DEFICIENCIES IN TIDAL FRICTION WITH CORRELATIONS TO THE PIONEER ANOMALY

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Abstract

The Pioneer anomaly has presented us with an unexplained variance in momentum under conditions that are close to a controlled laboratory experiment. Extensive analysis by Turyshev, et. al. has yielded no definitive explanation for the near identical slowing of these two spacecraft and the effort is yet to be confirmed by the "scientific method." Continued efforts to explain this anomaly may be served by comparison to other observed momentum anomalies such as the Earth's slowing rotation and the anomalous rotation of galaxies. While we trust that Newton's first law stands, a simple gyro test could be conducted to detect and measure a possible, very minimal, unaccounted slowing of the gyro's rotational velocity. The miniscule momentum variance, in the range of the Pioneer anomaly, would likely have been dismissed in prior gyro tests as system friction. An updated experiment, with special attention to friction, would unveil if momentum does also vary in the laboratory. The results, whether positive or negative, may be a powerful guide in the path to resolving Pioneer and other momentum anomalies.

1. Introduction

There are several natural occurring momentum anomalies that have been observed. The four that are addressed in this study are:

1. The slowing rotation of the Earth.
2. The slowing of the Pioneer 10 and 11 space probes.
3. Rotational velocities of Galaxies.

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4. The increasing altitude of the Moon.

It has often been demonstrated in science that underlying influences or physical behavior can be well masked by dominating influences. Could this be the case with tidal friction and the slowing of the Earth? There is no question that the workings of the Moon and Sun on the oceans have a slowing affect on the rotational velocity of the Earth. However, we would be remiss in our duties as scientists to assume that the tides are the entire influence. Given the history of the theory of tidal friction, it is fair to ask if tides are only a partial influence. Estimates have covered a broad range. The Topex/Poseidon tide models of Ray et al. [19] and others have now given us a very accurate mapping of the oceans. However, it still remains a major challenge to directly measure the turbulent bottom boundary layer (BBL) of the shallow ocean basins which are considered to be the primary contributors to a net negative tidal influence. The energy flux value for the ocean basins is sampled in specific areas and then projected for all the BBL areas. Walter Munk has stressed that "**the BBL estimates must be used with caution.**" [17]

The Moon is gaining distance from the Earth at a rate of 3.8 centimeters/year. The corresponding gain in angular momentum of the Moon implies that there must be a corresponding decrease in angular momentum in the rotation of the Earth. This translates to an increase in the length of day (LOD) of 2.3 *ms/cy* as calculated by Dickey et. al [7]. Since it is assumed that the entire increase in the altitude of the Moon is due to the ocean tides, oceanographers and scientists who are estimating the flux quantities have a determined value to agree with. Again, Munk cautions against this assumption.

F. Richard Stephenson has plotted historical eclipses and from his work he has estimated that the Earth is slowing at a rate of 1.7 *ms/cy*, averaged over the last 2700 years. [22] Meanwhile, the northern hemisphere is rebounding from the recession of the glaciers of the last ice age to cause an ongoing change in the Earth's moment of inertia. Coincidently this change results in a decrease in LOD of 0.6 *ms/cy*, which is just the quantity needed to offset the calculated value of 2.3 from the Moon and the measured 1.7 by Stephenson. However, Stephenson's earlier estimate, which included the more reliable eclipse records from AD 800 to 1950 put the change in LOD at 1.37 *ms/cy*.[21] In Stephenson's more recent work, he has placed more emphasis on the

ancient Babylonian clay tablet records of eclipses that occurred around 400 B.C. These eclipse records place the average mean increase in LOD at 2.6 *ms/cy*. In his earlier work, the emphasis was placed on the telescopic star occultation record of the last 200 years combined with medieval Arab records (circa 1000 A.D.). Both groups of data support the 1.37 *ms* number. The telescopic data is considered very reliable.

In Stephenson's earlier work he speculates that the 1.37 *ms* LOD slope line, which is constant from present time to 950 A.D., begins to skew at 950 A.D. and gradually increases for several centuries as we go back in time until it reaches the 2.6 *ms* value. It may be more likely that the eclipse records of ancient Babylonia are not that reliable or that the extreme decade fluctuations in LOD that occur may have been an influence during the Babylonian period. Elastic coupling between the Earth's core and mantle are considered a possible explanation for these large variations in LOD.

In Stevenson's more recent work, [22] he places a higher emphasis on the ancient Babylonian record. While the 350 years of telescopic measurements, and the Arab records of circa 1000 A.D., both support the 1.37 *ms* number, he adopts the speculation that the LOD, during the periods of no eclipse records, deviates from the 1.37 *ms* value toward the higher 2.6 *ms* value. He then uses the Babylonian number to estimate an average variation in LOD from 600 BC to our current time and increases the estimated variation in LOD to 1.7 *ms* and abandons the more solid measurement of the last 1000 years of 1.37 *ms*.

Efforts to increase the LOD variation to 1.7 *ms* may be influenced by the desire to have it combine with the 0.6 *ms* rebound value to equal the 2.3 *ms* tidal friction number. We see a similar desire in the flux estimates. With reference to the revised Stephenson number of 1.7, the Earth rebound estimate of .6, and the calculated increase of LOD at 2.3 *ms/cy*, Munk cautions, "this triple accord may be a cruel accident." [18] In addition, in the same paper Munk outlines the entire problem as an "enigma" with heavy emphasis on the fact that the "tuned" triple accord makes no allowance for the ongoing change in sea level.

An additional factor that puts into question what we think we know about the present estimated values for tidal friction is the prehistoric record for varying length of day. Fossils dating back 300 million years demonstrate a changing LOD that is close to today's value. This evidence is contrary to the fact that the Moon would have

been significantly closer to the Earth and therefore causing a much greater variation in the LOD if tides are the primary operator. [13]

Conservation of Mass

Geophysicist, S. R. Dickman, in his paper "Experiments in Tidal Mass Conservation, (1990) [8], writes, "A common feature of theoretical ocean tide models is their failure to conserve mass over the oceans. This failure distorts the tidal solution and imparts ambiguity to the calculation of tidal effects on gravity, crustal loading, and Earth rotation. Predicted effects of long-period tides on rotation could be uncertain by up to 50 percent in magnitude."

Interestingly, this 50 percent error that Dickman outlines is close to the 1.37 *ms* value of the total 2.3 ms/cy LOD variation.

These examples help to demonstrate that the study of Tidal Friction still remains an uncertain science. To date, there is not a definitive method for proving what is currently believed to be the total effect of the ocean tides on the slowing of the Earth's rotation.

