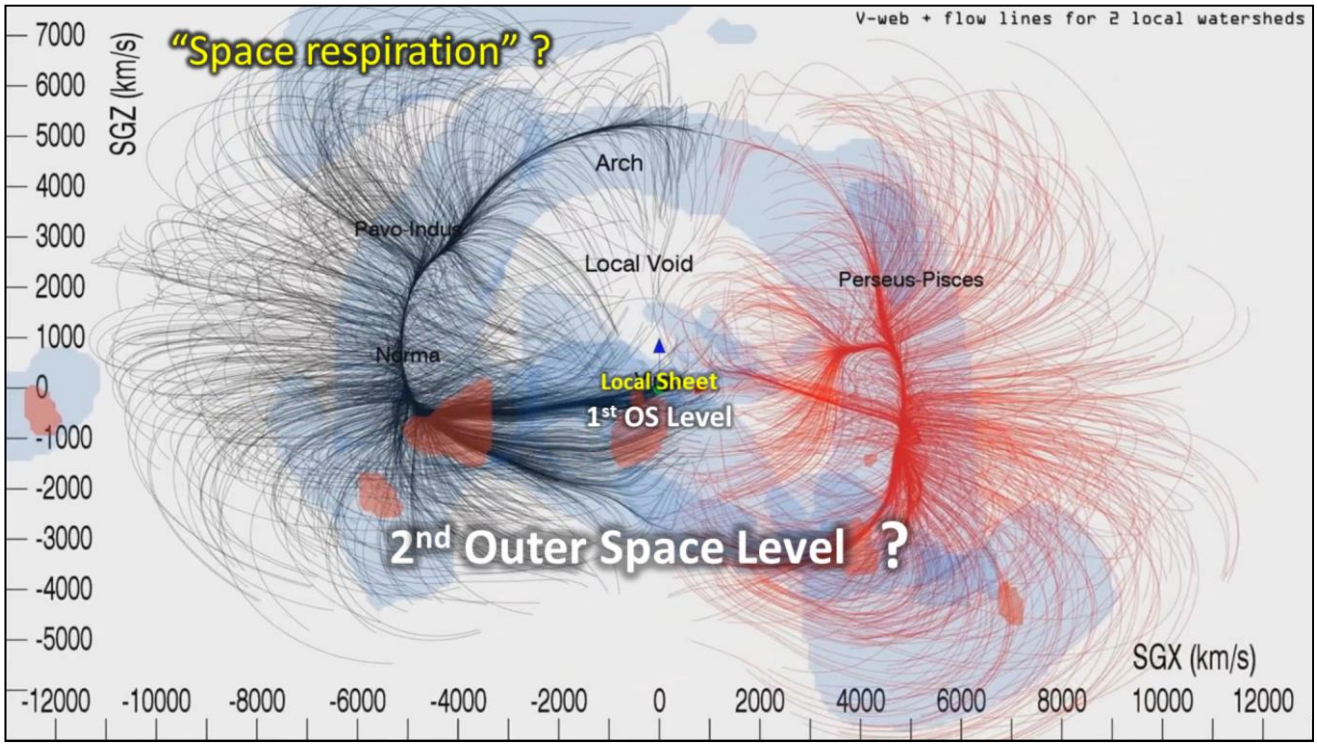
[Movie]:

