A modified Hubble law and implications

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Lecture for

MG13 Meeting, Stockholm, Sweden

- Based on my paper

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"Relativistic radial expansion Do we need dark energy?"

J. Phys.: Conf. Ser., v. 330, 012018 (6 Dec. 2011)

Abstract

In linear Hubble law no information beyond horizon r=c/H can reach us

Our Modified Hubble Law (MHL) for *measured* radial expansion velocity has unlimited radius of visible Universe

MHL fits the *measured* observations and solves Olbers paradox

MHL is based on Einstein's relativistic addition of velocities, neglected so far in this context

For relatively small distances MHL gives the linear Hubble law

Analyzing with MHL the existing

astronomical measurements on

dependence of luminosity versus redshift for type Ia supernovas shows that no cosmic deceleration is present, thus the assumption of cosmic deceleration is unnecessary

Also, calculating by MHL, the distances of high *z* objects and the dimension of the whole observed Universe are larger than believed to be so far

Farther measured supernovas are more distant than believed to be so far

MHL can also be used to predict the

luminosity of higher z type Ia supernovas to be studied in the future   Abstract end

Our Modified Hubble Law is based on Einstein's well known relativistic addition of velocities

$$V = \frac{v_1 + v_2}{1 + v_1 v_2 / c^2}$$

or

$$V_2 = \frac{v - v_1}{1 - v\, v_1 / c^2}$$

Using Einstein's relativistic addition of velocities the relative velocity between a point in the expanding Universe at a distance *r* from us and a point at a distance *r* +*Δr* from us on the same line of sight is

$$H\Delta r = \frac{V(r+\Delta r) - v(r)}{1 - v(r+\Delta r)v(r)/c^2}$$

where *H* is assumed independent of both *time* and *r*

In the infinitesimal $\Delta r \rightarrow dr$

$$H\,dr = \frac{dv}{1 - v^2/c^2}$$

Integration gives the Modified Hubble Law

$$v = c \tanh (Hr/c) \quad \Leftarrow\!=\!=\!=\!=\!=\!=\!=\!=\!=$$

where $v<c$ for any r because tanh is always < 1

For small r it gives the linear Hubble law

$$v = Hr$$

Distances

- **From linear Hubble Law $v = Hr$ we get $r = v/H$**
  For $v = c$ we get horizon at $r = c/H$

- **From our Modified Hubble Law**

$$v = c \tanh(Hr/c)$$

where *v* is the *observed* velocity, we get

$$r = (c/H) \operatorname{arctanh}(v/c), \quad \leftarrow=====$$

which represents distances *r* larger then given by
$r = v/H$ currently used
This is true for any *v*, thus for any *z*

The differences become bigger for larger v (large z

Horizon

For $v=c$ using MHL formula

$r = (c/H)\ arctanh(v/c)$

we get $r_{v=c}$=*infinity*, while for any $v<c$ we get finite distances

that implies that there is no horizon at finite distance (as exists for Linear Hubble Law)