If we maintain an open mind with regard to the underlying causes to observed momentum anomalies, we must take care to quantify what we know and what we assume. We know with fairly good certainty, from eclipse timings and laser ranging to the moon, the following:

1. The measured average slowing rotation of the Earth is 1.37 *ms/cy* for years 800 AD to 2000 AD

2. The increasing altitude of the Moon is 3.8 *cm/yr*.

What we estimate, and assume to be proven:

1. The ocean tides are entirely responsible for the Earth slowing at a rate of 2.3 to 2.4 *ms/cy.*

2. The ocean tides are entirely responsible for the 3.8 *cm/yr* increase of the Moon's altitude.

Is it possible that strong influences, such as the ocean tides, can mask alternate underlying influences? The history of science is rich

with this phenomenon. From Copernicus and Galileo, through Newton, and including the subtle influences of Relativity that were so easily masked by erroneous noise, it has been demonstrated that careful observation is required to unveil the complete influences. Historically we have seen that one dominating effect often is adopted as the total solution; at the expense of detecting other subtle influences. If it were not for the accidental discovery of the very subtle variation of Pioneer's motion, we may not now be seeking more precise observations with regards to other momentum anomalies. Again, a laboratory gyro experiment may well be the required test to show us which path to follow. If a momentum anomaly reveals itself with a gyro, we can compare the result to Pioneer, and also take a closer look at the Earth's slowing rotation. If a gyro anomaly does not emerge, than as Sherlock Holms would say, we have one less suspect.

2. Variable Mass

To formulate a correlation, we are first required to speculate on a potential source for the variation causing the anomaly. I enter this study by adhering to the long established fundamental understanding of the validity of Newton's first law: momentum must remain constant. What we observe in these anomalies is an unexplained variation in velocity or acceleration. We recognize that momentum is a constant and observation of the anomalies demonstrates that velocity is variable, therefore, the only other variable to consider in our momentum equation: $p = mv$, is mass. Since outside influences such as cosmic dust, etc., have been determined to be inadequate, particularly with Pioneer, we are directed to consider an internal inherent variation in mass as a possible cause for the observed anomalies. While there is no established proof or theory that verifies the existence of an intrinsic variation in mass, there has been much research to support this concept; [11][26][20]. Relativity establishes that both velocity and gravity cause variations in mass and matter. Applications of this principle have produced singularities: i.e., matter reduced to infinitely small volume. It is now commonly accepted that the Universe was born from a singularity. An assumption that has prevailed is that all matter of the Universe, in one quick flash, transformed from infinitely small to a constant fixed and static size for the life of the Universe. In addition, there have been numerous studies over the last century that have applied Relativity, Kaluza-Klein theory, and other applications and

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have predicted an ongoing and intrinsic variance in matter [26].   The recent ideas of "dark energy," also contribute to this postulate by providing a mechanism for the source of energy for an intrinsic variable mass [10]. (Equation 3.5)

By applying Newton's "conservation of angular momentum," a value for a speculative ongoing variance of matter is derived from the slowing rotation of the Earth. The measured LOD variation of 1.37 *ms/cy* is used for the slowing rotation and is considered in this study to be due to this speculative ongoing variance of matter rather than tidal friction. This approach assumes that tidal friction is responsible for the remaining .93 *ms/cy* of the total LOD estimated variation of 2.3 *ms/cy*. The obtained Δm value is then applied to the momentum anomalies of:

- the slowing of Pioneer
- rotational velocities of Galaxies
- the Moon's increasing orbit altitude

In the final analysis, what we currently observe in these momentum anomalies appears as a violation of Newton's first law. If we adhere to Newton's law, then what emerges is a requirement that mass be variable in an ongoing and intrinsic manner.

A Dynamic Earth

From the 1950's through the 1970's, the renowned and respected geologist, Samual Carey, advanced the idea that the continental drift was due to an increasing radius of the Earth. [3][4][5] This was not a modest effort. His research continues to carry influence in the scientific community. [15] He accumulated substantial geological evidence to support his hypothesis and made very convincing arguments. He also garnered a large following of supporters of his ideas. His theory eventually lost favor with the scientific community based on two primary objections:

1. Modern measurements by satellites failed to reveal any positive and ongoing increase of the Earth's radius.

2. A viable explanation for the mechanism providing the increase in the Earth's radius was not provided.

In light of modern theories of dark energy, the big bang and dark matter, could these two objections be adequately addressed?

Regarding the first objection, the general emphasis regarding Carey's research postulated that only the Earth demonstrated a dynamic nature of expansion. Since we are postulating that an intrinsic nature of expansion of matter could possibly exist, we are extending this expansion to all objects of ponderable mass. This includes Pioneer, the artificial satellites that also seemingly are affected by the ocean tides…..and also our yardsticks. What this means is that there is no convenient or obvious way to measure such an expansion. It only reveals itself in subtle ways, such as the slowing of Pioneer, or a percentage of the slowing rotation of the Earth

With regards to the second objection to Carey's postulate, since his day, new theories have emerged that open the door to a consideration for a mechanism to account for the increasing mass. For example, the theory of "dark energy" postulates that empty space has an energy value. Extension of thought could provide a theory for a conversion of space to mass thereby providing a possible mechanism for the increase in mass.

A relationship of space to mass

If we entertain the concept of "dark energy," or more precisely, empty space has an energy component, then we are guided to a postulate that defines an equivalency between mass, energy and space. Logic may be a useful tool to guide us to conclusions regarding the intrinsic relationships that exist between mass, energy and space, however, our conclusions are supported or reinforced if we can take a known mathematical relationship that delivers us predictable physical results and derive from that relationship the mathematical support for a postulate. In my studies of the kinship of space to mass I have applied Newton's law of gravity and proceeded from there.

$$g = G\frac{m_1 \cdot m_2}{r^2}$$

What Newton's law tells us is that the force of gravity is equal to a given amount of mass at a given distance. However, Newton did not have the benefit of Cavendish's work to establish the equivalency of mass to gravity. Newton did not know the value of G. What Newton established was the proportionality of mass to gravity. The gravitational constant "G" was a result of the insight and deduction of Cavendish and is generally given as:

$6.67 \times 10^{-11} N \cdot m^2 / kg^2$.

In my theoretical analysis of the equality of space to mass I found it necessary to remove "G" and return to the solid relationship of proportionality given by Newton.

$$g \propto \frac{m_1 \cdot m_2}{r^2}$$

The next step is to reduce the gravity equation to its basic form:

$$a \propto \frac{m}{r^2} \qquad \text{with } a = meters/\sec^2$$

Our intent is to unveil a possible proportional relationship between mass and space, therefore, we change the units to basic dimensions:

meters =	*distance* =	[L]
seconds =	*time* =	[T]
r =	*distance* =	[L]
m =	*mass* =	[M]

Substituting our general dimensions into Newton's law of gravity, we have:

$$[L]/[T]^2 \propto [M]/[L]^2$$

Rearranging dimensions we have:

$$\frac{[L]}{[T]^2} \cdot [L]^2 \propto [M]$$

Now we carry "[T]" to the right side and we are left with:

$$[L]^3 \propto [M][T]^2$$

$[L]^3$ represents space; length *x* width *x* height, so we have:

$$space \propto mt^2 \qquad\qquad (2.1)$$

Could it be possible that space has a direct proportionality to mass and time? Newton's law of gravity would seem to imply that it does. However, this equation leaves us with another question: is there a way to extend this relationship to an equality? For that extension of thought we need to delve deeper into our understanding of space. Our current knowledge of space is almost entirely defined by General Relativity. Relativity very precisely allows us to calculate the extent of the curvature of space due to mass. In our efforts to apply "dark energy" to a conversion to mass, we thus need to transform our Einstein

curvature measurement into a volume of space directly related to mass. This can be accomplished by, (for the sake of geometric convenience) visualizing the curved space as not curved or warped, but rather as space that is flowing into the object of ponderable mass. Geometrically, both models are equivalent. In other words, a passing beam of light would experience the same rate of deflection in both physical concepts: curved space and geometrically equivalent flowing space.

