

Essentials of Photon Decay Theory
For the Hubble
Cosmological Redshift

By

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A PHOTON DECAY EQUATION

$$\nabla^2 \phi = \frac{1}{c^2} \left(\frac{1}{h} \frac{\partial \phi}{\partial t} + \frac{\partial^2 \phi}{\partial t^2} \right)$$

PRECIS

A decay process is proposed for light-like radiation from cosmologically distant galaxies. This is intended as an alternative explanation for the observed redshift. The equation incorporates the Planck action quantum as a diffusivity constant in the denominator of the first partial derivative term of the ordinary expanded wave equation. Action slowly diffuses entropically from the momentum domain into the wavelength domain as the photon travels through vast reaches of space-time. The result is that photon momentum diminishes and wavelength increases proportionally at an exponentially diminishing rate. The results are in good agreement with current estimates of the Hubble constant.

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Note: In this document Doppler Velocity Shift is referred to ‘velocity shift’ and the Hubble Redshift, which is presumed here to result from photon decay, is referred to simply as ‘redshift’.

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PREFACE

In 1842 the eminent Austrian astronomer Christian Doppler¹ reported his discovery of a spectral shift in light emitted from stars. He concluded correctly that it was the result of radial motion of the emitting stars relative to the Earth, and the spectral shift was subsequently named after him. Velocity shift was also an appropriate explanation for the acoustic frequency shift from such objects as running horses, carriages, and projectiles. Doppler died in 1850 thirty nine years before the birth of Edwin Hubble², well before the acoustic Velocity shift was observed from railroad trains, automobiles and airplanes.

The early years of the twentieth century brought the construction of gigantic new telescopes such as the 100 inch Palomar reflector in California. As observations of galaxies proceeded, astronomers began encountering a different cosmology than was anticipated from observations of stars alone. But work on cosmology was interrupted by World War I with Hubble himself going off to fight³ in it, and progress was discouraging during the wars in the first fifty years of the twentieth century as atomic theory developed; cosmology is too far away from the stars that make war.

During the period from 1924 to 1936⁴, Edwin Hubble and others discovered another, different spectral shift which is always to longer wavelengths in light from the extremely distant galaxies that were unknown before the Civil War. Hubble's discovery became known as the Redshift. Its landmark disclosure was in 1929. Subsequent early discussion on the possible causes of the Redshift is fascinating reading in itself.

The 1945 Trinity⁵ test did not depend on the cosmological redshift for its development but brought new confidence to human understanding of the nature of the universe, and astronomy slowly resumed its patient work. The 1952 Bikini Atoll test moved the understanding of stars close to perfection. With computers, logic was standardized throughout the world. This document presents an equation which would almost certainly have been proposed by 1930 for the redshift, as all the necessary mathematics was well known by that time. The Planck action⁶ quantum h is put as a diffusion constant in the $\delta\phi/\delta t$ term of an ordinary wave equation. The result appears to predict values consistent with modern observations. Whether true or not it represents a theory which, though once discarded, was never well described.

The decay of waves of all kinds is well known in mathematics, engineering and physics. Damped waves are often used to describe water, sound, and sometimes electric field (light and other electromagnetic or photoelectric) waves. Water and sound waves are already described with decay constants and lossy electric field media are not unknown. It is only a slight extension to extend the decay process to include electric field radiation such as photons. A fast decay process usually looks like a damped cosine wave. In Figure 1, the decay rate is very fast so that only a few waves occur before the wave amplitude becomes small, with the wavelength increasing proportionally:

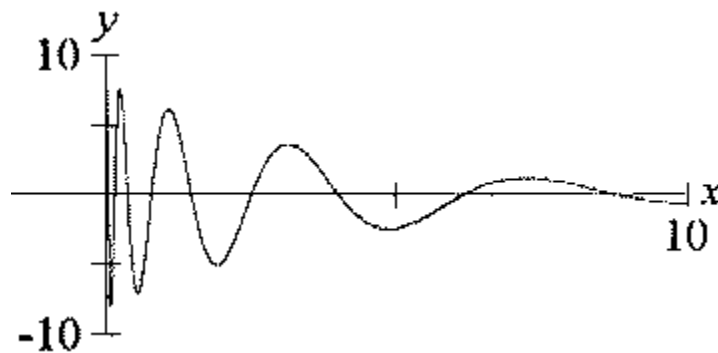


Figure 1

Photons appear to decay the same way, only it requires thousands of millions of years for a photon to decay in momentum or energy by only half its amplitude. The losses are into something more fundamental than heat—they are into distance and time, the very conjugates in action of momentum and energy.

Space-time is topologically⁷ indeterminate between dimensions conjugate under the action in mathematically defined manifolds at quantum magnitudes. The momentum and wavelength domains in the photon are adjacent domains. In the radiation in which redshift is observed, the action is concentrated into the momentum domain, and sparse in the distance domain. This momentum is high and the wavelength is short compared with the vast distances of space. Equivalently, the action is concentrated in the energy domain and sparse in the time domain; the energy is great and the wavetime is brief in comparison with the aeons of the time domain in the universe.

Action slowly diffuses from the momentum domain into the distance domain where it appears as longer wavelength. Equivalently, the action diffuses from the energy domain into the time domain where it appears as longer waveltime. This is an entropy process which depends on the relative action density in the domains involved, and it cannot reverse itself. The indeterminacy between dimensions is intrinsic to the quantum; that was Planck's discovery. The decay rate slows as the action becomes stochastically distributed between the two conjugate domains.

The photon is one integral action quantum; they may be linked as in a continuous wave, or in phase as in coherence. It is conjectured there will be found a (range of) wavelength, somewhere between the longest presently observed, and many light-years, where the action devolves into the background activity of space. This activity is the kind of thing which is currently thought of as "zero point energy".