From "**Laniakea**", https://vimeo.com/104910552

--- Tully CosmicFlows-2 ---

--- Tully CosmicFlows-3 ---

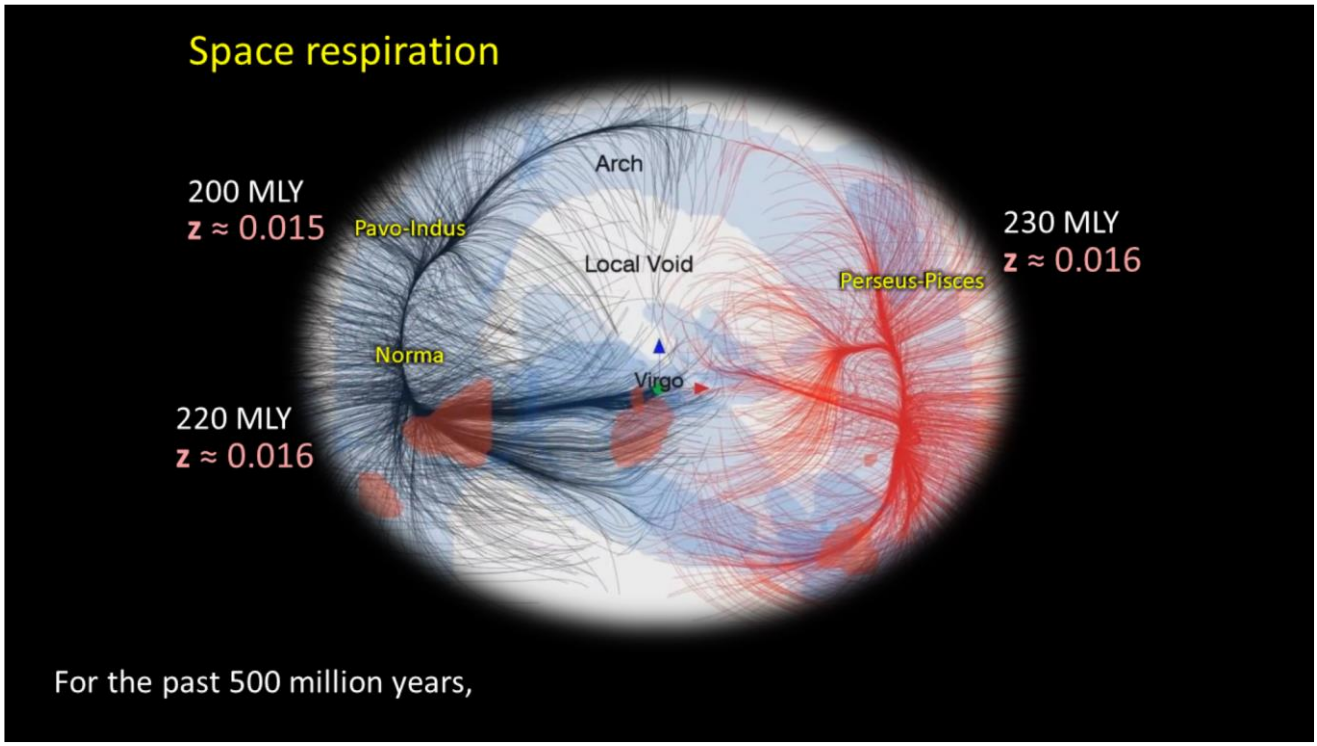
[**Implied velocities**, wrapping around our region of space.]



Allowing for some confusion about what's actually flowing where, if we think of the Local Sheet (here in the center) as the Urantia Book's "**first outer space level**", then this inferred flow of superclusters might indicate the **second**…

Well, obvious question: what about redshifts for all these clusters?

And is this consistent with the idea of "**space respiration**"?

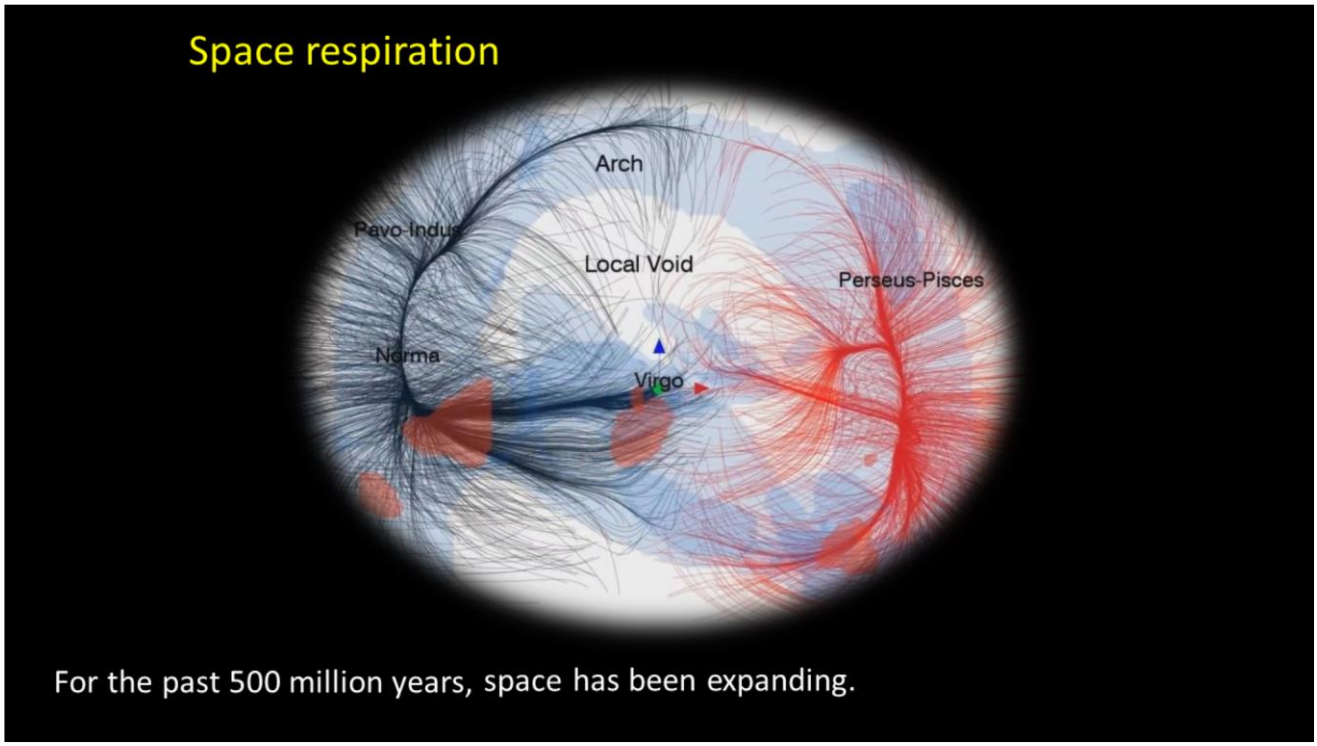


Regarding **redshift** and **space respiration**, the plot thickens:

- Here in the Norma cluster (about **220** MLY's away) galaxies have redshifts around **0.015** to **0.017**.
- Over in the Perseus-Pisces chain (about **230** MLY's away) clusters have similar redshifts.
- Likewise, up here in the Pavo-Indus group.

Now, in 1934, the author of papers 11 and 12 wrote that the current cycle of "**space respiration**" is about half way though its expansion phase.

In other words, for the past **500** million years, …



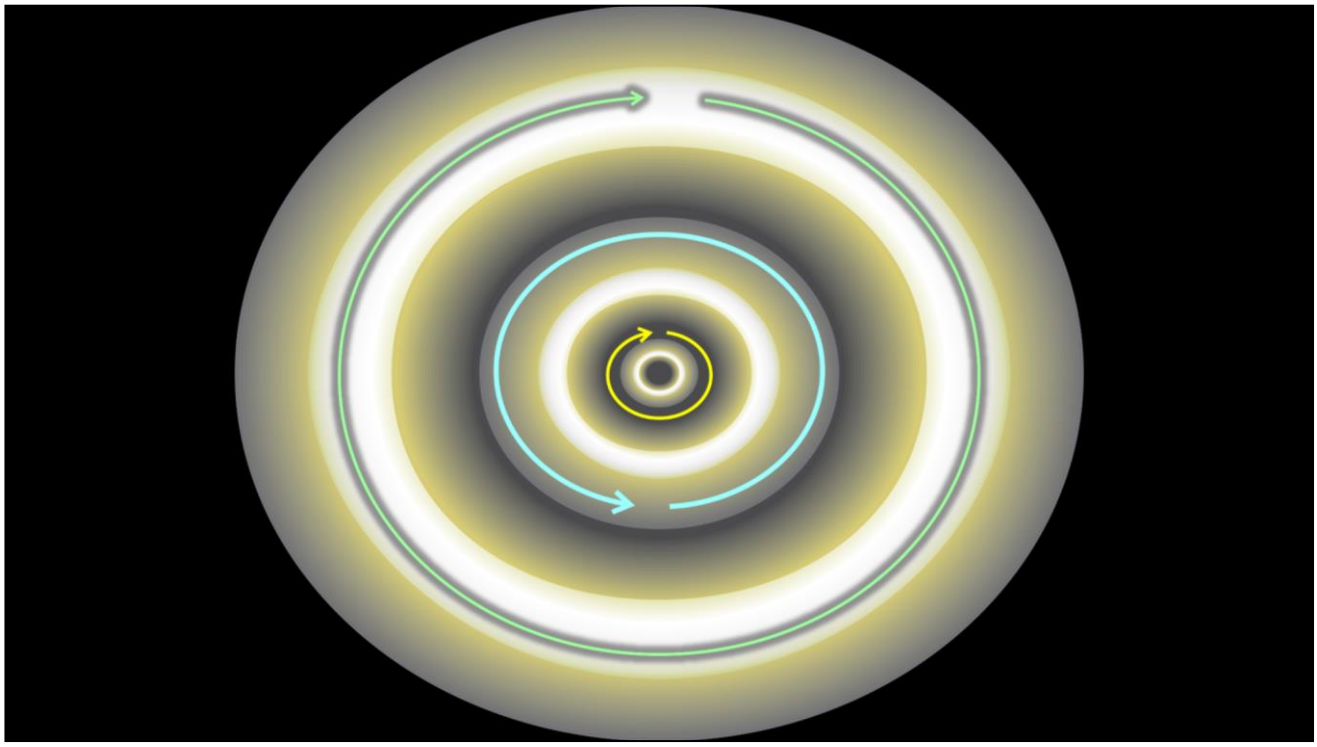
… pervaded space has been expanding.

So for this ring of nearby, "low redshift" regions (less than **300** MLY away), the last **500** million years – **of continuously accelerating expansion** – would explain this pattern of redshifts, of an apparent "**Hubble flow**".

And given such an apparent **LOCAL** Hubble flow, no wonder astronomers came to assume a **GLOBAL** Hubble Flow: who would ever expect this ring of superclusters – this second nested level of outer space – to be **rotating**?