We also **consider the <u>non-linear</u> definition of z**

$z=-1+\sqrt{(c+v)/(c-v)}$

and get

$$\mu = 25 + 5 \log_{10} [\ln(z+1)]$$

from which we get a graph of the

MAGNITUDE of SUPERNOVA LUMINOSITY

VERSUS

LOG10 of REDSHIFT

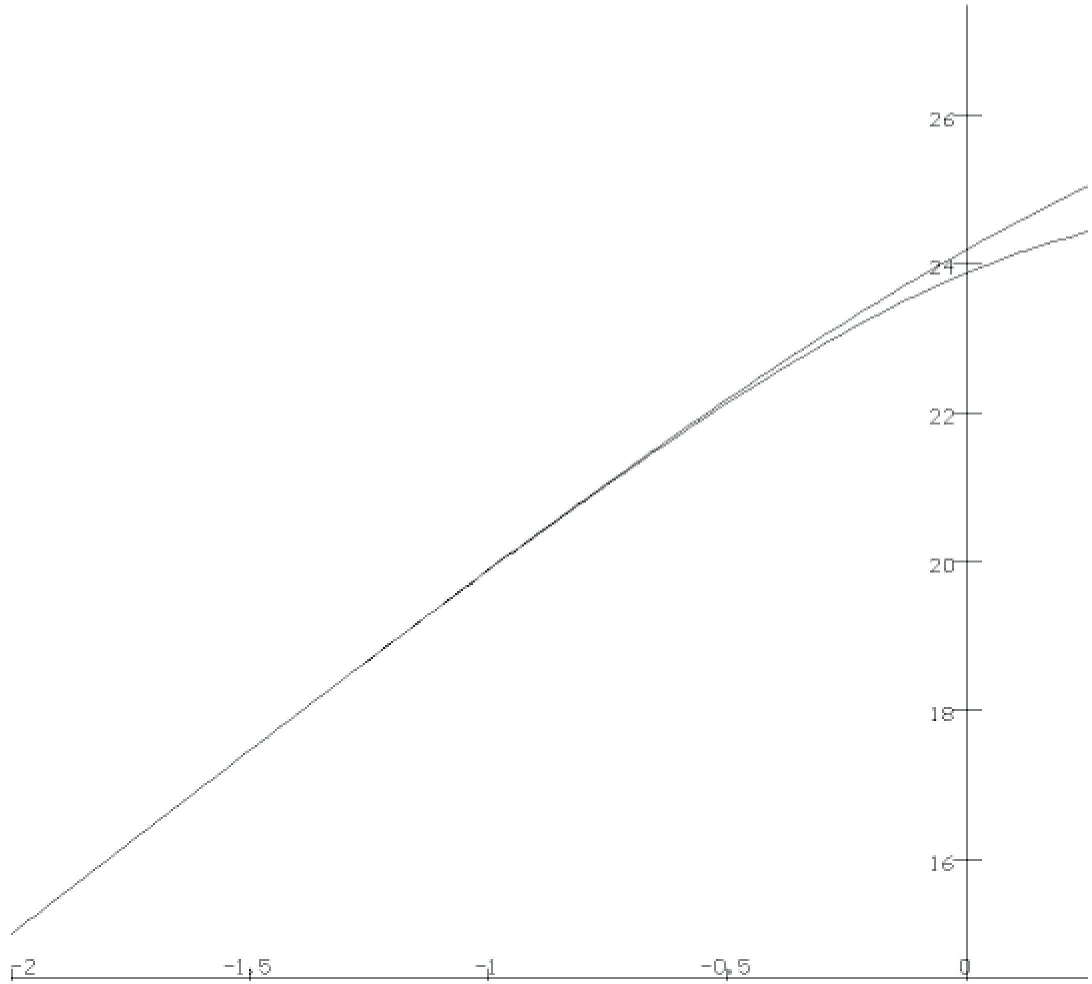
FOR Z BETWEEN 0.01 AND 1.8

The lower graph shows luminosity as a function of *z* for linear Hubble law

The upper graph shows luminosity

as a function of *z* from our MHL

Ben-Amots (2011) JPCS v 330, 012018



It is the same as the graphs in Perlmutter (1999), graphs of

the observations of Perlmutter

comparing to

the expected from linear Hubble law without acceleration of the expansion of the Universe

Perlmutter et al. (1999) estimated distance according to the observed luminosity of remote type Ia supernovas, whose absolute peak luminosity is considered as known

The corresponding redshift was the redshift of the galaxies that host these supernovas

Remote type Ia supernovas were found fainter than expected according to the value calculated with Hubble's Law, using the corresponding redshift, that is, the graph deviates upward

Perlmutter et al.'s (1999) graph Astrophys J. v 517, 565-586, p 568

This deviation upward (that is fainter) was interpreted as if the expansion of the universe is accelerating

It was further interpreted as if some repelling force causes the acceleration by acting against the gravitational attraction