The energy at short wavelengths is the normally observed spectral energy which can be measured with the photoelectric effect. The diffusion of action from the energy domain into the time domain (or, equivalently, from the momentum domain into the wavelength domain) is a normal diffusion. (On graphing the photon decay process one actually does encounter the Planck radiation curve but that is a different subject.) Waves decaying somewhat rapidly look like Figure 2:

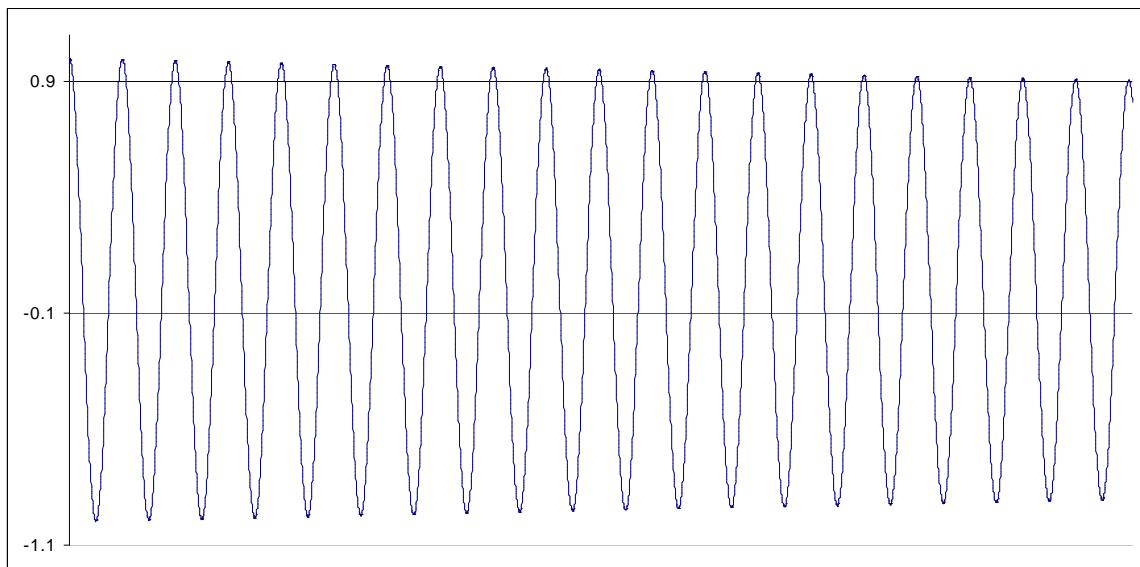


Figure 2

The number of waves is larger and the decay rate is smaller. The actual scale of a redshift wave cannot be depicted clearly in a spreadsheet chart, because the number of waves is astronomical – around 1,000,000 in a meter, and a parsec is 10^{16} meters means that in one parsec a light wave undulates or whatever it does some 10^{22} times, and in a billion light years, around 10^{29} times. The waves becoming densely indistinguishable and the decay process so slight as to be invisible on the chart in Figure 3.

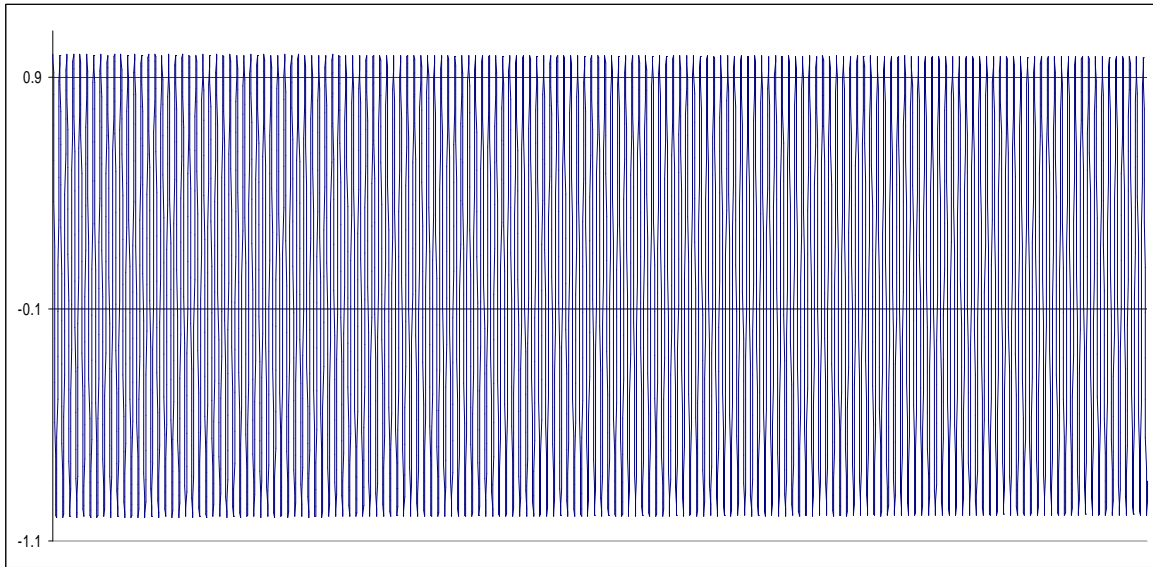


Figure 3

INTRODUCTION

We are to admit no more causes of natural things than are such as are both true and sufficient to explain their appearance.

Isaac Newton, The Principia, Rules of Reasoning⁸

An equation like this should have been written over seventy years ago. It is a simpler theory of the cosmological redshift that is named in honor of its discoverer, Edwin Powell Hubble. During the time when the solution proposed here could have been written, war and depression were desperately important and few controversies regarding obscure, distant and faint phenomena could be afforded. The problem was introduced to me in a high school class in 1958 and the writing of it begun in 1980 in Aberdeen, Washington. The theory is defended primarily because it had never been put into an equation. Like a forgotten prisoner in a dungeon, it needed *habeas corpus*, appearance in the courts of justice and needed public exposure.

The general wave equation is fitted using the Planck action constant as a damping constant. The partial time derivative d/dt term appears in decay and diffusion phenomena which are in widespread economically important global use.

The velocity shift discovered by and named after the Austrian astronomer Christian Doppler (1803-1853) was reported by him “in Prague at the Royal Bohemian Society in 1842.” This was almost a century before the discovery of the spectrographic redshift in the light from distant galaxies reported in 1929 by Edwin Hubble. The Doppler Velocity Shift was quickly postulated as the cause of the cosmological Redshift, as it was the only working theory of spectral shift at the time. Yet since 1850 a great deal of thought had taken place. Extremely distant galaxies in immense numbers had been discovered by new and more powerful telescopes, changing the very evolution of astronomy. America changed from a frontier wilderness to an intense, energetic, powerful and sophisticated highly unified nation. The scientific and technical advancements were evolutionarily significant events with geological impact. Doppler’s discovery had been assumed in Old World countries to be the proper explanation of spectral shift of all kinds throughout what was then the known universe. But Doppler and his contemporaries died long before Maxwell’s⁹ electromagnetic field equations, the telegraph, Civil War¹⁰, electric power production in Europe

and the United States, railroads, World War I, and airplanes emerged from technology, and all these developments took place before and during the time when Edwin Hubble discovered the cosmological red shift, always to longer wavelengths.