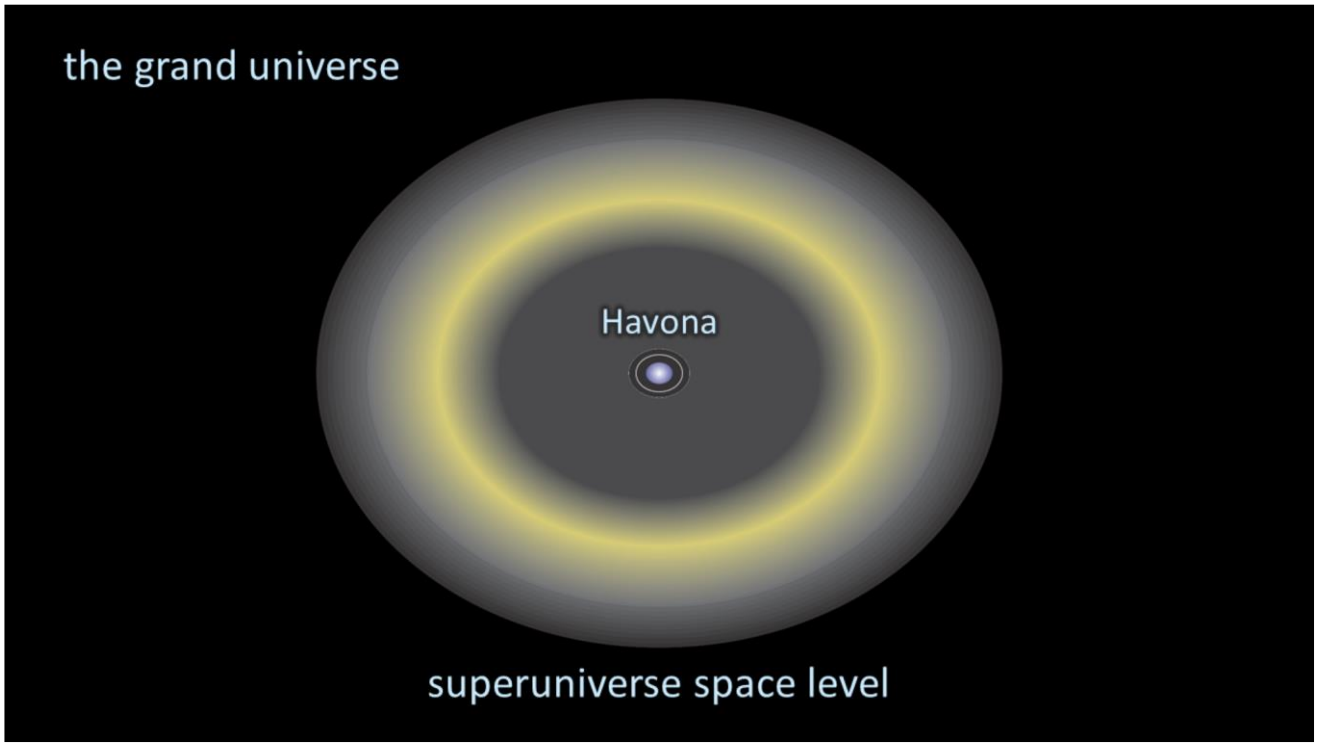
Beyond 300 million light years, it's still not possible to detect sideways motion, so astronomers and cosmologists alike are stuck with Lemaître's **assumption** about redshift. And that **model**, **ΛCDM**.

This business – of **redshift** from **rotation** and **respiration** – deserves its own seminar. So for now, let's just say that these inferred peculiar velocities (**sideways, relative to us**) fit neatly with the idea that (**relative to us**) this entire ring is rotating.