The formula for computing the curvature of space, as given to us by Einstein is:

$$B = \frac{\kappa M}{2\pi r}$$

with B the *sine* of the angle of deflection, "κ" is Einstein's coupling constant and r is radius or distance. Solving for the Earth we have:

$$B = \frac{1.87 x 10^{-26} \cdot 5.98 x 10^{24}}{2\pi \cdot 6.38 x 10^6}$$

$$= 2.79 x 10^{-9}$$

This value represents the *sine* of the angle of light as it is deflected by the Earth's gravitation. We can take this resulting vector and divide it into two components: horizontal and vertical. The magnitude of the horizontal vector is the speed of light. The magnitude of our vertical component, the one directed inward toward the Earth, is equal to our B times the speed of light.

$$v = 2.79 x 10^{-9} \cdot 3 x 10^8$$

$$= .84 \ meters/sec$$

We have derived a vertical component of our angle that represents the velocity of space inward to a star or planet. For the Earth this works out to .84 meters per second at the point vector and has an average value of 19.75 meters/sec averaged over the surface of the Earth. At the sun it is approximately 2,552 meters per second with an average of 547 meters/second.
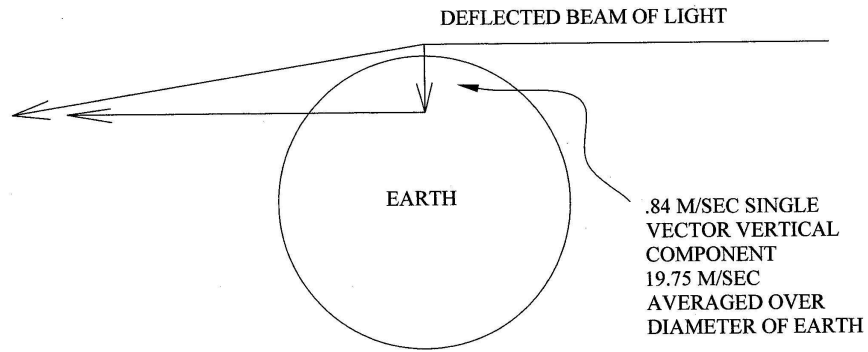
DEFLECTED BEAM OF LIGHT

EARTH

.84 M/SEC SINGLE
VECTOR VERTICAL
COMPONENT
19.75 M/SEC
AVERAGED OVER
DIAMETER OF EARTH

Figure 2.1

Using the area of the surface of the Earth and the amount of space that passes inward in one second, we can derive the volume of space that is consumed in one second: $4.29x10^{14}m^3/\sec$.

If we consider the postulate that Pioneer, the Earth and all objects have a very slight increase in mass each second, then we can calculate what increase in mass would be required to account for the non-tidal portion of the Earth's slowing rotation. The amount of mass the Earth would need to gain in one year is calculated in the next section (eq. 3.5) and the value of $5.6852x10^{16}kg/yr$ is attained. Converting this number to attain the gain in mass per second and taking the ratio of this number with volume of space consumed will give us an estimate of the equivalence factor of space to mass.

Surface area of the Earth:

$$a = 4\pi r^2$$
$$= 4\pi(6.38x10^6)^2$$
$$a = 5.11506x10^{14}m^2$$

Volume of space per second:

$$\text{vol/sec} = a \cdot 19.75m/\sec$$
$$= 5.11506x10^{14} \cdot 19.75$$
$$\text{vol/sec} = 1.0102x10^{16}m^3/\sec$$

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$$\text{Gain in mass/year:} \quad \Delta m / \Delta t \quad = 5.6852x10^{16} kg / yr$$

$$\text{Gain in mass/sec:} \quad \Delta m / \Delta t \quad = 1.8016x10^{9} kg / \sec$$

$$\frac{vol / \sec}{mass / \sec}: \quad m^3 / kg \quad = \frac{1.0102x10^{16}}{1.8016x10^{9}}$$

$$= 5,607,150 m^3 / kg$$

This calculation implies that approximately 5,607,000 cubic meters of space is equal to one kilogram of mass.

This volume of space is being drawn in and converted to mass per second each second, therefore our number becomes:

$$= 5.607x10^6 m^3 / kg / \sec^2$$

This relationship demonstrates the proportionality of space to mass.

Returning to our previous deduction for the volume of space per kilogram, we arrived at 5,607,000 cubic meters per kilogram each second. We can insert this conversion value into the equation derived from Newton's law of gravity and establish an equality of space to mass:

$$space = 5.607x10^6 mt^2 \qquad\qquad (2.2)$$

There are features of this equation that may be of significance. Our conversion constant was derived from theory and can be supported through measurement. In addition, the dimensions of our conversion constant; $meters^3 / kg / \sec^2$, are also naturally derived and provide the dimensional conversion necessary to establish the equality of space to mass. We have thus defined a new constant: a constant that defines the conversion of space to mass for each passing second of time. For convenience I have assigned it the symbol "DM." Our equation can now be written as:

$$space = DM \cdot mt^2 \qquad\qquad (2.3)$$

with $DM = 5.607 x 10^6 \, meters^3 \, / \, kg \, / \sec^2$

This postulate allows us to define a mechanism that supports Carey's hypothesis of an expanding Earth and at the same time, allows us to test for a correlation between an intrinsic increase in the mass of the Earth and the mass of the Pioneer spacecrafts. This mechanism addresses the "conservation of energy" requirement.

It is now universally accepted that energy and mass are directly equivalent. Equation 2.3 implies a similar equality of space to mass. One hundred years ago, the concept of mass spontaneously changing to energy was not accepted by most scientists who considered the postulate. However, a few decades later it was demonstrated that the radioactive decay of uranium precisely matched the reduction of mass and release of energy as predicted by relativity. Does equation 2.3 imply a similar spontaneous conversion between space and mass? We could defy this suggestion purely on an intuitive resistance to alternate explanations. As with all advances in research, experimental testing is required to determine if theory matches observation.