It is suggested that Hubble discovered the cosmological redshift because it is a different kind of spectral shift, and because of large scale cultural and geophysical factors. Exclusively new modes of thought were brought into an unspoiled virgin land. The western United States was settled in an essentially very recently compared to Europe, giving it the powerful advantage of fresh conditions of existence unpolluted by ancient, stagnant institutions. The civilization in which Hubble worked dates back to the sixteenth century so that its doctrines are strongly established, yet they consist entirely of patterns of thought that have been developed since then. Hubble was looking for a more complete cosmology than Europe guessed, for Europe was still impeded by ancient Roman traditions of which many were and still are ossified relics. Of course, Rome brought advances which are justly treasured but those are another matter; Rome knew nothing about spectral shift.

The point is important, because it illuminates the stiff resistance to anything except velocity shift as an explanation for the observed redshift even at the cost of elaborate theories about an “expanding universe” that began with a “big bang.” The velocity theory leads to increasingly complicated questions: How long has the universe been expanding? Does it exist only once? By what mechanism does it expand? And so forth. Those complex ad hoc explanations go against the grain of those who adhere to Newton’s statements in the *Principia*. Earlier admonitions to adhere to the simplest¹¹ way date back thousands of years and are found in ancient Roman, Greek and Chinese literature.

Photon decay in the redshift was apparently considered, yet in 1958 no equation describing it was written into mathematical form though it is not a difficult equation and would have been a simple exercise for a competent mathematician. The theory condemned as “tired light” had become an equation that never existed and its pursuit was discouraged. The equation proposed here would probably have been written before 1930, because by then the far more sophisticated mathematics by Schrodinger, Pauli, Dirac and others were leading the field. The entire equation results from setting

one variable, in one normal formulation of the wave equation, to the Planck action quantum h .

Since 1910 the photographic record of cosmological redshift has become vast, and is by now a mainstay in seeking understanding of the universe. Millions of spectrographic plates now exist and the production of spectra taken through larger telescopes is computerized. The redshift exists as a secular, honest and recorded fact which cannot be denied and it is quite distinct from velocity shift. In particular, though the velocity theory begs the question, the cosmological redshift is always to longer wavelengths, while velocity shift occurs both to longer wavelengths, and shorter (though not at the same time.) This creates recurring questions.

This photon decay equation of the redshift, if it is true, preserves the use of redshift as an extragalactic distance estimator in the universe. It is a simpler idea than the expanding universe theory, and brings greater confidence and consistency in gauging the universe we live in. An important aspect of photon decay theory is that we can actually see related quantum phenomena with one's own eyes. Using any laser, demonstrations of diffraction readily show distance and momentum becoming indistinct in wavelength-scale phenomena. In addition, the pocket laser permits one to validate one's perception of the speed of light, using distant reflecting signs in evening walks. General relativity offers abundant resources for seeing relative momentum as indistinct from relative position. The mass or energy which is a component of momentum is itself an intrinsic basis for a coordinate system and reference frame in which momentum is often observed.

We cannot say the same for universal expansion. The velocity shift explanation for cosmological redshift is mired in pre-Palomar European politics. If velocity shift is not the origin of the redshift, then insistence to the contrary is a true handicap and impairment for the sciences. All the necessary mathematical tools existed in the 1920's when the research of this sort was suspended, and existing mathematics has all that is needed to write a good extragalactic redshift photon wave decay equation.

The problem is closely related to statistical realities in which we live. As velocity increases beyond about 200 kilometers per second, energy losses increase dramatically, resulting in what is literally a tax on the energy of galactic motion. Rotation velocity curves of edge-on galaxies, which cannot be easily be misunderstood or used to deceive, confirm that velocities

of stars is limited to less than 200 kilometers per second. Our own Milky Way Galaxy's velocity is normally around 60 km sec⁻¹. At this part of galactic rotation, the Earth and Solar System are moving parallel with the Galactic Apex, and the total velocity is around 120 km/sec.

