PART I -- THE HUBBLE LAW'S TROUBLES

- *The Hubble Parameter Measurement Problem.*
- *The Hubble Law is Asymptotic.*
- *The Hubble Law Assumptions are not Valid.*
- *The Hubble Law Requires Exceeding the Speed of Light.*

SECTION 1

The Hubble Law's Troubles

COSMIC DISTANCES

The Hubble Law deals with distances from Earth to far distant cosmic objects. In order to accurately treat the subject the method for specifying cosmic distances must be clarified.

The most common popular contemporary unit of cosmic distance is the *light year*, the distance that light travels at velocity $c = 299{,}792{,}458.\ m\ s^{-1}$ in one Julian year (*365.25 days*).

However, at the time of the development of the Hubble Law the unit of cosmic distance was the *parsec* [*pc*], which was based on the length of the *astronomical unit* [*au*].

The *au* was originally the distance from the Earth to the Sun. Because that distance varies due to Earth's orbit being slightly elliptical the *au* was taken as the mean distance. In 2012 the *au* was arbitrarily defined as $au = 149{,}597{,}870{,}700\ m$ (*which is about 150 million km or about 93 million miles*).

The *parsec* was originally defined as the distance at which *1 au subtends an angle of 1 second of arc*. It was redefined to $pc = [648{,}000/\pi]\cdot au$ in 2015. That is $1\ pc = 3.086\cdot 10^{16}\ m$.

The *parsec* is about *3.26 light years*.

THE HUBBLE LAW

The Hubble Law is based on the observation in physical cosmology that the lines in the spectra of various cosmological objects are shifted toward the red of the spectrum, toward longer wavelengths.

- The line spectra on the Earth of the various pure elements exhibit characteristic lines at specific wavelengths from which the element whose spectrum it is can be identified.

- In the line spectra of various observed distant cosmological objects the sets of lines characteristic of specific elements are collectively "reddened", appearing shifted in wavelength toward the red end of the spectrum, longer wavelength, an effect referred to as a "redshift".

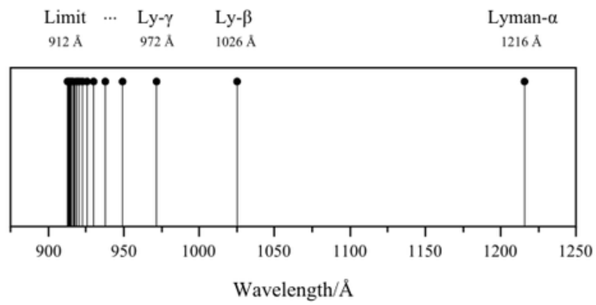

Figure 1-1
Lyman Series of Hydrogen Spectral Lines [Reference: Wikipedia]

In the Hubble Law that redshift is interpreted as a Doppler Effect due to relative velocities of the observed objects away from the Earth [recessional velocities].

The Doppler Effect is the phenomenon that when a source of light is traveling away from an observer he sees the wavelengths of the line spectra of that light shifted toward the red end of the spectrum, toward longer wavelengths. The reason for the phenomenon is that during each cycle of the oscillatory wave form of the light the recession of the light's source away from the direction of its propagation lengthens, so to speak "stretches", the wavelength.

The measured shift, or rather the velocity inferred to be its cause, is found to be approximately proportional to distance from the Earth for objects up to three hundred or so megaparsecs (*mpc*) away per Hubble's then analysis.

The inferred relationship between redshift and distance combined with an inferred relation between recessional velocity and redshift yields a mathematical expression for Hubble's Law as follows:

$$v = H_0 \cdot d \quad \text{or} \quad d = {}^{v}/_{H_0} \quad \text{or} \quad d \approx {}^{f(redshift)}/_{H_0} \qquad (1\text{-}1)$$

where:

v is the velocity away from the Earth of the astronomical source [recessional velocity] expressed in $^{km}/_{s}$.

