New Gravitational Theory with Experimental Validation

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1 Abstract

A revolutionary new gravitational theory is proposed { including the discovery of diallel, gravitational-¯eld lines. This new gravitational theory is a more general description of the gravitational attraction between bodies than the traditional theory. The traditional theory is a specialized case of the new theory. We have devised and conducted an experiment to di®erentiate between the new and the traditional and have obtained a±rmative results consistent with the new theory. This was accomplished using simple pendulums as gravitational detection devices along with some special timing measurement techniques.

2 Explanation of New Gravitational Theory

The energy-density, rather than just the mass, is a key consideration in this new theory. In this new gravitational theory the attraction between two bodies depends on the energy-densities of each of the two bodies. The energy-density of a body is communicated at the velocity of light via diallel, gravitational-¯eld lines.

Fundamental to this new theory is the discovery of diallel, gravitational-¯eld lines. These connect the two bodies { providing a path for the gravitational information to °ow. To see the evidence of these diallel lines in nature requires a paradigm shift away from the traditional view of gravitational interaction. (see web site www.allanstime.com)

The general model now being used to describe the gravitational ¯eld is that the waves are transverse to the direction of propagation of the gravitational energy. No experiments have been able to directly measure gravitational waves, but from the interaction of gravitational energy between a binary pulsar pair, Professor Joseph Taylor (Princeton U.) was able to con¯rm Einstein's prediction that gravitational energy travels at the velocity of light.[Taylor] These ¯ndings are also consistent with the new theory, that the energy travels at the velocity of light.

To better understand how the gravitational energy is transmitted along diallel, gravitational ¯eld lines in this new theory, consider the following. As there are seven spherical shells providing the quantum states for any and all of the elements in the periodic table, so there are seven cylindrical shells surrounding a nuclear shell composing each of these diallel lines. All of the force ¯elds can carry photons and/or particles along these diallel lines. Quantum states exist for these diallel lines, also. They similarly depend on the energy conditions.

It may be helpful in envisioning the diallel quantum states to consider other physical systems with cylindrical symmetry and having eigenfunction solutions [Collins]. One such example is the set of modes de¯ning the electromagnetic ¯elds propagating along a circular-cylindrical waveguide. Of special interest are the modal distributions in the case of highly-overmoded waveguides, a situation that may occur when the free-space wavelength of the electromagnetic ¯eld is much less than the diameter of the waveguide. Solving the electromagnetic wave equation, subject to the appropriate boundary conditions and assuming a waveguide of in¯nite length, yields ¯eld expressions given in terms of Bessel functions of the ¯rst kind. These functions provide an orthogonal set with which to describe the waveguide modes. The eigenvalues are related to the zeroes of the Bessel functions. The particle density distributions in a diallel-quantum state would be described in terms of a similar set of orthogonal functions. Although a great many electrons could propagate along a diallel line by occupying a multiplicity of quantum states, Fermi-Dirac statistics would limit the number of electrons in each state to two electrons. In addition, just as the electromagnetic ¯eld can be circularly polarized (the macroscopic manifestation of the spin quantum number of the associated photons) leading to a spiraling of the ¯eld vectors in the circular waveguide, the density distribution of a particle in a diallel-quantum state may also be described as spiraling.

2.1 The Fundamental Field Equation

The following equation is fundamental in understanding how the force ¯elds interact and come together for this new theory:

$$D = \frac{E}{cG} = ¦_{2}; \qquad (1)$$

where D is the relativistic density, E is the energy of the uni¯ed ¯eld, c is the velocity of light, G is the universal gravitational constant, and the last part of the equation, $= ¦_{2}$, the parallel component will be explained below.

2.1.1 Density Dependance, D

The density D is the dependent variable; changes in the energy (energy °ow in and out of a region) cause changes in the density. For example, the energy °ow to and/or away from any space-time continuum along the diallel lines determines the corresponding change in the density in that space-time continuum.

Appreciating the importance of the energy density at the particle level, as well as in a region, is integrated in this new theory. The energy can come from any of the force ¯elds. For example, both equations apply: $E = mc^2$, where \m" is the relativistic mass and $E = h^o$, where \h" is Planck's constant \o" is the electromagnetic frequency of the photon.

2.1.2 Parallel Component (¦_2)

A dimensional analysis of the above equation reveals that ¦_2 has dimensions of length, time and mass as the force ¯elds interact. The forward slash \/" denotes being parallel in the theory's mass-space-time continuum along the local diallel lines. The \sub-2" on the \ ¦ " denotes the energy coming in or going out in the mass-space-time continuum along the diallel lines in the local environment or region.