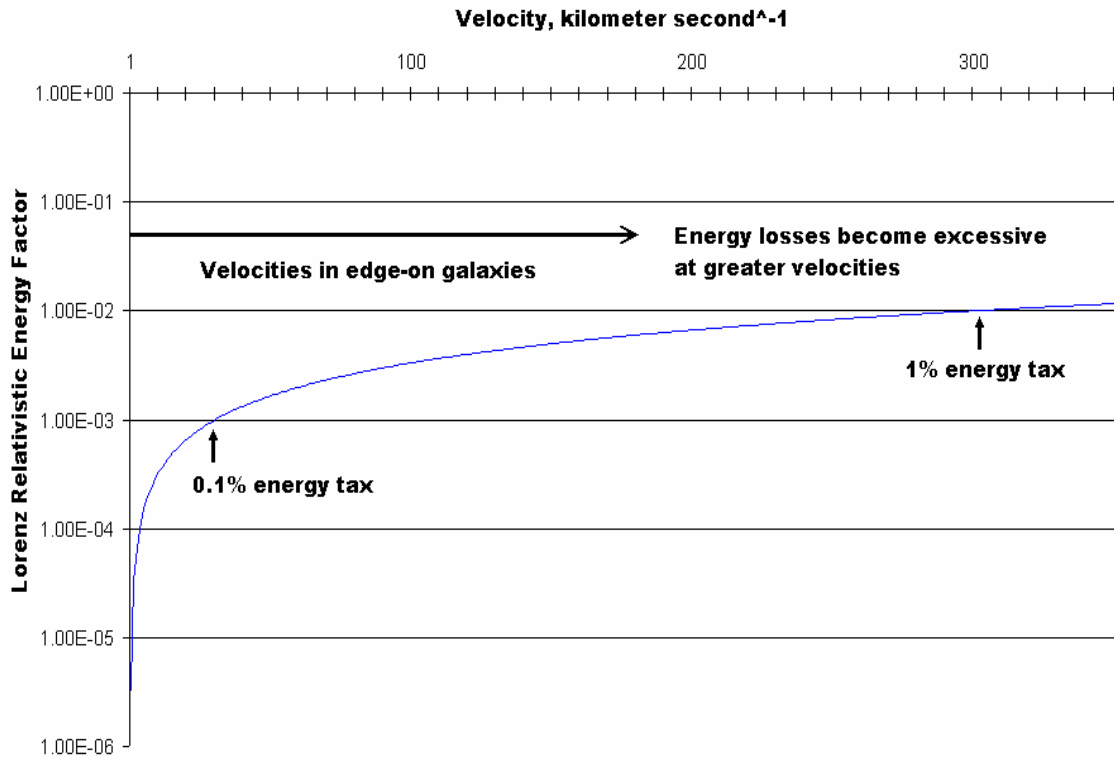


Figure 4

The assumption that the universe is expanding results in the observed data being misinterpreted to suggest that many galaxies move at velocities in excess of 10,000 kilometers per second, a velocity at which sustained relativistic energy loss is unbelievable.

The extra relativistic potential energy acts to cause higher potential valences to become accessible in the evolution of life, and this, combined with the fact that the vector sum of the Solar and Galactic Apex are almost directly toward the Andromeda Galaxy, could result in more rapid evolutionary adaptation and greater diversity of form and activity. In other words we are at the present geological era in Galactic Springtime, in a "Year" of seasons each of which spans some 55 million years. That is why it is vital for human beings to be very careful with the development of technology as it is taking

place in the planet's evolution. These processes will continue adaptively for millions of years, and already we are causing vast consumption of many non-renewable resources, devastating destruction of wildlife and hurried, clumsy structural, chemical, industrial and civil changes in the way the human species develops its own destiny.

Ancient Chinese society warned against haste in the beginning; human beings are not merely beginning a new Earth year, decade or century or even millennium. Developments in nuclear energy, space flight, knowledge and materialism have taken place recently, which mark the beginning of an entire Galactic evolutionary period of hundreds of millions of years. It does not mean to stop everything, but favor more certainly, with great care those ways of life that have proved stable and trustworthy in the past, and which increased confidence that in time, the very best ways of life will become evident to the highly communicative species that human beings are. At the same time it means rejecting and preventing more thoroughly those things which have proved destructive.

Such vast periods of time beggar recorded human history. Yet celestial phenomena have been used since ancient times as instruments of both just guidance and criminal control of human populations, by good kings and bad, as guidance for the planting of crops, and in the conduct of war. The Redshift itself has been observed, measured and observed thousands of times by professional astronomers unmolested by politics and uninterrupted by world events, but the subsequent interpretation of the evidence has not been sanctified against demagoguery and perjury. It was easier and vital to justify the claim that the redshift meant the universe is expanding, at a time when national effort was distorted by conflict both East and West. Bigger budgets, bigger militaries, and bigger claims are among the extravagances that are made more easily and less detectably if it is proclaimed that the universe itself is in continual expansion without limit. However, what really exists is a planet which is of finite size and which must inevitably contain the results of all that human beings and human industry do to it for millions, even hundreds of millions of years. It may be that the industrial and technological revolutions are so vast that they have changed the planet utterly into an engine powered system of changes, but it is still certain that living beings on planet will have to endure whatever is made of it for all time to come. In a manner similar to the question, "What if everybody did this?" it is important for civilization to cultivate a question of "What are the long-range consequences?"

COORDINATING VELOCITY AND DECAY SHIFT

A definite distinction exists between velocity shift toward either longer *or* shorter wavelength, and the redshift which originates in photon decay and appears *only* toward longer wavelengths. Both velocity spectral shift and cosmological redshift which is presumed here to result from photon decay are important tools in astronomy and cosmology. Whatever theory is proposed, these tools are already so well observed in practice that the theory must not require any adjustment of the observed facts. The observed data is already well known, carefully measured, thoroughly documented and recorded, and very accurate.

Fundamental uncertainty exists in determining directly both the distance and the velocity of distant objects. It is possible to determine the distance accurately with spectral shift if the velocity of the distant emitting object is zero. Conversely, it is possible to determine the velocity of the emitting object accurately if its distance is already known. It is not possible to determine, using spectral shift alone, both the velocity and distance of a redshifted object at the same time. This is similar to problems of determining momentum and position and momentum of objects here on Earth and in fact is itself a cosmological limit on certainty.

Relativistic energy losses prevent objects from moving very rapidly and for the most part, stable velocities everywhere are limited to a few hundred kilometers per second. Velocities exceeding this are rarer in proportion to their magnitude. So it is possible to be somewhat certain of distance, within the range of velocities permitted by relativistic energy losses. This is good, and correlates well with the rotation curves¹² of edge-on spiral galaxies, which show the flat velocity limited by relativistic energy loss. The theory not only fits the facts, it appears in the right places. For gravitationally bound or interacting systems such as Stephen's Quintet of Galaxies¹³ it is possible to determine the relative velocities¹⁴ of the components although, as stated above, spectral shift alone does not permit exact determination of both the velocity of the group and its distance at the same time.

Energy losses are demonstrated on Earth in particle accelerators where greater energy is necessary to accelerate particles to speeds close to that of light than would be the case if relativistic energy losses did not exist. Once acceleration and maintenance energy input ceases, fast particles rapidly lose energy to relativistic energy loss.

Thus velocity shift is excellent for determining relative velocities in objects that are found to be the same distance away from Earth. This includes galactic rotation curves, stellar rotational velocity, stellar orbital velocities in multiple star systems, the velocity of gases in stellar atmospheres and the relative velocities of galaxies which are obviously interacting, as when they are physically intersecting.

Velocity shift adds or subtracts from redshift velocity calculations. If an object is moving toward Earth, its light is shifted toward shorter wavelength. If this is not accounted for, then the object's distance calculated from decay shift alone, would appear erroneously less. Conversely, if photon decay is not accounted then the object appears to be moving away from Earth. In both cases many objects exist at intermediate distances where velocity shift and decay shift are of comparable magnitudes. If an object is moving away from Earth then its light is shifted toward longer wavelength. Failure to distinguish decay results in an assumption that velocity shift is caused by recessional velocity that is greater than actually exist. Decay is the eigenfunction of time.