This assumed force was associated with a further assumed "dark energy"

But then – additional surprise Riess et al. (2001) Fig 11 Astrophys. J., v. 560, 49-71, p. 61

And Riess et al. (2001) Fig. 12

Astrophys. J., v. 560, 49-71, p. 62

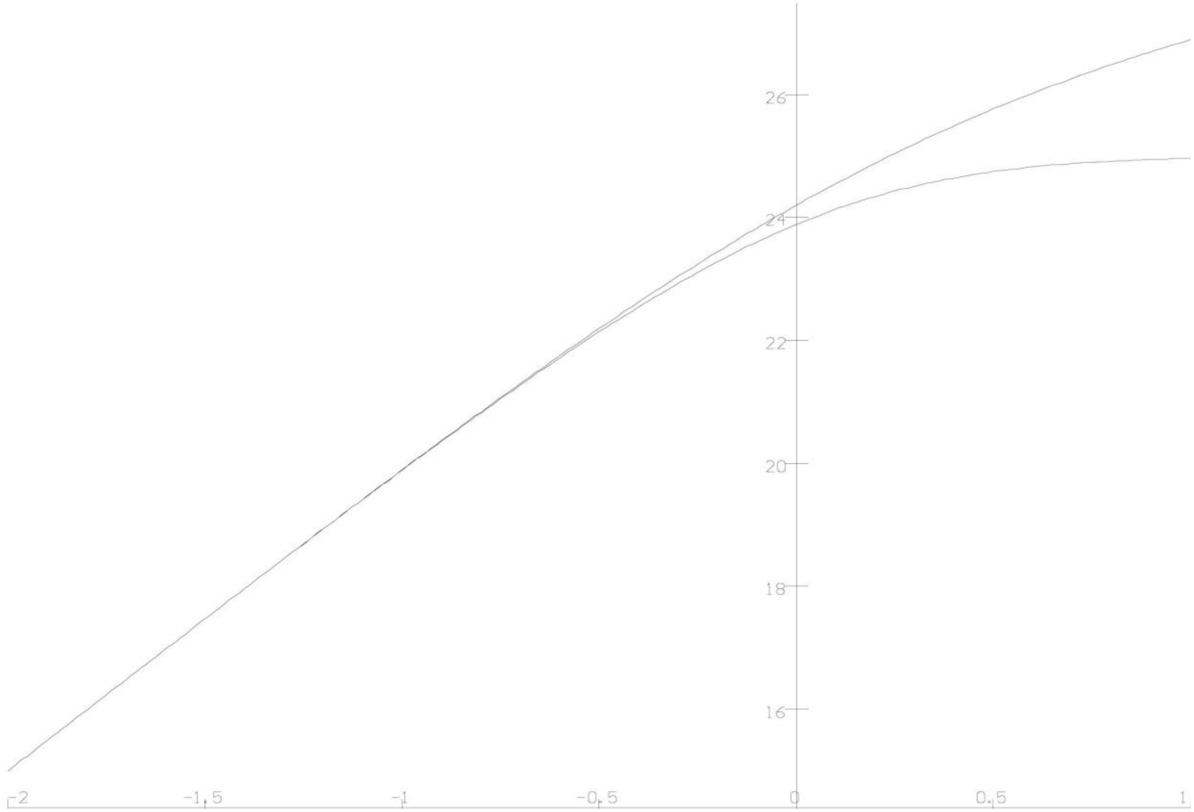
Riess (2001) Fig. 12 shows an accelerating region of the Universe, but farther, for higher *z*, he shows a decelerating(!) region of the earlier Universe (descending graph at higher *z*)

Figure 2 in my paper also shows this descending slope for high *z*

Figure 2 from my paper (next page)

"Relativistic radial expansion: Do we need dark energy?" J. Phys: Conf. Ser., vol. 330 012018 (6 Dec. 2011)