3. CONSERVATION OF ANGULAR MOMENTUM AND EARTH'S ROTATION

By applying the principle of "conservation of angular momentum," coupled with the speculation that matter may have an intrinsic property of expansion, we can derive the increase in mass and radius required to account for the slowing of the Earth. Given the stability of molecular structure, and if all sub atomic particles of mass are increasing in size at an extremely small rate, it is likely that this happens while maintaining the same relative distances between sub atomic particles. Therefore, mass increases, and radius and volume increase while density remains constant.

The slowing rotation of the Earth is well established. What is not commonly recognized is that only 43% of the decreasing angular velocity may be caused by the ocean tides. The cause for the other 57% is unproven. Measured variations in the rate of the Earth's slowing rotation, particularly in the last 200 years, help to establish an allocation

for the lost momentum that may not be related to the tides. The Moon's increasing altitude would indicate that in the past the tidal influence would have been larger. However, historical measurements from eclipses outline a very constant rate of slow down. Figure 3.1, compiled by Stephenson [21], diagrams a rate of 1.37 *ms/cy* that may be non-tidal. This rate is also supported by medieval Arab eclipse timings.
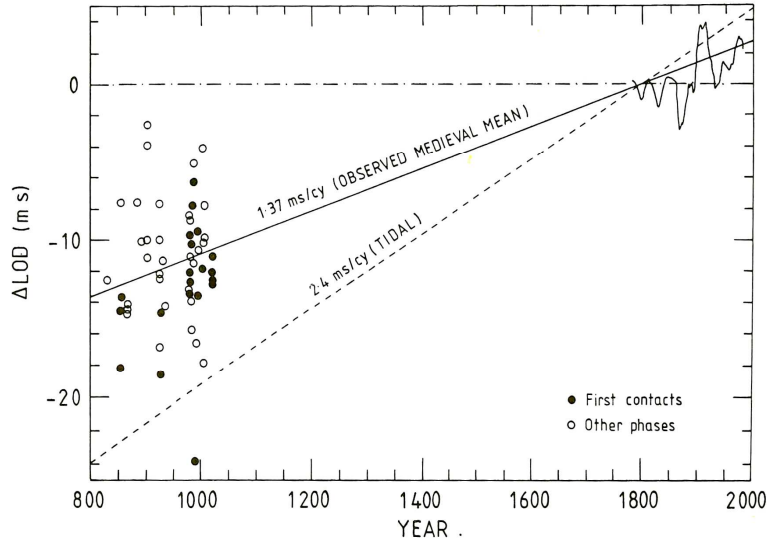

Fig. 3.1. Changes in the length of day (Δ LOD) relative to the reference day of 86400 SI seconds as derived from medieval Arab eclipse timings. The accurately mapped fluctuations since A.D. 1780 are shown for comparison. Also shown are the best fitting straight line to the data points which passes through Δ LOD = 0 at A.D. 1800 (full line) and the theoretical tidal variation (broken line). From Stephenson [12]

The following analysis applies Newton's law of "conservation of angular momentum" to calculate the increase in radius and mass the Earth would have to gain in one year to account for the unexplained 57% of the slow down. It also assumes that density remains constant.

We will use the following data for our calculations:

Mean radius Earth	$= r_0$	$= 6.371 x 10^6 \, meters$
Mass of Earth	$= m_0$	$= 5.9736 x 10^{24} \, kg$

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Moment of Inertia	$= I$	$= .3308mr^2$
Angular Velocity	$= \omega$	$= 131,490^0 / yr$
		$= 2294.933433 \; rad/yr$
Change in velocity	$= \Delta\omega$	$= 3.6361x10^{-5} \; rad / yr$
		$= .50sec/yr$
		$= 1.37ms/cy$

Angular Momentum $\quad = L \qquad\qquad = I\omega$

$$L = (.3308m_0r_0^2)(\omega_0)$$
$$= .3308(5.9736x10^{24})(6.371x10^6)^2(2294.933433)$$
$$= 1.8407166x10^{41}$$

To solve for the increase in mass and radius we put m in terms of r:

$(k = $ density conversion constant for mass to radius$)$

$$m = k \cdot \frac{4}{3}\pi r^3$$

$$k = \frac{5.9736x10^{24}}{4/3\pi(6.371x10^6)^3}$$

$$k = 5,514.73583405$$

Returning to our equation for angular momentum:

$$L = .3308r_0^2 \cdot 4/3k\pi r_0^3 \cdot \omega_0$$
$$L = 8/15k\pi r_0^5 \cdot \omega_0$$

We substitute another constant to reduce the numbers in the equation:

$$K = 8/15k\pi$$
$$K = 9.11954267x10^4$$

Which yields:

$$L = K \cdot r^5\omega \tag{3.1}$$

To find the rate of increase in the radius:

$$\frac{dA}{dt} = K(5r^4\omega\frac{dr}{dt} + r^5\frac{d\omega}{dt}) \tag{3.2}$$

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If we hold to Newton's first law then A remains constant and $\dfrac{dA}{dt} = 0$

Therefore: $5r^4\omega\dfrac{dr}{dt} = -r^5\dfrac{d\omega}{dt}$ (3.3)

$$\frac{dr}{dt} = \frac{-r}{5\omega}\frac{d\omega}{dt}$$ (3.4)

$$= \frac{-6.371x10^6(-3.6361x10^{-5})rad / yr}{5(2294.933433)}$$

$$\frac{dr}{dt} = 2.01884663 cm / yr$$

This deduction shows that the radius of the Earth is increasing at a current rate of approximately 2 centimeters per year.

The next task is to solve for the increase in mass. If density is to remain constant then the mass of the Earth is increasing with the cube of the radius. The following equation yields the increase in the mass of the Earth for one year:

$$m = k\frac{4}{3}\pi r^3$$

$$\frac{dm}{dt} = k\frac{4}{3}\pi 3 r^2\frac{dr}{dt}$$ (3.5)

$$= k 4\pi r^2\frac{dr}{dt}$$
$$= 5,514.73583405 \cdot 4\pi \cdot (6.371x10^6)^2 \cdot .0202$$
$$= 5.68523302x10^{16} kg / yr$$

To check if our calculations are correct, we insert $m + \Delta m, r + \Delta r, and, \omega - \Delta\omega$ into our equation for angular momentum. According to Newton's first law, A should not change.

$$L = .3308 \cdot 5.97360006x10^{24} \cdot 6,371,000.0202^2 \cdot 2294.93339664$$

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$$L = 1.84071666x10^{41}$$

This result is equal to our original calculation for angular momentum indicating that it is conserved.