If either velocity or distance can be determined more accurately in other ways such as Cepheid luminosity-distance correlation, that adds to the accuracy of determination using both sources of spectral shift. For objects at greater distances this is of course difficult because all systems with large redshift are extremely distant and are usually beyond such estimators as Cepheid variables or parallax.

An intermediate example is the Andromeda Galaxy, Messier 31. Photon decay redshift is very small in light from M31 because of its proximity, and the relative velocity between the Milky Way Galaxy Earth and M31 dominates. The two galaxies are approaching each other and the net spectral shift is blue, or toward shorter wavelengths and greater momenta.

The indeterminacy of both absolute distance and radial velocity is an example of shifting the uncertainty in a problem toward a form that serves the purpose better. The distance and radial velocity cannot both be known perfectly, but if the tradeoff is optimized, we can do better. Relativistic energy loss is in our favor, because it limits the velocity for most ordinary objects, and that increases the accuracy with which decay redshift can be used to determine distance. With that constraint working for the researcher,

decay redshift becomes an even more important tool for understanding extragalactic cosmology. It is essentially an absolute measure at greater distances, and light which arrives on Earth with a good spectrum increases the estimate of confidence in the validity of that measure.

EQUATION DEVELOPMENT

The inception of this work was the idea that the first derivative diffusion equation should be superimposed on the wave equation. Consider *Laplace's Equation*¹⁵

$$\nabla^2 \phi = 0$$

Equation 1

It is the basis and starting point for a dazzling realm of mathematics. In particular three equations derived from it are appropriate to photon decay theory, these being

The *wave equation*¹⁶

$$\nabla^2 \phi = \frac{1}{a^2} \frac{\partial \phi}{\partial t}$$

Equation 2

The *diffusion equation*¹⁷

$$\nabla^2 \phi = \frac{1}{a^2} \frac{\partial \phi}{\partial t}$$

Equation 3

And the *vortex equation*¹⁸

$$\nabla \times \omega = 0$$

Equation 4

The latter lends confidence these first order partial differential equations are truly universal, as the vortex can be observed in eddies, whirlpools, whirlwinds, tornadoes, hurricanes and galaxies, but is not used in this description of photon decay.

Appropriate forms already exist in many presentations of the wave equation which are widely distributed in the literature. Dettman describes the unbounded wave¹⁹ as:

$$\nabla^2 \phi = a_1 \phi + a_2 \frac{\partial \phi}{\partial t} + a_3 \frac{\partial^2 \phi}{\partial t^2} - f(x, y, z, t)$$

Equation 5

This more complete form is much more versatile than will be needed in the cosmological redshift equation. In the second term of the above equation, b will have to be simply related to h , the Planck action quantum.

It must also be correctly related. Operational amplifiers as the “machine” from which my *deus ex machina* was drawn, in the same manner as quantum mechanics was drawn from various machines and relativity was drawn from railroad cars in motion. Machines are formidable rational tools whose importance cannot be overestimated. When they work properly, they are truth incarnate in such principles as they demonstrate. The operational amplifier can be used to simulate both wave and diffusion equations well with high accuracy. Comparison with a machine makes it possible to check whether logic, signs, symbols and ordered symbol relationships in theory are sensible.

A simpler form of the wave equation is ubiquitous in the literature:

$$\nabla^2 \phi = a_2 \frac{\partial \phi}{\partial t} + a_3 \frac{\partial^2 \phi}{\partial t^2}$$

Equation 6

It is necessary to be both simple and careful, because the equation being developed is based on the idea that the decay process is intrinsic to the photon’s interstellar and intergalactic behavior, not to its origin (as from an electron transition) and several factors must all be taken into account at the same time.

First, light from space is usually from an excited atom or molecule, but it can be from positron-electron annihilation, synchrotron radiation or other sources.

Second, when we first observe light we may not know whether it has been redshifted or not, if we do not know the spectrum of which it is a part and whether it corresponds to any particular red-shifted line.

Third, photons can now be accumulated singly. If the source is faint, with an indecipherable spectrum and only a few quanta detectable, it may not be known for a long time from what part of the spectrum it was emitted and it cannot be correlated with any particular element or transition. It might easily have come from noise and be a part of no particular spectrum at all. Yet it is still light, and behaves as all light does when it reaches our eyes or instruments. It is not until enough quanta have been accumulated to form a resolvable spectrum, that a spectrum can be interpreted for elemental lines, and only after the emitted elemental lines have been identified by their relation to other spectral lines or to the envelope of the spectrum can its wavelength shift be determined.

Fourth, spectral lines are not infinitely narrow even when emitted from electronic transitions. Spectra are often broadened at their source during emission in hot and moving stellar atmospheres, or by stellar rotation. They are also broadened during their long travel from distant objects, though surprisingly little in the pristine clarity of most of space. Many sources are moving at slow, non-relativistic rates of a few hundred kilometers each second. That is what makes it possible to measure the rotation curves of edge-on galaxies, the rotation rates of stars, and even some of the convection rates in the atmospheres of stars.

Fifth, the uncertain relationship between position and momentum is an attribute of space-time. Position is a state of zero velocity. Both are relative to near and distant reference points in both moving and stationary coordinates. No absolute position or velocity in space-time exists. There is (almost only) a field propagation velocity c which is the relation between distance and time. Momentum itself is relative to the object, such as a planet or star or field with the object bringing its own gravity, or to distant references. All these factors create additional logical terms that must be resolved consistently.

The Equation 6 makes it possible to merge the diffusion and wave equations:

$$\partial^2 \phi = \frac{1}{c^2} \left[f \left(\frac{\partial \phi}{\partial t} \right) + \frac{\partial^2 \phi}{\partial t^2} \right]$$

Equation 7

The required constant term will fit into this general form at or near f . It should permit a description of light waves without forcing any distortion upon our concept of celestial photons and without requiring any attempt to adjust the facts which are basically the observed and photographed spectra.

As the equation neared this form it became clear that the Planck action quantum would be involved in the constant f . Other than c , the only remaining constant in the photon which can be the decay constant is the action quantum h , itself. After all, c and h are the only two constants that exist in the photon. Two other quantities, the electric and magnetic field constants, affect the photon but are properties of the electric field of space, not of the photon itself. The decay function must have been a function of h and p , and maybe another c . This results in a more narrowly defined but still vague form.