Ben-Amots (2011) JPCS v 330, 012018



The reason for this downwards departure is NOT deceleration, but that the redshift *z* is not linearly proportional to the expansion velocity *v* because of the non-linear redshift definition of *z*

The graph is actually the result of *two* non-linear *phenomena*

a) The non-linear relativistic addition of velocities acts first causing an upward deviation

b) The non-linear definition of the redshift z, which causes downward *stronger* deviation

The the second non-linearity prevails

Instead this, so far decelerating expansion

of the Universe was chosen to explain the downward deviation, neglecting both non-linearities

The upper graph considers the two most significant relevant non-linear relativistic effects, although not considering acceleration.

Ignoring these two relativistic effects only because of neglecting acceleration leaves us with a concept that is strictly insufficient to handle the expansion of the Universe in large velocities and distances

The same Figure 2 in my paper predicts the future observations for farther distances up to z=10, in accordance with the descending slope of "deceleration" of Riess (2001) in Fig. 12 and by others for z up to 2

- **So, neither acceleration nor deceleration of the expansion of the Universe is necessary to explain the observations**
- **Remote type Ia supernovas seem fainter than expected according to the value calculated with the Hubble's Law simply because they are farther away from us than believed according to Hubble Law**

Perlmutter, Riess and Schmidt started a new era in astronomy

THE DISTANCE TO REMOTE GALAXIES IS MEASURED BY THE ABSOLUTE LUMINOSITY OF THE PEAK OF TYPE Ia SUPERNOVAS IN THESE GALAXIES *MORE ACCURATELY* THAN BY REDSHIFT *Z* AND LINEAR OR NOWADAYS' HUBBLE LAW

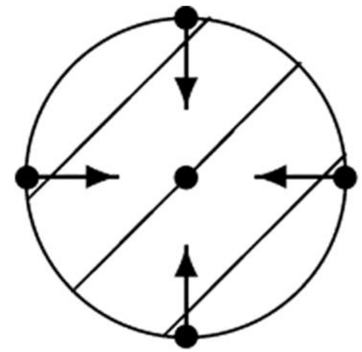
Our results *seem* as if they ignore the effect of gravitational attraction of the matter in the Universe, nicknamed *empty Universe.* Yet

1) **In large scale the Universe is *isotropic***
2) **The Universe is *infinite*, as our derivation shows in slides 8-9: *r = (c/H) arctanh(v/c)***

   For *v* →*c* we get *r*→ *infinity!!!*
3) **Thus, in large scale**

a) **The gravitational attraction of the matter in the Universe is equal in all directions**
b) **The resultant of the gravitational attraction of the matter in the Universe is zero**
c) **The net effect of the gravitational attraction of the matter in the Universe is indeed the same as of empty Universe!**

CLOSED/LIMITED UNIVERSE



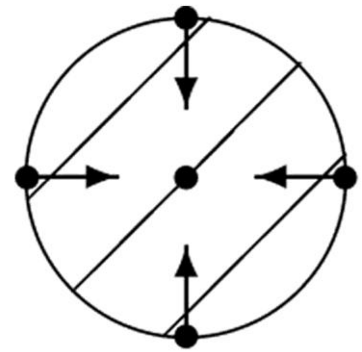
AT THE EDGE, NO GRAVITATIONAL FORCE ATTRACTS OUTWARD

BUT GRAVITATIONAL FORCES ATTRACT INWARD

THE RESULTANT GRAVITATIONAL FORCE IS INWARD

Similarly, we are situated on the surface of the Earth, and are gravitationally attracted toward the center of the Earth