This analysis shows what the increase in radius and mass of the Earth would be if there exists an inherent dynamic nature to matter. It thus provides us a mechanism that may account for the anomalous momentum problem regarding the Earth's rotation. Tidal friction and geophysical solutions seem to fall short of solving this anomaly. In addition, the results from this analysis can be extended to the anomalous momentum problems regarding the Moon's increasing orbit, the slowing Pioneer spacecraft and the rotating galaxies. The predicted change in the Earth's mass: $5.68x10^{16} kg / year$, is used as the rate of increase in the analysis of these other anomalies. If we take our Δm and divide it by the mass of the Earth, we then have the universal decimal percentage rate for which mass is increasing. This rate for one year is:

$$\frac{\Delta m / year}{m} = 9.5119x10^{-9} / year$$

This number can be considered a constant and assigned the symbol: m_d

Converting this rate of change to seconds we have:

$$m_d = 3.0142x10^{-16} / \sec$$

Applying the same conversion for decimal percentage rate of change for any given radius, we have:

$$r_d = 1.0047x10^{-16} / \sec$$

We can also do the same for ω, and the decimal percentage rate of change for rotational velocity for any given rotating body is:

$$\omega_d = -5.0235x10^{-16} / \sec$$

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We will see throughout the remainder of this study how these three values can be applied to various anomalies and produce results that are very close to what is observed.

Note: The variation rate for radius may be directly proportional to the molecular density of the object of mass in consideration.

4. PIONEER 10 AND 11

The Pioneer spacecraft represent an exceptionally good momentum anomaly. They were constructed by Earth scientists; therefore we know every aspect of them. We have two Pioneer spacecraft, and in addition, the Galileo and Ulysses space probes. All four demonstrated a similar reduction in velocity, seemingly in complete violation of Newton's first law.

The Pioneer 10 spacecraft was launched in 1972 and Pioneer 11 followed in 1973. Radio Doppler and ranging data from these now distant spacecraft indicate an apparent anomalous deceleration with a magnitude of $a \sim -8.74 x 10^{-8} cm/s^2$ directed towards the Sun [2][24]. Much effort has been expended looking for systematic origins to account for this discrepancy but none has been found. In applying the derived rate of change in mass that was calculated from the non-tidal slowing of the Earth, we can estimate a slowing of the pioneer spacecraft due to two factors:

1. The increasing mass of the Pioneer spacecraft with time will result in a slowing velocity as momentum is conserved.

2. The increasing mass of Earth based clocks results in a slowing of the clocks.

Note: The postulate presented herein outlines a possible intrinsic variation in mass of all the matter in the Universe that was born from the "Big Bang." If we pursue this postulate, than we are guided toward the task of evaluating all physical interactions with the additional insight of an ongoing and intrinsic increase in the mass of all atoms. This would include the atoms that are set to spin within an atomic clock and the frequency that is used as the time keeping mechanism. These

atoms would indeed experience a reduction in angular momentum. However, with this postulate of "dynamic matter," all yardsticks are growing, thereby reducing the availability of a reference that demonstrates the rate of change of growth. In the case of our clocks, again our clocks are as our yardsticks, and with all of them slowing at the same rate, we have no convenient reference to detect any error.

The slowing clock is currently misinterpreted as Doppler shift in the Pioneer signal.

Although the mass of the Sun would also be increasing with time per this postulate, the added gravitational force would be too small to be significant.

By applying our postulate of an intrinsic increasing variation of mass, and using the decimal percentage rate for Δm that was derived from the non-tidal slowing of the Earth's rotation, we can calculate the deceleration value for the Pioneer space probes. The values are as follows:

$$m_0 \quad = \quad 270\text{kg} \qquad\qquad \text{(mass of Pioneer)}$$

$$v_0 \quad = \quad 1.224x10^6\, cm\,/\sec \quad \text{(velocity of Pioneer)}$$

$$d_m \quad = \quad 9.5x10^{-9} \quad \text{(yearly rate of mass variation)}$$

Per Newton's first law and as with are calculation for the Earth, we hold momentum constant. Our equation for momentum is:

$$p = m_0 v_0 \qquad\qquad\qquad (4.1)$$

Our equation for the variation in velocity based on a one year increase in mass:

$$v_1 = \frac{p}{m_0 + \Delta m} \qquad\qquad\qquad (4.2)$$

$$= \frac{m_0 v_0}{m_0 + (9.5x10^{-9} m_0)} \qquad\qquad\qquad (4.3)$$

$$= \frac{v_0}{1+9.5x10^{-9}} \qquad (4.4)$$

$$\frac{\Delta v}{\Delta t} = \frac{\dfrac{v_0}{1+9.5x10^{-9}} - v_0}{year} \qquad (4.5)$$

$$= \frac{\left(\dfrac{1.224x10^6}{1+9.5x10^{-9}} - 1.224x10^6 \right) cm/\sec}{3.15576x10^7 \sec}$$

Therefore: $\quad a = -3.7x10^{-10} cm/\sec^2$

The increase in mass with time combined with the velocity of $1.224x10^6 cm/\sec$ for Pioneer 10 and 11, results in $a \sim -3.7x10^{-10} cm/s^2$. This is lower than the measured value of $a \sim -8.74x10^{-8} cm/s^2$. However, we must incorporate into our analysis the method in which the deceleration of Pioneer is measured. Time is read on an array of clocks on Earth. These clocks are used to measure the Doppler shift of the signal being received from Pioneer. The measurement for clock acceleration, as measured by the NASA team [2], is: $-a_t = -2.53x10^{-18} s/s^2$. Applying the postulate that <u>all</u> matter has an intrinsic property of expansion, we would conclude that our clocks, because the time keeping mechanism is getting heavier with each second, would be providing a measurement of time that would require a correction. The caesium based atomic clocks use the angular velocity of the caesium atoms for calibration. We must also include in the speculation that if there does exist an ongoing intrinsic expansion of matter, then it must happen at the sub-atomic level and that the quantum increment advances at the same rate. In Section 2, the decimal percentage value for $\Delta \omega$ was derived. This number is:

$$\omega_d = -5.0235x10^{-16} /\sec$$

This number, when multiplied by "ω," represents the decrease of angular velocity for any rotating body. In the case of the caesium clock, the clock is in essence, continually being reset, and there is no

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opportunity for an accumulation of the slowing angular velocity as there is with the Earth. This is because the clock is calibrated by a continuous stream of atoms that are uniformly set in spinning motion. Therefore, ω_d represents a close approximation of the instantaneous slowing of the clock. An interesting note is that the advertised uncertainty value for the caesium clock is: $5x10^{-16}$.

We can apply the ω_d number to provide the correction for our clocks that are used to measure the slowdown of Pioneer. A change in angular velocity due to the dynamic matter process results in a directly proportional rate of change in our clocks. To arrive at an adjusted value of time we divide our dynamic matter rate of change value by the time acceleration value of the Earth based clocks used to measure the Pioneer Doppler signal. If we multiply this adjusted value by the actual deceleration of Pioneer as calculated by using the dynamic matter process, we arrive at the value which we perceive to be the deceleration value of Pioneer. Thus we have:

$$\frac{\textit{Deceleration of clocks due to } \omega_d}{\textit{Deceleration of clocks measured at Earth}}$$

$$x \quad \textit{the actual deceleration of Pioneer}$$

$$= \quad \textit{Perceived deceleration of Pioneer}$$

$$\frac{-5.0235x10^{-16}}{-2.53x10^{-18}} \cdot 3.7x10^{-10} = 7.35x10^{-8} cm/\sec^2 \qquad (4.6)$$

This value is within 16% of the value of $a \sim 8.74 \pm 1.33x10^{-8} cm/s^2$ calculated by NASA for the deceleration of Pioneer. Also note that our result is nearly equal to the low side of the margin of error.