Combining the energy with this term we have $E{=}P\,i_2$. Hence, we see that this denotes the energy per mass, per length and per time taken in the parallel direction of the local diallel lines. The quantity in the denominator of equation(1), cG, is the normalizing factor, so that the dependent variable, D, is the density factor taken in the parallel direction of the diallel lines. It is the density that is the principal resultant output after combining the energy from the force ¯elds.

Since the subscript \sub-2" denotes the energy from all sources coming into or going out of the local environment or region, a \sub-1" is implied for the energy, E, and the resulting density, D, as the recipients of the net energy coming in along the diallel lines into the environment or region.

The dependent variable D can also be taken as density of matter in the usual sense: mass per unit volume. But in general, D is a tensor description as the dependant variable resulting from that part of the energy tensor, E, coming from the parallel part ¦_2, as described above. The need for the tensor description comes because the diallel lines have direction and the applicable parallel part comes in through the ¦_2 term for equation (1) or through the ¦_1 and ¦_2 in the force equation, equation (2).

2.2 Force Equation for the New Theory

From the above ¯eld equation, we can derive a force equation:

$$F = \frac{1}{c^2 G r_{12}^2} \int_{Vol_1} E_1 = \text{¦}_2 \, dV \int_{Vol_2} E_2 = \text{¦}_1 \, dV; \qquad (2)$$

where the integrals are over the volumes of each of the two bodies being attracted, and where r_{12} is the distance between the energy-density centers of the two bodies. The integrals across the ¦ terms give the direction for the force vector, which depends on the direction of the diallel lines.

If we let the two bodies be two homogeneous spheres and use equation(1), then equation(2) becomes the classical gravitational force equation:

$$F = G\frac{m_1 m_2}{r_{12}^2}; \tag{3}$$

where r_{12} is now the distance between the centers of mass of the two homogeneous spheres. Naturally, these spheres can be made arbitrarily small – point masses – as in the classical gravitational theory.

3 Theoretical Basis for the Experiment

If one can create a high energy-density body on the surface of the earth, then a larger than average number of the diallel lines coming forth from the earth will be pulled into this body. Because of the ¦ term and the higher energy-density, the earth's diallel, gravitation-field lines will be pulled in toward the vertical center line of the high energy-density body. This bending is observed, for example, above a highly intense thunder-cloud storm system and is evidenced as high energy electrons are emitted upward along these diallel lines that are bending inward toward the local vertical of these high energy-density systems. These have been called "Blue jets." [University of Alaska] (See for example: "http://www.allanstime.com/images/red_sprite.htm)

4 Experimental Setup to Differentiate between the New and the Old Theories

We set up a simple experiment to differentiate between the traditional equation and the new force equation (i.e. equation 3 and equation 2, respectively). The experiment was kept simple for educational reasons, and to demonstrate that a very fundamental experiment can be done with relatively simple techniques and apparatus.

4.1 A Simple Pendulum as a Detector

Since a simple pendulum is sensitive to the local gravitational acceleration, g, it may be used as a detector. The following is the first-order equation for the period of a simple pendulum with a length "L" for its bob's suspension.

$$T = 2\pi\sqrt{\frac{L}{g}}. \tag{4}$$

If a high, energy-density source can be found, then this new theory predicts that the diallel, gravitational-field lines radially protruding from the earth will be bent toward the vertical, center-line of this high, energy-density body, that is sitting on the earth. This is like a lens bending light rays.

These diallel lines define the local vertical. If a high-energy density object is place immediately under a swinging pendulum and if the diallel lines are bent inward, then as the pendulum bob swings outward, the local vertical for the bob will have been modified to be in closer alignment with the support line for the bob. Hence, the restoring force for the bob will be reduced – causing a slowing of the pendulum beat and an increase in its period.

The basic intent of this first experiment was to determine if the effect predicted was present. Three different kinds of energy densities were chosen in order to show generalization of the force equation: chemical, magnetic, and electrostatic. For a high, chemical-energy density a car battery was conveniently chosen. Six one-farad capacitors connected in parallel were chosen to create the high, energy-density electrostatic field. A five kilowatt transformer was chosen to generate the high, energy-density magnetic field. More will be discussed about the characteristics of each of these energy densities in the experimental analysis.