H_0 is Hubble's constant expressed in $^{km}/_{s}$ per mpc

d is the distance of the astronomical source expressed in mpc

$f(redshift)$ is the velocity Doppler-related to the redshift

THE SEVERAL PROBLEMS WITH THE HUBBLE LAW

1-Hubble Parameter Measurements

The first, and most obvious, problem with the Hubble Law is that of determining the value of its constant H_0. Recent measurements have resulted in drastically different values for the constant. Evidence from the Hubble telescope has produced a value for the Hubble constant of $H_0 = 73$. A recent analysis by a team tracking the problem puts the constant in the range of $72\text{–}75$. Using another entirely different method a probable range of only $66\text{–}68$ results.

Such results should lead to questioning at least whether H_0 is a true physical constant and more reasonably to questioning the overall general validity of Hubble's Law. Figure 1-2 below lists the numerous various results of attempts to pin down the value of the Hubble constant this 21st century.

Date published	**Hubble constant (km/s)/Mpc**	**Observer**
2017-10-16	70.0+12.0 −8.0	The LIGO Scientific Collaboration and The Virgo Collaboration
2016-11-22	71.9+2.4 −3.0	Hubble Space Telescope
2016-07-13	67.6+0.7 −0.6	SDSS-III Baryon Oscillation Spectroscopic Survey
2016-05-17	73.24±1.74	Hubble Space Telescope
2015-02	67.74±0.46	Planck Mission
2013-10-01	74.4±3.0	Cosmicflows-2
2013-03-21	67.80±0.77	Planck Mission
2012-12-20	69.32±0.80	WMAP (9-years)
2010	70.4+1.3 −1.4	WMAP (7-years), combined with other measurements.
2010	71.0±2.5	WMAP only (7-years).
2009-02	70.1±1.3	WMAP (5-years). combined with other measurements.
2009-02	71.9+2.6 −2.7	WMAP only (5-years)
2007	70.4+1.5 −1.6	WMAP (3-years)
2006-08	77.6+14.9 −12.5	Chandra X-ray Observatory
2001-05	72±8	Hubble Space Telescope

Figure 1-2
21st Century Measurements of the Hubble Constant
[Reference: Wikipedia]

2-The Hubble Law is Asymptotic

The relativistic relation between redshift and theoretical recessional velocity for z > 1 is the Fizeau-Doppler formula equation *(1-2)*.

(1-2)

$$z = \frac{\lambda_{\text{observed}}}{\lambda_{\text{emitted}}} - 1 = \sqrt{\frac{1 + v/c}{1 - v/c}} - 1$$

That solved for v is equation `(1-3)`.

(1-3) $$v = \frac{(z+1)^2 - 1}{(z+1)^2 + 1} \cdot c$$

Equation `(1-1)` with substituting for *v* in it from equation `(1-3)` yields the asymptotic relationship of separation distance expressed in megaparsecs versus redshift, equation `(1-4)`. Since `1 parsec` is about `3.26 light years` the distance, *d*, can be expressed as time into the past that the locally observed light was emitted by its far distant source.

(1-4) $$d = \frac{v}{H_0} = \frac{c}{H_0} \cdot \frac{(z+1)^2 - 1}{(z+1)^2 + 1} \quad \text{in mpc or} \times 3.26 \text{ in mega light years}$$

Figure 1-3 is a plot of equation `(1-4)` for several different values of the Hubble Constant, values consistent with the Hubble Constant measurements problems presented above.

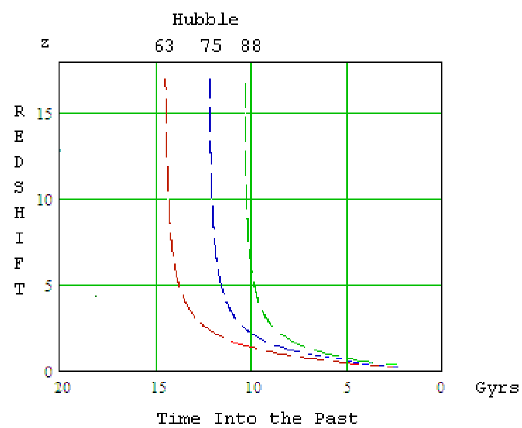

Figure 1-3
The Asymptotic Hubble Law

Unfortunately, the currently more favored value for the Hubble Constant, $H_0 = 73$ fails to correspond well to the currently favored age of the universe of about `13.8 Gyrs` for which the Hubble Constant is about $H_0 = 71.3$.