In March of 2008, results of a new study of Pioneer by a team of JPL scientists demonstrated that a percentage of the deceleration of the deep space probe may be due to uneven thermal radiation [24][25]. The estimate of the contribution of this effect may be as high as 30%. However, it may be that a more conservative estimate of the uneven

thermal radiation factor addresses the 16% shortfall from the dynamic matter prediction.

There are also three other important points regarding the anomalous acceleration of Pioneer 10 and 11. The observed nature of the deceleration is not related to the inverse square law associated with gravity. Also, as determined by the NASA study, the anomalous motion is related to velocity; see [2] and equation (3.5). In addition, the deceleration is independent of distance [2]. All three of these significant observed characteristics of Pioneer agree with the postulate of a variance of matter as applied to conservation of momentum and the Pioneer anomaly. By contrast, the uneven thermal radiation model, unlike the observed nature of Pioneer, would be dependant on distance from the sun. The Turyshev model [24], is based on a distance of 25 A.U.. At distances greater than 25 A.U., the uneven thermal radiation would have less of an effect on Pioneer bringing it closer to the 16% deficit.

5. DARK MATTER

Rotational anomalies have been observed in galaxies and galaxy formations. Astronomers have found that the outer areas of Galaxies are rotating at greater velocities than expected. The very broad conjecture has been offered that there exists a halo of dark matter surrounding galaxies thus providing the mass necessary for the rotational velocities observed. The primary problem with this concept is that there is no direct observational data or proven theory that supports the existence of dark matter. Dark matter has been offered primarily because there should be more gravitational mass to account for the galactic rotations. Cosmologists studying these rotational velocities estimate that the amount of additional matter required is 10 to 100 times the amount that is observable.
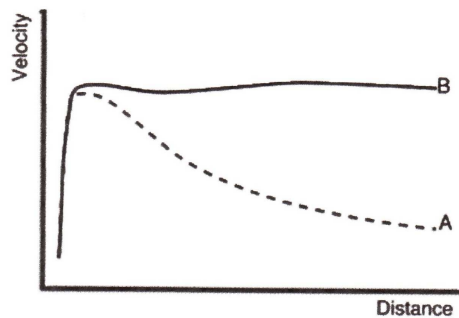

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Fig. 5.1   Rotation curve of a typical spiral galaxy: predicted (**A**) and observed (**B**). Dark matter can explain the velocity curve having a "flat" appearance out to a large radius

The dynamic matter postulate addresses these rotational anomalies. It was shown how if we apply the dynamic matter concept, then the mass of the Earth is increasing at a rate of:

$$5.567 x 10^{16} kg / year.$$

With this increase, the Earth's rotational velocity is decreasing. This is a result of Newton's law of "conservation of angular momentum." What this implies is that as one looks back in time at the distant galaxies, one is looking at younger galaxies with matter that had less mass. In consideration of a postulate of "dynamic matter," we speculate that the number of atoms in the stars remains constant but the mass of the individual atoms increases with time. A star consisting of young matter has the same energy output as the same star type that is composed of older matter but at the same time it has less mass than its older counterpart. For the dynamic matter analysis we need to apply this proposed phenomenon to the rotational velocities.

Recent observations with infrared imaging [23], have shown that the stars at the center of the Milky Way are much younger than the outer stars. This is contrary to previous theory that older stars inhabit the center. Measurements show an age of 10 to 15 million years for the interior stars compared to several billion years for the outer stars. These new observations that date the age of stars at the center of our galaxy add support to the theory that new stars are being created via the Hawking black hole return of energy to the universe [12].

Age variations of stars within the Milky Way have also been established by measurements of two stars in globular cluster NGC 6397; see [6]. From this research, the elapsed time between the rise of the first generation of stars in the entire Galaxy and first generation of stars in the cluster was deduced to be 200 million to 300 million years. Globular clusters generally occupy the outer ring of galaxies and contain the oldest stars. By applying the postulate of "dynamic matter," we can predict that a variation in age of two stars also results in a variation of mass while maintaining the same energy output. In other words, for two stars of different age but are identical with regard to the number of atoms and resulting energy output, they will have different

masses. This is because the older star has existed longer with the dynamic matter effect and its atoms are larger and more massive. We can calculate what this translates to in terms of the different masses. We apply the Δm constant derived in Section 2.

$$m_d = 9.5119x10^{-9} / year$$

If we consider two stars with an age variation of 200 million years, we have:

$$\frac{m(t)}{m_0} = e^{m_d(t-t_0)} \tag{5.1}$$

$$\frac{m(t)}{m_0} = 2.7183^{9.51x10^{-9} \cdot 2x10^8}$$

$$= 6.69$$

This is the multiple of mass. The outer stars would have close to seven times the mass of the interior stars.

If we consider two stars with an age variation of 300 million years, we have:

$$\frac{m(t)}{m_0} = 2.7183^{9.51x10^{-9} \cdot 3x10^8}$$

$$= 17.34$$

This is the multiple of mass. The outer stars would have close to 17 times the mass of the interior stars.

The Milky Way is believed to have dark matter equal to about ten times the mass of the visible stars. This value falls nicely between the calculated range of 7 to 17. As we can see from the above calculations, the concept of a "dynamic matter" addresses the problem of the non-proportional rotational velocities of galaxies.

The theory of dark matter has been troublesome. While the additional gravity offered by the theory does address the rotational velocity anomaly, the theory that predicts dark matter is incomplete. In addition, scientists have been unsuccessful in detecting dark matter. The need for "dark matter" is eliminated and is replaced by "dynamic

matter", of which there exists theoretical support derived from Relativity and the Big Bang [12].

6. ORBIT OF THE MOON

In 1969 the Apollo astronauts placed a reflector on the Moon that has been used to measure the distance between the Earth and the Moon. Because of the coarse variations in the Moon's orbit, the rate of change of orbit is based on the Doppler shift of the laser ranging, and not the overall duration of the laser echo. What this implies is that the time measurement of this shift is in the range to be affected by the slowing of our clocks by the postulated "dynamic matter" effect. This is similar to the clock adjustment in the Pioneer calculations in section 4.