The result, not yet visible, must describe a decay function which is logarithmic, since the photon is required (by this hypothesis) to be similar to the decay of radioactive materials. At this point there are several possible ways to go. One is to arbitrarily assign a log function to the diffusion term, and see what that decay constant has to be to result in a half-life on the order of a billion years. An expansion from Dettman of the logarithm based on a series looking something like this:

$$\log(a) = 1 + \frac{1}{h} - \frac{1}{2h^2} + \frac{1}{3h^3} - \frac{1}{4h^4} \dots$$

Equation 8

For the purposes here, this is unnecessarily complicated. Diffusion itself behaves logarithmically. An approach directly unifying the wave and diffusion equations results in a simpler though still tentative form:

$$\nabla^2 \phi = \frac{1}{c^2} \left[f(\hbar, c, p) \frac{\partial \phi}{\partial t} + \frac{\partial^2 \phi}{\partial t^2} \right]$$

Equation 9

Here, the equation is only an approximation. With a little thought, it begins to make better sense:

$$\nabla^2 \phi = \frac{1}{c^2} \left(\frac{1}{p\lambda} \frac{\partial \phi}{\partial t} + \frac{\partial^2 \phi}{\partial t^2} \right)$$

Equation 10

Momentum p and wavelength λ are explicit in this form of the equation. The rate of decay in time depends on the state of the photon at that time. Equivalently as above, the equation can also be written in terms of energy and wavetime to form:

$$\nabla^2 \phi = \frac{1}{c^2} \left(\frac{1}{E\tau} \frac{\partial \phi}{\partial t} + \frac{\partial^2 \phi}{\partial t^2} \right)$$

Equation 11

Here, energy E and wavetime τ are explicit.

But these are two different variables, and the diffusion constant is fragmented. How are we to signify that momentum and wavelength, or energy and wavetime, which are necessary at any one point in the spacetime journey of the photon, are related to each other in the correct way?

The unifying quantum h that Planck discovered is the key. The diffusion constant is made into one integral whole by the use of the Planck action quantum, a single symbol for which h was chosen.

The photon, a single wave of any light-like radiation, is a free eigenfunction of the unit quantum of action. It lasts so long because it is an almost perfectly conservative system. The imperfection in its conservation is only because the wave cannot commute, or swap places, with an earlier or later

cycle and has no way to compress wavelength back into momentum, or time back into energy. That, after all is the order of time.

When the two variables are related that way and used to predict the half-life, the result first appeared to be around ten billion years. So the form did provide a solution which is somewhere near the value which was at that time being computed at observatories from Cepheid variable based luminosity-distance estimates and from other extrapolations. The equation now takes on the character of a successful solution in that it at least proposed a stable theory which is an alternative to the Expanding Universe theory.

It is now possible to calculate p from λ , or λ from p , using the equation $p * \lambda \geq h$, and one can integrate λ to get the path distance or use p , λ and c to obtain the energy and wavetime. It's not really possible to describe this equation without h , because we have no other way of corraling both momentum and wavelength to unify the diffusion constant.

The resulting equation

$$\nabla^2 \phi = \frac{1}{c^2} \left(\frac{1}{h} \frac{\partial \phi}{\partial t} + \frac{\partial^2 \phi}{\partial t^2} \right)$$

Equation 12

is explicit in h , and is essentially the final version presented here.

This contains no more than the necessary information. It touches on relativity and quantum mechanics in the parameter of the first order derivative term, for the quantity hc appears in physical constants and other relativistic mathematics. The appearance of quantum mechanics in the relativistic wave equation means the origin of this thought is in the successful synthesis called quantum electrodynamics and at the same time, care was taken to consider the order of entropy in both thermodynamics and information theory in the preparation of the theory.

It goes in the right direction, which is to say that for an energetic photon (say in the X-ray or ultraviolet) the diffusion rate of action from momentum into wavelength (or from energy into wavetime, whichever you prefer) is faster, while for a lower energy (such as an infrared or microwave) photon, the diffusion rate is lower, in a manner similar to radioactivity.

CONSTANTS AND VARIABLES

Here are several of the constants and variables used in this work. These are concepts important to the development of the photon decay equation. They are standard and empirically valuable sources of understanding in that they are extensively used throughout the world in economically significant production of numerous goods which are appropriate machines.

| Symbols²⁰ | | | | |
|-----------------------------|---------------|----------------|--------------|---------------------|
| Class | Symbol | Meaning | Value | Dimensions |
| Constant | c | speed of light | 299792458 | meters/second |
| Constant | h | action quantum | 6.626E-34 | Joule-second |
| External | E | Energy | variable | Joules |
| External | p | Momentum | variable | Kg-meter/second |
| Intrinsic | λ | Wavelength | variable | meter |
| Intrinsic | ν | wavenumber | variable | meter ⁻¹ |
| Intrinsic | τ | Wavetime | variable | seconds |
| Intrinsic | Hz | Frequency | variable | Hertz |

Table 1

The photon decay equation stands reasonable comparison with the reported spectrographic Redshift data when that data is converted to a half-life. Redshift data is often reported as a frequency or wavelength shift in primary data so it will be possible for others in the future to use unbiased primary data. A few relationships on which the equation is based are:

| | |
|----------------------|---------------------------------------|
| $E = h * \nu$ | energy=quantum * frequency |
| $E = p * c$ | energy=momentum * speed of light |
| $h = p * \lambda$ | quantum=momentum * wavelength |
| $h = E * \tau$ | quantum=energy * wavetime |
| $c = \lambda * \nu$ | speed of light=wavelength * frequency |
| $c = \lambda / \tau$ | speed of light=wavelength / wavetime |

Table 2

COMPARING PHOTON WITH RADIOISOTOPE DECAY

If photon decay half life is on the order of 2-10 billion years as is suggested by recent estimates of the correlation between distance and redshift, the duration of time should not be a cause of worry in terrestrial affairs. Sufficient phenomena of a statistical nature are attached to both nuclear isotopes and the behavior of light waves, to believe that probability plays a significant role in both the large and small extremes of photon behavior. Many radioisotopes have commensurate half-lives exist, and several much longer. The following table lists several:²¹

| Isotope | Half-life, years |
|---------------|------------------------|
| Bismuth 210 | 3×10^6 |
| Cesium 135 | 3×10^6 |
| Palladium 107 | 7×10^6 |
| Curium 247 | 1.6×10^7 |
| Iodine 129 | 1.7×10^7 |
| Uranium 236 | 2.39×10^7 |
| Samarium 146 | 7×10^7 |
| Plutonium 244 | 8×10^7 |
| Potassium 40 | 1.28×10^9 |
| Uranium 238 | 4.5×10^9 |
| Thorium 232 | 1.41×10^{10} |
| Rhenium 187 | 7×10^{10} |
| Platinum 190 | 6×10^{11} |
| Tantalum 180 | $> 1 \times 10^{13}$ |
| Hafnium 174 | 2×10^{15} |
| Zirconium 96 | $> 3,6 \times 10^{17}$ |

Table 3

As with all information herein, this is empirical data in the public domain. These half-lives have been measured many times in both government and corporate laboratories in both national and international collaboration around the world. Though very slow decay rates have large margins of error, their general trend and approximate half-lives are well established.