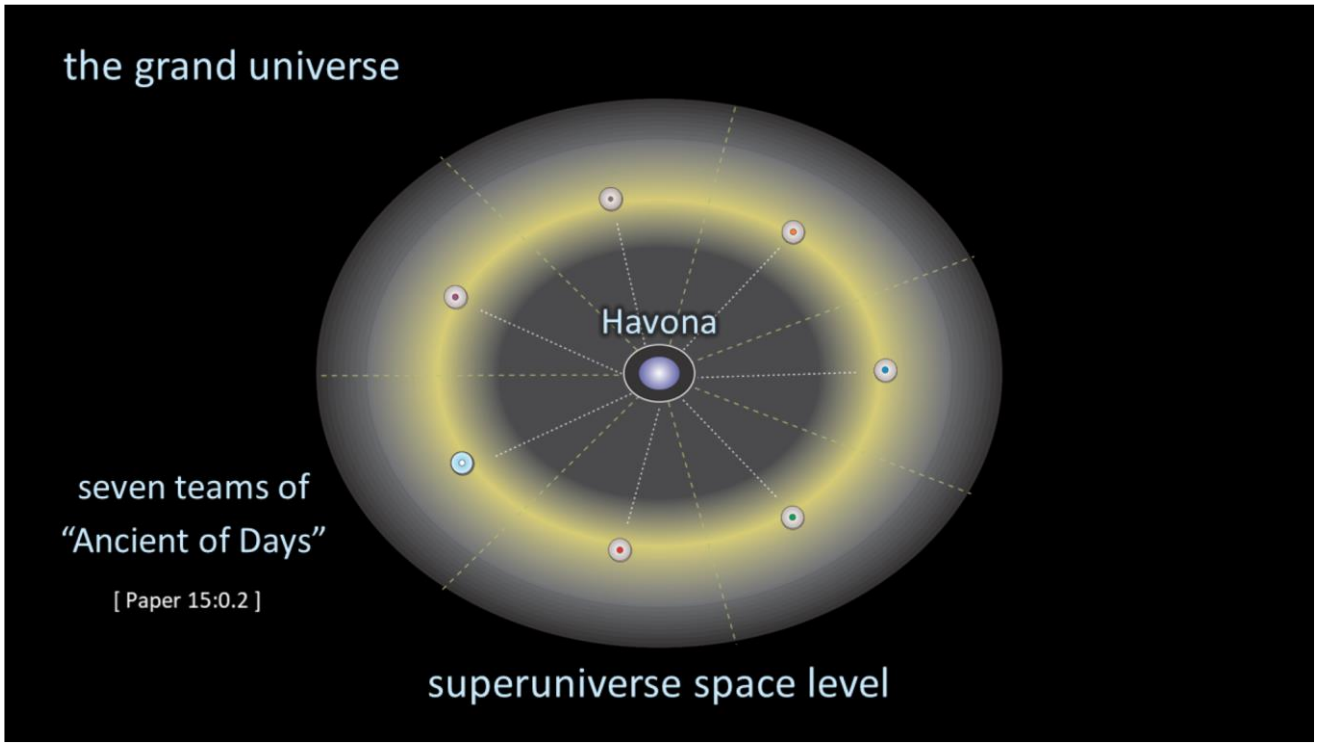
However, all this belongs to a study of the "**master universe**", and its nested, counter rotating levels of outer space.