Measurements have shown that the mean distance between the Earth and the Moon is increasing consistently at a rate of 3.8 centimeters per year. The popular explanation that has been offered for this phenomenon is attributed entirely to the ocean tides. The Moon attracts the water toward it. The result is a calculated rise in the ocean water of 3.23 centimeters at the highest point and from there slopes away. As the Earth rotates, the ocean is pulled with it. This results in a lag of the ocean bulge. The high point is no longer in direct line with the Moon. The gravitational attraction of this area of elevated water exerts a lateral pull on the Moon and accelerates it to a higher orbit. In reaction, some of the angular momentum of the Earth is transferred to the Moon. The analysis is not included in this paper, but it agrees with the conclusions of Hipkin, [13] and others that this elevated water is not adequate to account for the 3.8 cm/year increase in orbit that is measured. The 3.23 cm amplitude of net equilibrium tide that is considered responsible for the Moon's increasing altitude is considered too small to cause such a large increase. In addition, it is broken up by the continents when they pass under the Moon. Also this tidal bulge experiences undulations with some ahead of the Moon, others behind it and still others on either side. The integration of these undulations appears to be inconclusive in verifying this tide as the total source of the rather large increase of the Moon's orbital distance.

The majority of the dissipation of tidal friction energy is spent as heat as the tides flow over shallow basins. It is estimated by some that approximately 1/30 of the total tidal friction energy is transferred to the moon. I adopt the approach in this study, based on the measured

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slowing rotation by Stephenson, that only 47% of the Earth's decreasing angular velocity is attributed to the ocean tides. Recognizing this reduced value for tidal friction and applying it to the ocean tide effect on the moon requires us to reduce the tidal affect on the moon by, at the very minimum, 47%. This situation leaves us with the task of identifying a possible alternate cause for the majority of the perceived increase in the moon's increasing altitude.

Is section 2, we considered the Earth's slowing rotation as an angular momentum problem. We wish to do the same with the Moon. However, the situation with the Moon is different. For the Earth we have a congruous body of mass and we can view the variation in radius as a confined interaction between the molecules of the Earth. With the Moon, we have a large separation between the two bodies in consideration. We are required to consider the gravity of the Earth and the centripetal force of the moon for our analysis. If we continue with the postulate that all bodies of mass are increasing, then at first consideration it may appear that the increase in gravity, due to an increase of mass in both the Earth and Moon, would exactly match the increase in centripetal force. However, we must remember that any increase in gravity is conveyed at the speed of light. Therefore, there is a 1.27 second delay for the increasing effect of gravity, while the increase in centripetal force is instantaneous. Therefore, the orbit of the Moon will increase.

Our objective is to determine if the change in radius of the orbit between the Earth and Moon may be due to an ongoing increase in mass. We will simplify the problem by using a mean average radius. This gives us an approximate solution which is very close to that of the ellipse. We start with our equation for the balance of gravity and centripetal force:

$$G\frac{Mm}{r^2} = m\frac{v^2}{r}$$ which reduces to:

$$r = \frac{GM}{v^2}$$ (6.1)

Our parameters are as follows:

Mass of Earth	$M =$	$5.9736x10^{24}\,kg$
Gravitational constant	$G =$	$6.673x10^{-11}$
Velocity of Moon	$v_0 =$	$1024.70m/sec$

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Elliptical orbit circum.	$s =$	$2,418,892,271.378\ m$
Periods per year	$P =$	13.3685
Mean radius of orbit	$r_0 =$	$379,632,854.77m$

We wish to solve for the change in radius of the Moon's orbit. Our change in radius is dependant on the dynamic matter effect on the moon. This manifests itself by the change in the velocity of the Moon as its mass increases. Therefore:

$$r_1 = \frac{GM}{(v - \Delta v)^2} \tag{6.2}$$

Our value for Δv is equal to the velocity of the moon times our percentage decimal factor for the change in mass as derived in section 2 of $9.5119x10^{-9}/\ year$. In addition, because gravity is traveling at the speed of light, we also multiply Δv by 1.27; the time for gravity to travel from the Earth to the moon. In our simplified approximation, we will use the average change in velocity for one year; therefore our expression is divided by 2. Inserting values we have:

$$r_1 = \frac{6.673x10^{-11} \cdot 5.9736x10^{24}}{\left[1024.7 - \left(1024.7 \cdot 9.5119x10^{-9} \cdot 1.27/2 \right) \right]^2} \tag{6.3}$$

$$=379,632,859.35\ meters$$

$$\Delta r = 4.58\ meters$$

We saw in the Pioneer calculations in section 3 that we must also take into consideration the effect that the dynamic matter process has on our clocks. Because of the doppler shift from the laser ranging, the range of the clock measurement is in the range that is affected by the dynamic matter effect. So while our result of 4.58 meters appears large, we must next apply the clock error. Our laser signal delay is approximately: $4x10^{-18}\ meters/\sec$. Again, as derived in section 2, our clock error is: $\omega_d = 5x10^{16}/\sec$. Our clock adjustment equation becomes:

$$\Delta r = \frac{4.58}{5x10^{-16} / 4x10^{-18}} \qquad (6.4)$$

$$= 3.7 \; cm/\text{year}$$

This is very close to our measured value of 3.8 cm/year. This result implies that possibly 97% of the increase of the Moon's orbit is from the dynamic matter effect.

7. RELATIVE CHANGES

It may appear at first glance that an annual increase in the mass of the Earth of $5.6282x10^{16} kg$ would be easy to detect and would likely not go unnoticed. However, if one ponders the postulate deeper, it becomes apparent that all changes are relative. If one recognizes that all objects of ponderable mass are increasing at the same rate, then the invisibility of these changes becomes more apparent. For example, if one was to repeat the Cavendish experiment to re-check the gravitational constant and also measure the mass of the Earth, here are some of the considerations. First, his reference masses of 1 kilogram each are increasing at the same rate as the mass of the Earth. Therefore, our experimenter believes he is using one kilogram masses. But in reality, his reference masses have also increased over the past year. In addition, the filament that suspends the masses and twists under the gravitational attraction, is somewhat thicker, heavier and has a slightly higher resistance to twisting than the same filament of one year prior.

What becomes apparent is that all things in our immediate time frame remain relatively equal; our yardsticks are increasing with our world. However, it seems possible, from the analysis included herein, that when we observe events that occur at very large distances or events that involve large changes in time, and also, the relative motions that exist in the depths of space, variations begin to emerge due to an ongoing and intrinsic increase in mass.

8. PROPOSED LABORATORY TEST

The Pioneer spacecraft may represent a test of Newton's first law. Momentum should be conserved but indeed the data demonstrates that these two spacecraft and also two others are slowing in velocity when in fact they should not be. Even more recent data shows that

there are now several additional space probes that are also demonstrating momentum anomalies. If we choose to adhere to Newton's first law, and if we can exclude outside interferences, which is believed to have been done in the case of Pioneer, then few alternate explanations present themselves. One consideration offered herein is a possible dynamic increase in matter. A steady increase in matter will slow the motion of a moving body.