COMPARING OBSERVED AND PREDICTED REDSHIFT

The following calculations were performed with a spreadsheet and are presented without comment.

Calculation of the photon half-life from observational data

| | | | |
|----------|--------------------|-------------|---------------|
| Constant | c | 299792458 | meters/second |
| Constant | h | 6.62607E-34 | Joule second |
| Constant | parsec | 3.09E+16 | meters |
| Constant | light-year | 9.46E+15 | meters |
| Constant | light-years/parsec | 0.307 | |

Calculation of the photon half-life from observational data

| | | |
|---|----------------|-------------------------------------|
| Observed Hubble constant ²² | 75,000 | m s ⁻¹ mpc ⁻¹ |
| Express as fractional frequency shift | 0.0000250173 | Mpc ⁻¹ |
| For half-life, divide 0.5 by the fractional frequency shift to get megaparsecs at half frequency | 19,986 | Mpc |
| To convert to parsecs, multiply by one million | 19,986,163,867 | parsecs |
| Converted to light-years | 6,127,784,561 | Light-years |

Calculation of the photon half-life from the presented equation

| | | |
|---|---------------|-------------|
| Calculate the suggested denominator $h \cdot c^2$ | 5.95521E-17 | |
| Divide into $4 \cdot \pi$ (why?) | 2.11015E+17 | seconds |
| Convert to light years | 6,686,648,153 | Light-years |

The calculated value is 9% larger 1.09

Table 4

MOMENTUM AND WAVELENGTH

Wavelength and momentum of a photon as it travels through several thousand megaparsecs of space. Note the constant value of action. The momentum relaxes to one-half its original value in six billion light years, and the wavelength increases to twice its original value during the same time.

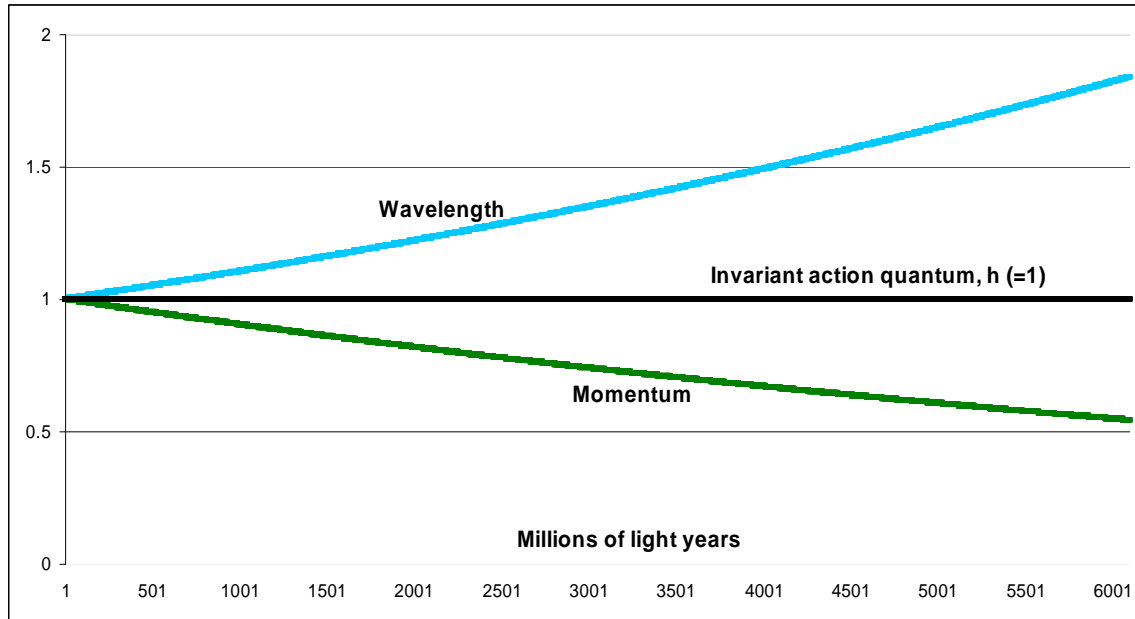


Figure 5

In intergalactic space the photon's action quantum gradually becomes redistributed in a process driven by the implacable entropy of the Third Law. The action moves from high momentum into the empty length dimension of space's distance, where it must remain as wavelength because of the characteristic integrity of the free photon. In this particular description of the action, the momentum p is conjugate inside the photon with wavelength λ under the total action of the photon h . By internal is meant that quantities λ and p are both internal factors of the quantum photon, and by conjugate is meant that the product of wavelength λ and momentum p has the dimensions of and is numerically equal to the action quantum.