So for now, …

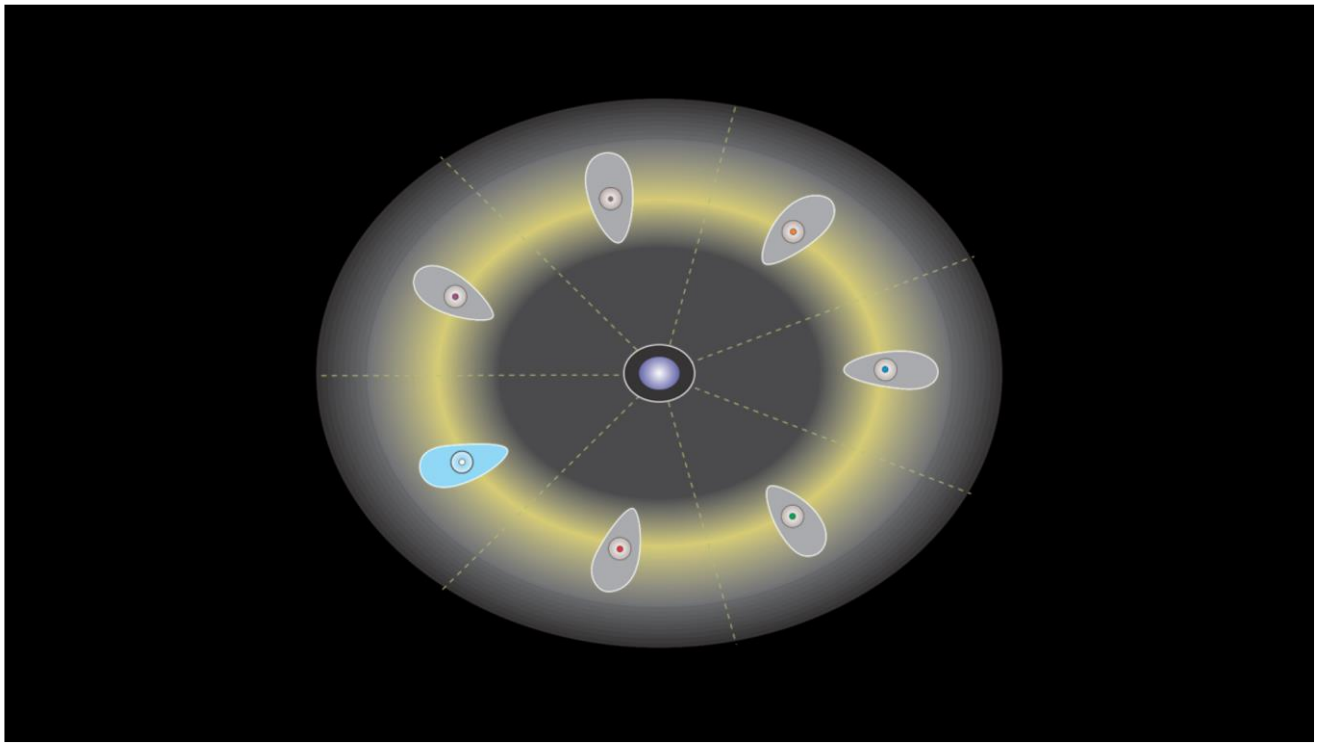


…. let’s return to where we began,

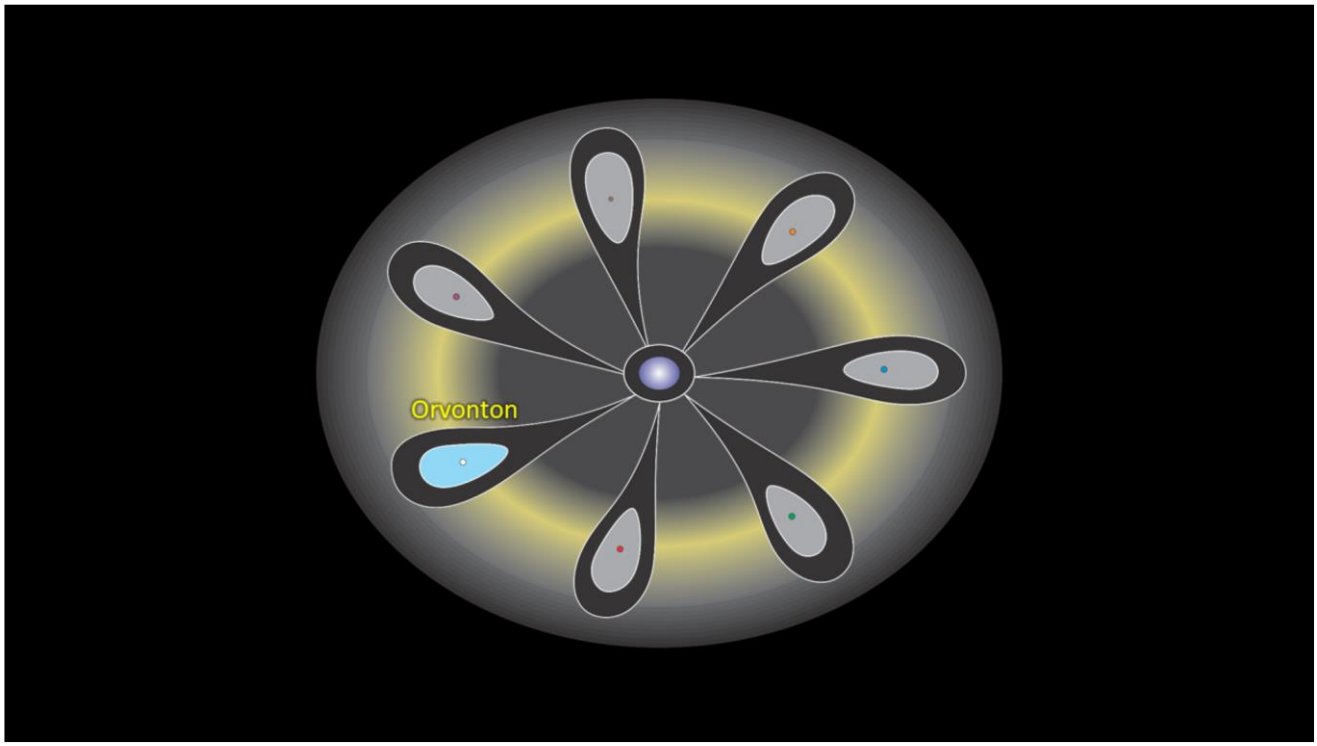
in the superuniverse space level, at the dawn of time.



When those seven small teams of "**Ancients of Days**" stepped out…
into the superuniverse rim of the grand universe wheel.



… to kick-start the adventure of time.