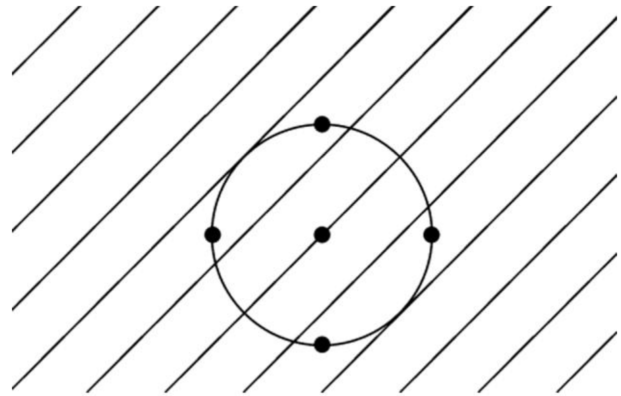
CLOSED/LIMITED UNIVERSE



An observer surrounded by spherical isotropic distribution of matter. No NET RESULTANT force is applied on the observer but THE GRAVITATIONAL FORCES APPLY INWARD *pressure*

IF HE SEES ACCELERATING EXPANSION, HE MAY THINK OF DARK ENERGY THAT DRIVES THE ACCELERATING EXPANSION AGAINST THE INWARD FORCES

INFINITE UNIVERSE



An observer surrounded by isotropic
***Infinite* distribution of matter**
All points are equivalent
Neither force *nor pressure*
are applied on the observer
like in EMPTY UNIVERSE!
This was suggested by Newton

Olbers's paradox

- **Substituting our Modified Hubble Law**

$v = c \tanh(Hr/c)$

- **in the relativistic definition for the shift of frequencies**

$f'/f = \mathrm{sqrt}[(c-v)/(c+v)]$

we get

$f'/f = \mathrm{sqrt}\{[1-\tanh(Hr/c)]/[1+\tanh(Hr/c)]\} =$

$= \exp(-Hr/c)$

- **The energy integral results finite = black sky**

$\int_0^{infinity} f'/f\, dr = \int_0^{infinity} \exp(-Hr/c)\, dr = c/H <$ **infinity**

(multiplied by a constant)

Comment on other equations

Our definition

$$H\,dr = \frac{dv}{1 - v^2/c^2}$$

does not include *r* explicitly, so it is *local* definition

Friedmann equation

$$(dA/dt)/A = 8\pi Gu(t)/3c^2 - kc^2/r_{c,0}^2\,A(t)^2 + \Lambda/3$$

and Robertson-Walker metric/space

$$ds^2 = c^2dt^2 - A^2(t)[dr^2/(1-k\,r^2) + r^2(d\theta^2 + \sin^2\theta\,d\Phi^2)]$$

explicitly include the "universal" parameter *A(t)* representing the "radius" of the Universe, and the Universe energy u(t). Further, they need to receive this information *instantaneously* from the edge of the Universe, although v < c, and moreover, to continuously coordinate these time dependent values over the space of the whole Universe.

So, they are unqualified for large distances:

A(t) is the same in the whole Universe in any given time. This raises yet another problem:

To coordinate this parameter *A(t)* instantaneously around the whole Universe, information must be propagated instantaneously from all the points in the Universe to all the other points in the Universe. This means infinite velocity of information, although *v* must be smaller than *c*

So, with this definition of *A(t),* both Friedmann equation and Robertson-Walker metric/space are unqualified for large distances

GENERAL RELATIVITY VS SPECIAL RELATIVITY

• In our derivation above we used the Einstein special relativistic addition law of velocities, which implies that there is no velocity larger than *c*

Yet Friedmann equation, which relies on general relativity, uses instantaneous data from remote parts of the Universe, which demands velocity larger than *c*

• We think that nothing can substitute the special relativistic addition law of velocities – neither Friedmann equation nor general relativity

HUBBLE CONSTANT TIME INDEPENDENT OR VARIABLE IN TIME

In our derivation above we assumed *H* to be constant in both *r* and time

Yet according to Friedmann equation *H* is a function of time, (which may have an influence on its dependence on *r* for large *r* too)

We assume that laws of Nature are valid anywhere and during all times

Such laws of Nature include constants like

c, G, Planck constant and Hubble constant *H*

We think that the laws that involve time-dependent “constants” are not laws of Nature but information. Yet according to Einstein’s relativity, information propagates with velocity up to the speed of light *c*