A corresponding test to the Pioneer anomaly can be performed in the laboratory. If a rotating gyro is set in motion within a vacuum chamber the nature of its slowing motion may yield correlating results. Per Newton's first law, a frictionless gyro rotating in a perfect vacuum should not have any slowing. In a real test, friction cannot be eliminated entirely. However, the lost rotational velocity due to friction will vary with the rotational velocity; ie., the greater the velocity then the greater the effects of friction. By contrast, the lost velocity due to "Dynamic Matter" should appear as constant regardless of the velocity. By measuring lost rotational velocity at different rotational velocities this variation can be used to quantify those losses due to friction and reveal the losses due to the "dynamic matter" effect. The expected result would be a change in velocity comparable to the change measured for the non-tidal slowing of the Earth's rotation. The decreasing angular velocity of the gyro should be changing at a decimal percentage rate of $\Delta \omega_d = -5.0325 x 10^{-16} / \sec$ as calculated in section 3. This amount of change is very slight and it is likely that in past gyro experiments the change was attributed entirely to friction. This oversight may be similar to the historic measurement of time and mass variations due to relativity. They were so slight, that until we knew what to look for, they went undetected.

9. DIFFERENTIAL CRUST TO CORE GROWTH

The distinguished geologist, Samual Carey, by applying numerous and varied geological observations, calculated an ongoing increase in the radius of the Earth that is very close to the rate calculated in this paper. The rate I calculated was based on applying conservation of angular momentum against the non-tidal slowing of the Earth's rotation. One contributing observation in Carey's research was that when the Earth is reduced in size, then all of the continental shore lines fit together. If Carey's expanding Earth hypothesis is to be

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reconciled with the "Dynamic Matter" hypothesis presented in this paper, then the different rate of expansion for the Earth crust and core must be addressed.

The Earth's crust has an average temperature of 200 to 300 degrees Fahrenheit while the core is around 10,800 degrees. The Dynamic Matter growth process says that inward flowing space is being converted to mass. Space has no temperature. When a quantum unit of space is converted to mass, then that new layer of mass would assume the temperature of the host mass. This implies that there is a secondary expansion occurring during the space to mass conversion process. In the case of the Earth, the mass in the core would have a larger rate of expansion than the mass in the crust, due to the temperature difference. The temperatures in the Earth crust and core are in a temperature range to provide the necessary differential. It is important to keep in mind that not all the mass of the Earth is affected every ongoing second by the temperature expansion. It is only the new mass that is being added to the existing mass.

10. EARTH EXPANSION TEST

The movement of the continents is now closely monitored. Instruments like *Doris,* combined with *Topex/Poseidon* and *Spot,* and in addition, GPS data from NASA JPL, now plot absolute vector positions of numerous locations. The vectors are limited to continental land masses and islands. Any movement of the sea floor would need to be interpolated from the known vectors provided by the land based stations.

A possible test could be conducted by simply doing a vector analysis from the known data. The surface of the Earth could be divided into equal segmented areas and an average vector determined for each segment. By adding the known vectors, the net relative movement of the segments could be determined. This exercise would reveal if there is a resulting increase or decrease in the surface area of the Earth. Data for changing elevation of land masses may be erroneous if the satellite orbits are also affected by the "dynamic matter" effect. (note: see section 6, *Orbit of the Moon*.)

From equation 3.4, it was estimated that the radius of the Earth could be increasing at a rate of 2.02 *cm*/year. This represents an

increase in circumference of 12.68 *cm*/year. As was seen in section 9 with the relative increase in length of an iron and granite rod, we determine that the perceived increase of the Earth's circumference would be 66% of the total increase. This is in accordance with the postulate that the predominately iron interior of the Earth is expanding at a rate three times of the predominately granite crust. If the granite was expanding at the exact same rate as the iron interior, then there would be no perceived increase in the circumference and there would be no continental drift due to an expanding Earth. The vector analysis, if this postulate is correct, should yield a net perceived increase of 8.45 *cm*/year of the Earth's circumference.

It may be likely that a vector analysis has previously been performed. However, given the reluctance of consideration of expanding Earth theory, previous analysis may have been overlooked or not conducted with the possibility of expansion in mind. In the context of this paper, expanding Earth is linked to Pioneer and other anomalies, and hopefully offers additional motivation for a comprehensive vector analysis.
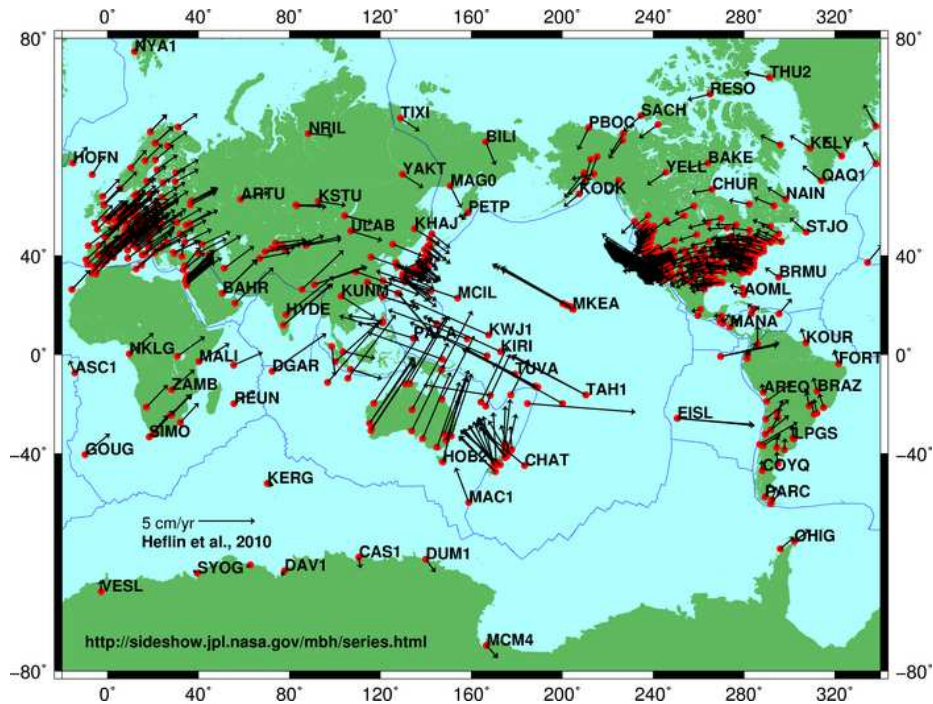

FIGURE 10.1

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Plate motion based on Global Positioning System (GPS) satellite data from NASA JPL. Vectors show direction and magnitude of motion. http://sideshow.jpl.nasa.gov/mbh/all/images/global.jpg

By observing the NASA vector map, (figure 10.1) there are land mass movements that show the areas of land getting further apart. In addition, there are areas, such as the northern Pacific, where North America and Northeast Asia are moving closer together. Also note that Southern Africa, Australia and South America are moving away from Antarctica. By establishing a vector map that distributes the vectors as evenly as possible from the known data, then a net change for the surface are of the Earth should be possible to calculate.

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