3-The Hubble Law Assumptions

There are two assumptions on which the Hubble Law is dependent. Neither is supported by facts.

The First Assumption

- It is assumed that the recession velocity of distant cosmic objects is approximately proportional to the object's distance from the Earth.

Figure 1-4, below demonstrates that the assumption that recession velocity of distant cosmic objects is approximately proportional to their distance is sufficiently invalid to nullify the concept of H_0 being a "constant".

That defect alone is sufficient to account for the range of measured values for H_0 given in Figure 1-2.

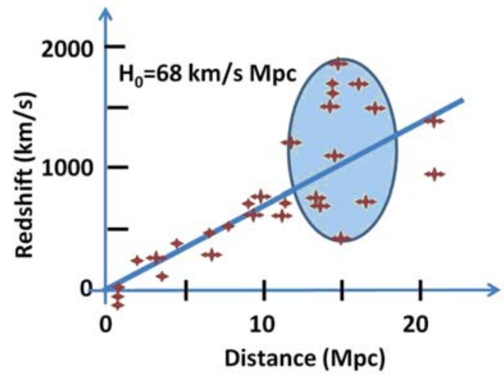

Figure 1-3
Fit of Some Redshift Velocities to Hubble's Law
[Reference: Wikipedia, "Hubble's Law"]

<u>The Second Assumption</u>

- It is assumed that the Doppler Effect is the cause of redshifts.

The quantification of this effect is as follows.

(1-2)

$$f_{observed} = \frac{c}{c+v} \cdot f_{source} \qquad c = \text{light speed} \qquad v = \text{recession velocity}$$

$$\lambda_{observed} = \frac{c}{f_{observed}} = \frac{c+v}{f_{source}} \qquad f = \text{frequency} \qquad \lambda = \text{wavelength}$$

$$v = \lambda_{obs} \cdot f_{src} - c = [\lambda_{src} + \Delta\lambda] f_{src} - c = \Delta\lambda \cdot f_{src} = \frac{\Delta\lambda}{\lambda_{source}} \cdot c$$

The variable designation for redshift is z per equation (1-3).

(1-3)

$$z = \frac{\lambda_{observed} - \lambda_{source}}{\lambda_{source}} = \frac{\Delta\lambda}{\lambda_{source}}$$

That is z is the ratio of the change or "shift" in the wavelength to the originating light source wavelength. Therefore the recession velocity of equation (1-2) is the redshift fraction of equation (1-3) of the speed of light as equation (1-4).

(1-4) $v = z \cdot c$

The speed of light, c, is an absolute maximum speed limit. Therefore, $v > c$ is not possible which means that the redshift cannot be greater than 1.0.

On the other hand many actual redshifts measure to be greater than 1.0, the largest recently reported being $z = 11.9$.

The discrepancy between the speed of light limit and the high measured values of z is deemed resolved as follows.

> It is contended that of the total recession velocity producing the extreme redshift most of that motion is due to expansion of space, expansion of the Universe, not actual classical motion of the receding object. Due to the expansion the distance to remote galaxies can increase at more than light speed, $c = 3\cdot 10^8\ m/s$. It is contended that this does not imply that the galaxies move faster than the speed of light.

What is being contended is that there is a means by which distant cosmic objects can increase their distance from us such that it is as if, for redshift purposes, their speed exceeds light speed while the objects are actually not at all physically moving faster than light.

The objects are said to have their location in space carried along, by expansion of space, at in excess of light speed, but their position in their location is only moving at less than light speed producing a minor Doppler-like redshift component of the overall total redshift due to the spatial expansion.

Substantial development of the concept and substantial mathematics treating the assumed expansion of space describe the effect. But, they do not prove or validate what the equations describe.

Basically the contention that distant objects can get farther from us at a rate producing redshifts as if the object were moving faster than light, but without ever exceeding the speed of light is untenable.

That leaves the Hubble Law in "limbo". There must be an alternative explanation of redshifts that does not defy reason, does not defy logic, that meets the classic requirement of Occam's Razor: the simplest solution is most likely the correct one.

There is such a solution:

The Universal Exponential Decay,

Which follows.