If *H* is assumed

time-dependent *H*, then according to Friedmann equation *H* depends on *R(t),* which represents the radius of the Universe, and also on the energy of the Universe *U(t).* Both *R(t)* and *U(t)* are remote informations

According to Friedmann equation, $H(t)$ needs instantaneous knowledge of

a) the radius at the edge of the Universe, and

b) the energy of the whole Universe

both in contradiction with the law of Nature that information can propagate anywhere in velocity that does not exceed the speed of light c

We distinguish between law of Nature and information as follows

A time independent - place independent constant, does not need signals that propagate spatially in order to be coordinated in time and space, thus it may be treated as being constant, as a law of Nature

A variable in time constant, needs the information being propagated over space in order to coordinate it over space thus cannot be a law of Nature

If something is varying in time, it can vary differently in different places in the Universe, unless information from other places reaches that place and causes it to vary in coordination

Friedmann equation and similarly Robertson-Walker metric are unqualified for large distances, while fixed Hubble constant H may be treated as a law of Nature - which is the reason we treated H being constant on the overall Universe.

The special relativity Einstein's law of addition of velocities is taken into account in our derivation, but this law of Nature was neglected so far in this context by all, including in Friedmann equation and Robertson-Walker metric

Nothing can replace relativistic addition of velocities

ΔΔΔΔΔ

The age of the Universe

For the linear Hubble law the integral of *dt=dr/Hr* and the age of the Universe are finite. The age is also finite in Friedmann equation or Robertson-Walker metric

- **For our modified Hubble law we get**

v = dr/dt = c tanh(Hr/c)

and we obtain

dt = dr/[c tanh(Hr/c)]

Integrating we get

t = { ln [sinh(Hr/c)]}/H

From 0 to R

OR FROM R TO INFINITY

THE INTEGRAL IS INFINITE

GIVING INFINITE AGE OF THE UNIVERSE

PAST OR FUTURE

Our derivation considered the most significant effect of relativistic radial expansion

We should not ignore it only because it does not consider the less significant acceleration, which might become significant in even higher z

We got for **constant acceleration**

$$v = c \tanh[(aT + Hr)/c]$$

in §9 in my paper: Ben-Amots JPCS v330 (2011)

For **any acceleration** we recommend Karapetoff (1944) concept of velocity versus **rapidity** that includes **any acceleration** versus **festination**

Karapetoff V, Rev Mod Phys v16 pp33-52 (1944)

Any acceleration

- • Robb (1911) firstly named the concept of **RAPIDITY**

In (my) simple words:

- The *observed* velocity that we *measure* is the **rapidity** after being transformed by Einstein's relativistic addition of velocities to velocity $v=(v_1+v_2)/(1-v_1v_2/c^2)$
- The velocity is what counts in the equations but we must remember the original velocity that is **rapidity**
- Karapetoff (1936, 1944) gave the most accurate and detailed analysis of velocity versus **rapidity** up to now
- • MHL $v=c\ tanh(Hr/c)$ can be proved also by **rapidity**
- • Karapetoff (1944) extended to any acceleration versus **festination,** that is versus the original acceleration before being transformed relativistically to acceleration
- • We suggest this Karapetoff's (1944) concept of **rapidity**, which includes relativistic acceleration, to **exactly** consider **any acceleration** together with radial expansion

Is DARK MATTER consisting of Jupiters?

The current belief is NO, because the DARK MATTER cannot be baryons, because the appropriate conditions necessary to create baryons after the big-bang did not last during enough time to create baryons in sufficient amount as needed to form the huge expected amount of DARK MATTER

But with MHL we found infinite age of the Universe

So, there was enough time to create sufficient amount of baryons as DARK MATTER, as Jupiters or other baryonic bodies

This is not a proof, but the main claim against baryonic dark matter is invalidated

We cannot solve problems by the same thinking that caused them

Albert Einstein

Thank you