CHART II

PHOTON POWER

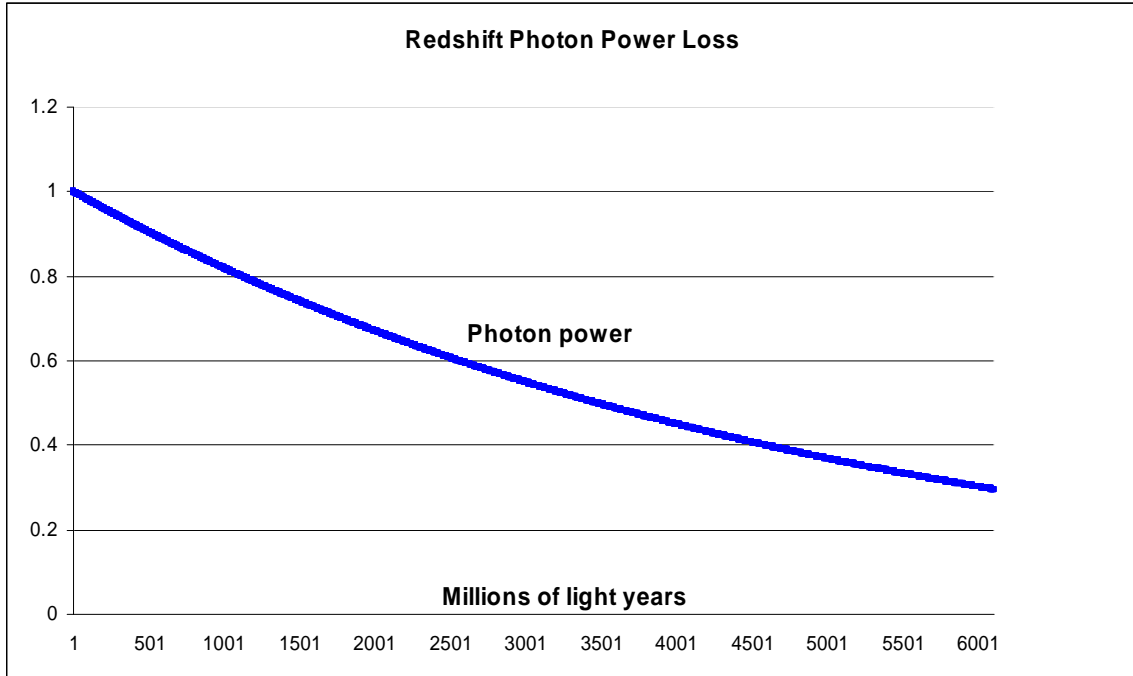


Figure 6

Photon power loss as it travels through space. The time rate of change of the energy is the power of the photon. As energy is lost, wavetime increases and the photon quantum expends from its energy reserve. Because it is a ratio E/τ of energy to wavetime, the power decay rate is faster than for energy alone. The quantity of power is dependent on both photon energy and the photon wavetime. This suggests that the political power of the inhabitants of Planet Earth might not automatically extend throughout the universe.

FUTURE WORK

Separating the constant term c^2 and using Gaussian coordinates where $c=1$, covariance $(x, y, z, -ct)$ leads to the possibility of adapting the equation to general relativity where the space-time distance ds should be set in the metric tensor $g^{\mu\nu}$. I do not know how to do this but it is a good idea and remains for future work.

It may be possible to test for photon decay directly. In principle, reflected light could be mixed in frequency with the transmitted light, and if the path distance is sufficient and decay exists, a frequency comparator will result in a 'beat' frequency. Light is around 500 terahertz, and beat frequencies of 0.001 Hertz would be easily detectable, making a decay of one part in 10^{15} detectable. However, the constraints on this test are severe and it may not be possible to obtain significant results from any kind of experiment like this on Earth alone due to inadequate length of baseline. This problem is formidable: comparing the returned frequency with the original frequency requires the frequency stability of the terrestrial reference be stable to within the round trip time of the signal.

Tests using transceivers, located at a distant planet, which return an amplified signal to Earth, may be possible. The returned signal will have to be an amplified copy of the original signal because the frequency of the returned signal must be absolutely identical. The remote receiver should be isolated from the transmitter with local geological formations (hill or crater) with the received frequency pre-amplified sent to final amplifiers through fiber optics or some other appropriate medium, and then retransmitted back to the original transmitting station on Earth. An estimate of the necessary baseline should be calculated.

ENDNOTES

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- ¹ Bio on Doppler: <http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Doppler.html>
- ² Bio on Hubble: <http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Hubble.html>
- ³ http://antwrp.gsfc.nasa.gov/diamond_jubilee/1996/hubble_nas.html
- ⁴ http://antwrp.gsfc.nasa.gov/diamond_jubilee/1996/sandage_hubble.html, by Sandage
- ⁵ <http://www.lanl.gov/history/atomicbomb/trinity.shtml>
- ⁶ <http://www.lanl.gov/science/centers/quantum/light.shtml>
- ⁷ Theodore W. Gamelin and Robert E. Greene, Introduction to Topology, 2nd Ed. (Dover Publications, Inc., Mineola, New York 1983, 1999)
- ⁸ Sir Isaac Newton, The Principia 1729 Translation by Andrew Motte. (Two volumes. University of California Press, Berkeley 1962) Volume II, page 398.
- ⁹ <http://scienceworld.wolfram.com/biography/Maxwell.html>
- ¹⁰ <http://www.civilwarsignal.org/>
- ¹¹ <http://plato.stanford.edu/entries/simplicity/>
- ¹² <http://www.nrao.edu/imagegallery/php/level3.php?id=471&verb='y'> and <http://www.eso.org/outreach/press-rel/pr-2004/images/phot-15c-04-normal.jpg>
- ¹³ http://chandra.harvard.edu/photo/2003/stephan/stephan_comp_labels.jpg
- ¹⁴ <http://www.eso.org/outreach/press-rel/pr-2004/pr-24-04.html>
- ¹⁵ Dettman, Mathematical Methods in Physics and Engineering (McGraw-Hill, New York 1962) Page 115
- ¹⁶ W. Pauli, Theory of Relativity (Dover Publications, Inc, New York 1958) page 1
- ¹⁷ Dettman, Mathematical Methods in Physics and Engineering (McGraw-Hill, New York 1962) Page 112
- ¹⁸ Graham Woan, The Cambridge Handbook of Physics Formulas, (Cambridge University Press, Edinburgh, 2000) page 84
- ¹⁹ Dettman, Mathematical Methods in Physics and Engineering (McGraw-Hill, New York 1962) Page 208
- ²⁰ Peter Mohr and Barry Taylor, CODATA Recommended Values of the Fundamental Physical Constants, 1998 (Journal of Physical and Chemical Reference Data) downloaded from the internet
- ²¹ Handbook of Chemistry and Physics, (The Chemical Rubber Company) 1987. Look for the section on Radionuclides and Isotopes. The book is in transit.
- ²² Several reports of recent determinations of the Hubble Constant are http://map.gsfc.nasa.gov/m_uni/uni_101expand.html ; <http://cfa-www.harvard.edu/~huchra/hubble/> and <http://www.eso.org/~bleibund/papers/EPN/epn.html>