Two high-quality, nearly-identical, commercial pendulum clocks were employed for the experiment. They were placed on a low table and on either side of a reference clock and a thermometer. (See Figure 1) Later, we will also discuss the temperature effects on the experiment. The table was constructed sufficiently low so that the energy density source could be placed immediately under one clock (pendulum clock A) and then conveniently moved to be under the other clock (pendulum clock B) for an A, B comparison.

4.2 Time and Frequency Measurement Techniques

Though the apparatus was relatively simple and the experimental setup not complicated, the best time and frequency metrology techniques were implemented to ascertain the size of the effect and its uncertainty (see figure 1). Vastly superior techniques could have been designed and implemented to study the desired effect, but the resources were not readily available. The measurement equipment used, though rather primitive, was adequate to achieve the precision needed.

4.2.1 Advantage of Heterodyne Technique

The heterodyne principle was used in order to obtain additional leverage on the precision needed for the experiment. This was accomplished by designing a beat frequency between the two pendulums. From the equation above one can see that the period of the pendulum is dependent upon its length. The suspension on pendulum A was shortened slightly and the suspension on pendulum B was lengthened slightly. A beat period of 100 seconds was chosen for reasons that will be explained later. The period of the pendulums used was about 1.36 seconds, and for this period the length difference needed was about 12.5 millimeters for simple pendulums.

To see the advantage of the heterodyne principle, let ν_A be the frequency of pendulum A and let ν_0 be the ideal reference frequency. We can write the fractional offset frequency of pendulum A as follows:

$$y_A = \frac{\nu_A - \nu_0}{\nu_0} = \frac{\nu_b}{\nu_0}; \qquad (5)$$

where ν_b is the beat or difference frequency. If we take the time derivative of equation (5), realizing also that $\nu_b = \frac{1}{T_b}$, where T_b is the beat period, we obtain the following:

$$y_A = \frac{\Delta\nu_A}{\nu_0} = -\frac{\nu_b}{\nu_0}\frac{\Delta T_b}{T_b}. \tag{6}$$

Hence, very small changes in the fractional frequency of pendulum A can be observed corresponding to much larger changes in the beat period as reduced by the heterodyne factor, $\frac{\nu_b}{\nu_0}$. The heterodyne factor acts like an error multiplier — making changes much easier to observe. In our case the heterodyne factor was about 1.35×10^{-2}, or in terms of error multiplication it is about 74.

4.2.2 Counting Cycles of the Pendulums

Because these particular pendulum clocks did not have a mechanism for counting the number of swings that had occurred, this had to be done externally. Should there be any question about the number of cycles that had transpired, the experiment was videotaped. In worst-case, the number of cycles could be counted against the WWVB reference clock, that is tied to the Atomic Clock at NIST Boulder, Colorado. Fortunately, through some time and frequency metrology tricks this did not have to be done. Because of the good stability of the pendulum clocks, a few cycles could be measured precisely with a quartz crystal oscillator based stop watch, and then the occurrence of a future cycle could be predicted. This process was continued — giving refinement in the measurement of the pendulums' beat period as the experiment progressed. [Sullivan]

The beat period of 100 seconds, chosen above, gave both a useful heterodyne factor, and it also helped in resolving the counting of the correct number of cycles that had transpired. For example, every three beat periods (300 s or 5 minutes), the two pendulum clocks would come into synchronism again. The precise timing of the beat periods between the two pendulum clocks gave us the accuracy we needed to detect changes in the pendulum periods.

4.2.3 The Reference Clock

The WWVB clock has a radio receiver to keep it locked to the atomic clock in Boulder, Colorado. This radio receiver wakes up at 11:00 p.m. local time, and synchronizes the internal clock to the Boulder clock. We had three such clocks on site for this experiment. Even though the specification on the clocks was an accuracy of 0.8 seconds, the three clocks were typically in agreement within one or two tenths of a second. Frequency stability of the WWVB clock was estimated to be of the order of one part in 10^6.

4.2.4 The Quartz Stop Watch

The contribution of the stop watch to the measurement uncertainty was comparable to that of the WWVB clock. This is because its time base was also a quartz crystal oscillator, and it was used strictly as a stop watch and not as a source of accurate time. In other words, it was used as an independent source of timing of the periods of the pendulums. The frequency stability of the quartz crystal oscillator in the stop watch was also estimated to be of the order of one part in 10^6. The readout of the stop watch was to 10 milliseconds. The main limitation for the stop watch measurement was the human reaction time – ability to push the button at the right moment. This reaction time was tested to be at about 40 milliseconds using the WWVB clock as a calibration device.