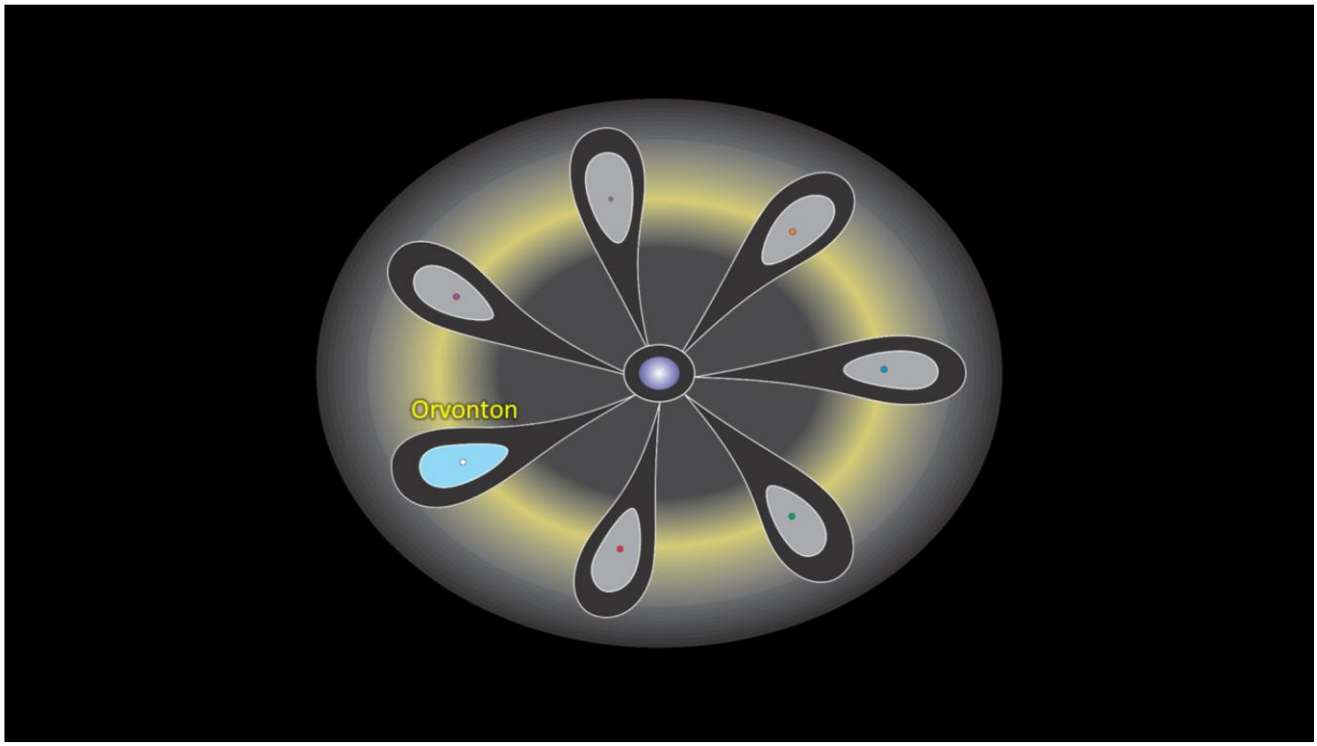


… within the radiated influence of Seven Master spirits,

Mind over matter,

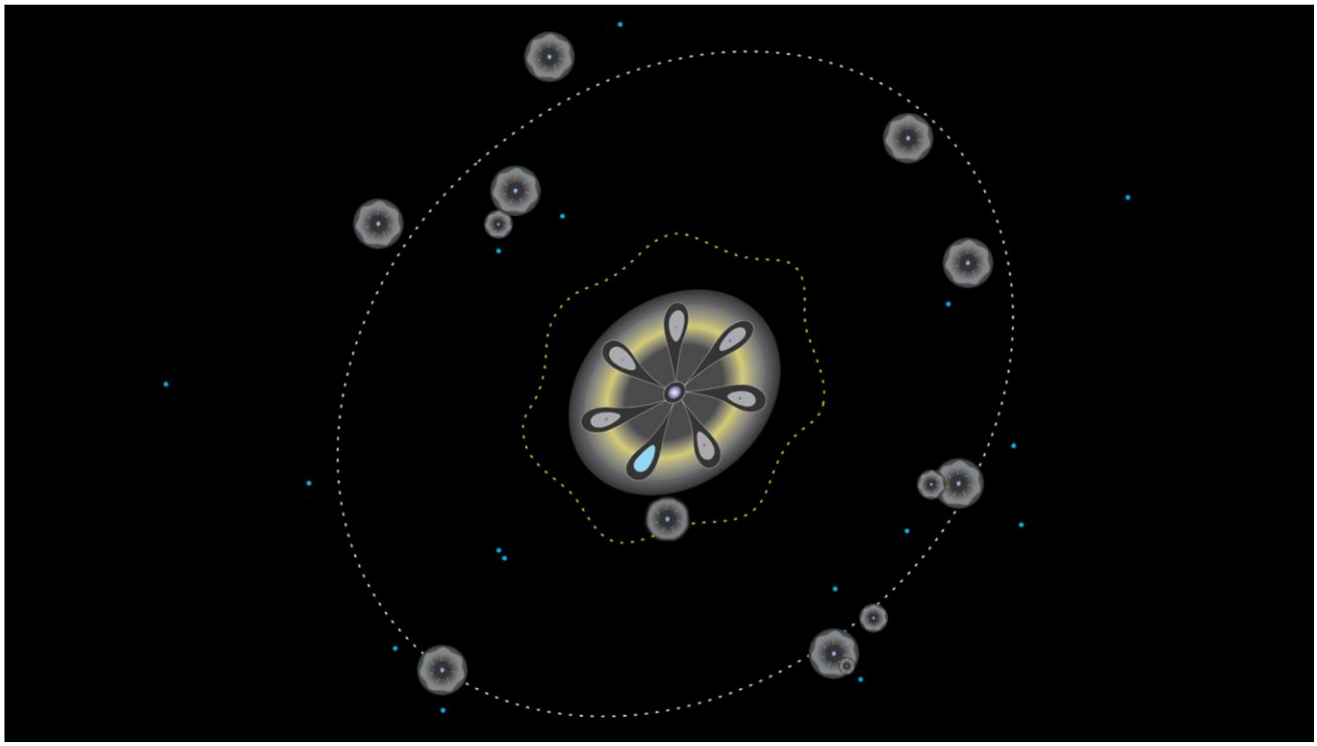
Spirit over mind.

The First Source – and his Architects – watching on.



[Notes]:

xxx



[Notes]:

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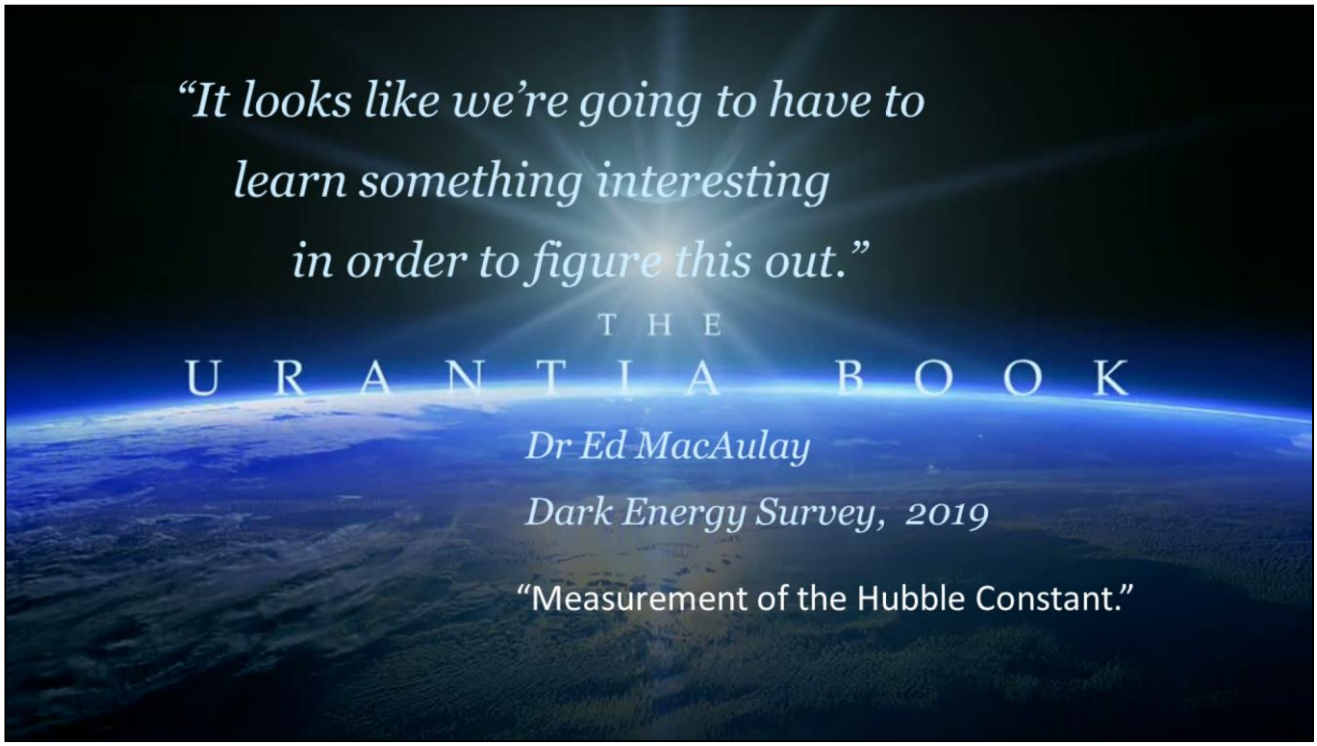

To repeat what Dr Ed MacAulay said earlier this year:

"It looks like we're going to have to
learn something interesting
in order to figure this out"

Dr Ed MacAulay discusses paper: https://arxiv.org/abs/1811.02376

First Cosmological Results using Type Ia Supernovae
from the Dark Energy Survey: ***Measurement of the Hubble Constant****.*

https://www.darkenergysurvey.org/des-year-3-supernova-cosmology-results/

https://www.coursera.org/learn/data-driven-astronomy