4.2.5 Double the Precision with A,B Comparison

The energy-density body was first placed directly under pendulum A and left for sufficient averaging time (typically an hour). Then, it was moved under pendulum B and left for the same amount of time – then back under pendulum A, and this process was repeated N times. Let us assume that each time the energy-density is placed under a clock that the size of the frequency slowing of the clock is δ – according to the new theory. Let ν_A and ν_B be the natural unperturbed frequencies of the two pendulums. Then we may write an expression for the fractional beat frequency when the energy density is under A and then under B:

$$y_A = \frac{\nu_A - \delta - \nu_B}{\nu_0}; \text{ and } y_B = \frac{\nu_A - (\nu_B - \delta)}{\nu_0} \tag{7}$$

Now if we observe the change in the fractional frequency between these two measurements, we may calculate $y_B - y_A$, which from the above equations yields:

$$y_B - y_A = \frac{2\delta}{\nu_0} \tag{8}$$

So we see that we gain an additional factor of 2 in the precision using this technique. Further, we may approximate equation(6) with finite differences replacing the derivatives:

$$\frac{y_B - y_A}{\Delta t} = \frac{2\delta}{\nu_0 \Delta t} = -\frac{\nu_b}{\nu_0}\frac{T_{bB} - T_{bA}}{T_b \Delta t}. \tag{9}$$

By combining the heterodyne principle with the A, B Comparison technique, we obtain an error multiplication factor of 2X74 = 148 for our experiment, which turned out to be very useful and sufficient.

When no energy-density source was placed under either pendulum clock, then we simply observed, as expected, the random variations of the free-running clocks, but without the steps in frequency that occur coincident with the introduction of a high, energy-density source immediately below it.

4.2.6 Use of Synchronous Detection and averaging

One of the significant limitations in many precision experiments is in dealing with drifts, trends, and low frequency processes such as 1/f noise and random-walk noise. These effects have no convergent variances and often degrade the precision otherwise obtainable. These limitations can, in large measure, be dealt with by using synchronous detection.

In the above averaging time, the average is long enough to average down to what is called the "flicker floor." This is where the frequency stability versus averaging time τ bottoms out. At this nominal τ value, we switch the energy-density from under clock A to being under clock B. We wait another interval τ, then switch it back — recording the change in beat period (per the above equation) synchronous with these intervals. In a well controlled experiment, the changes in frequency will have random and uncorrelated residuals. We tested ours for the longest and most difficult part of the experiment with the transformer, and they were random and uncorrelated. In this case, the confidence on the estimate of the size of the effect is the standard deviation of the mean. In other words, the confidence improves as $\sqrt{N}$, where N is the number of switches performed for the experiment.

5 Experimental Results

We tabulate below the experimental results of how much the pendulum clocks were slowed in parts in a million. We also list the confidence on the estimate per the above discussion and the number, N, of switches for each of the three different types of energy densities.

There was some temperature dependence between the pendulum clocks. This was only a significant problem for the magnetic-field energy-density because of all the heat generated in order to properly load the 5 kilowatt transformer. From the above pendulum equation, as the length increases with increasing temperature, the period of the pendulum will increase. For brass, this is only about 10 parts in a million per degree centigrade. Since we were observing the differential by looking at the beat period, the effect should be smaller, but it was not. Apparently, the temperature effects upon the support and actuating mechanism was more significant. We measured a coefficient over a reasonably linear portion of the data, then subtracted, to first order, the effects of temperature from the data. The temperature was relatively stable for the other two energy-densities, since they dissipated negligible heat.

The pendulum bob was tested as being made of magnetic material. Being concerned about the stray magnetic fields associated with the transformer coupling to the pendulum bob, a magnetic field coil sensor was constructed in order to find a transformer configuration where there would be negligible magnetic-field coupling to the pendulum bob. Such an orientation was successfully found, and we believe that any residual coupling had negligible effects on the results of the experiment.

It is interesting that classical gravitational theory gives a speeding up of the pendulum by about one part in a billion due to the simple introduction of a mass under the pendulum. This is more than a thousand times smaller (hence, unmeasureable) and of opposite sign as can be calculated from equations (3) and (4) above than that given by the new theory.

Pendulum Slowing with Different Energy-Densities				
Energy Type	Slowing	Uncertainty	N	Energy-Density
Chemical (12 V car battery)	34	13	4	475,000
Magnetic (5 kw Transformer)	14.1	5.1	13	—
Electrostatic (6 farads cap.)	6	3.7	11	105

Table 1: The Slowing of the Pendulum clocks in parts in a million due to High Energy-Density in thousands of joules/m^3 below the clock. N is the number of synchronous detection switches performed

Since the pendulum is only swinging, basically, in one dimension, and the energy-density diallel line con¯guration is theoretically a ¯ve-dimensional ¯eld system, one may expect the slowing to be proportional to the ¯fth power of the clock slowing. Well within the uncertainties of the measurement, the chemical and the electrostatic results, taken together, are consistent with this hypothesis. Though the dimension of time is also present, during each of the measurement periods, the diallel-lines were time independent and stationary. Hence, the e®ects of the time dimension were negligible.

Within the experimental errors, a fourth power and a sixth power are consistent with the data, but the ¯fth power is by far the closest ¯t to the data { as well as being consistent with the new theory. Clearly, this power law dependence and dimensionality needs to be studied with greater precision and in much more detail.

6 Conclusion

There are some simple and logical next-step experiments that one could conduct to further study the validity of this new theory. Because the diallel lines are bent by a high energy density, these bent diallel lines de¯ne the local vertical. This bending could be easily detected with an plumb-bob device or re°ecting mirror and an interferometer. The size of the e®ect, estimating from the results in table 1 is of the order of 10 microns over a meter. That would be very easy to detect. With the capacitor bank, it would be easy to charge and discharge it as well as study proportionalities. The ¯fth power force ¯eld dependence could be studied, for example. If this ¯fth power force ¯eld dependence is a valid model of nature, then this opens up a whole new area of research as well.

Because of the importance of errors that have been found in space orbit determinations, studying the weight change predicted by this new theory could be very important. This could well explain the "extra tug" apparently observed in some space probe data [Anderson, Katz, Murphy]. A simple balance scale with a capacitor bank on one side could be constructed. Again, an interferometer could be used to detect changes in the weight with energy-density changes. The new theory would predict these to be, also, in the part per million range. As the energy-density increases, the body would appear to weigh more.

We have learned much in performing this research program, and we have designed a web site [www.allanstime.com] to assist those interested as best we can to continue the research. There is a great deal to be done, and the theory has many important application opportunities. We are only in the infancy of understanding how the ¯fth force ¯eld works, but what little we know is very exciting. We look forward to working with other colleagues as we see more insights and understanding of this new theory come forth.

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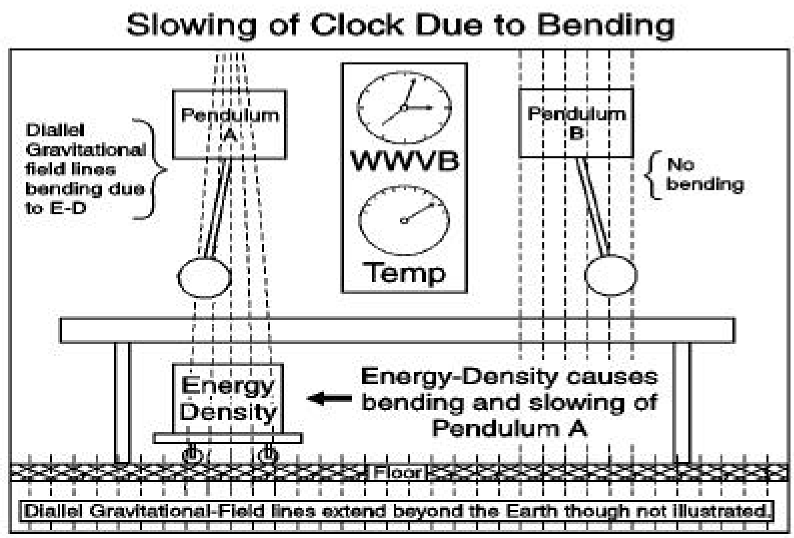
Slowing of Clock Due to Bending
Pendulum A
Diallel Gravitational field lines bending due to E-D
WWVB
Temp
Pendulum B
No bending
Energy Density
Energy-Density causes bending and slowing of Pendulum A
Floor
Diallel Gravitational-Field lines extend beyond the Earth though not illustrated.

FIGURE 1