The Laithwaite Gyroscopic Weight Loss: A First Review

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Abstract
The Laithwaite Gyroscopic Weight Loss is an important body of knowledge that needs to be examined further, because the current research into possible gravity shielding requires spinning superconducting discs. Both experiments require spinning disc, and both experiments claim weight loss.

Prof. Laithwaite demonstrated gyroscopic weight loss of a 23 kg motorcycle wheel. Laithwaite effortlessly raised the 23 kg motorcycle wheel above his head. His fellow professors specializing in rotational mechanics were unable to discover the theoretical mechanisms for it. NASA's experiments on gyroscopic weight loss did not produce any measurable results.

A comparison of Laithwaite's and NASA's experiments revealed substantial differences, thus reopening this issue. This paper documents these differences, and makes available for public scrutiny and open debate Laithwaite's, NASA's and the author's own experiments.

Sufficient experimental evidence is presented to confirm that the Laithwaite Gyroscopic Weight Loss is genuine, and not due to gyroscopic forces. There are key threshold conditions that need to be attained, before weight loss can be observed. Laithwaite's and NASA's experiments were on opposite sides of these threshold conditions, thus differences in observed results.

If a gyroscope can lose weight, under what conditions is it observable, and what are possible theoretical explanations for such an effect? This research uses a structured approach to compare a gravitational field with a centripetal force field to determine the key experimental parameters, which account for differences between the experiments.

Further, two possible theoretical approaches, curvature and gradient, within the context of Lorentz-FitzGerald Transformations and Principle of Equivalence, are examined to explain weight loss. It appears that gradient is a good candidate.

Does the Laithwaite Gyroscopic Weight Loss have propulsion potential? More experiments are required to calibrate this behavior as it is difficult to differentiate between gravitational buoyancy and thrust. The next set of experimental confirmations and calibrations are expected to be completed by December 2006. Further research will shed light on whether these results will impact theoretical and experimental work.

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1. Introduction

1.1 A Brief History:

In 1973, Prof. Eric Laithwaite (1921 - 1997)[1], the inventor of the linear motor and Emeritus Professor of Heavy Electrical Engineering at Imperial College, London, UK, presented some anomalous gyroscopic behavior for the Faraday lectures at the Royal Institution. Included in this lecture-demonstration was a big motorcycle wheel weighing 50lb that he spun up and raised effortlessly above his head with one hand, claiming it had lost weight and so contravened Newton's third law.

1.2 The Four Rules:

Laithwaite demonstrated[2] four rules[3]. A precessing gyroscope,

1. Will not exhibit lateral forces in the plane of precession.
2. Will not exhibit centrifugal forces in the plane of precession.
3. Will not exhibit angular momentum in the plane of precession.
4. Will lose weight.

1.3 Scope:

The scope of this research is restricted to the fourth rule only, as this is the most pertinent to future space propulsion technologies. A scientific approach was taken to examine Laithwaite's fourth rule; duplicating wheels, & fabricating an experimental set-up to prove or disprove this last claim.

Others (Podkletnov & Nieminen, 1992; Hayasaka & Takeuchi, 1989; and Lou et al 2002) observed or did not observe similar anomalous weight change with, or in the presence of, spinning disc. The author believes that there might be some commonality with the Laithwaite gyroscopic weight loss, but extensive experimental & theoretical work is required.

1.4 Results:

Deconstruction and analyses of what Prof. Laithwaite had observed is repeatable provided the scale is on that of a motorcycle wheel. A rotating-spinning disc will lose weight.

2. A Conceptual & Theoretical Perspective.

2.1 Introduction:

This section presents a brief introduction on how time dilation can be the source of gravitational effects. All theories, gravity, physics, scientific & sociopolitical, have explicit and implicit assumptions or axioms. The author believes that time dilation as a side effect of gravity is an implicit assumption of existing theories on gravity. Altering this assumption, and presenting it as time dilation is the cause of gravitational effects, lends itself to the development space propulsion technologies, as this disengages the link between the force field effect and the mass source of this field.

[1] BBC 1997, http://www.bbc.co.uk/history/historic_figures/laithwaite_eric.shtml

[2] Videos of Laithwaite's, The Royal Society Christmas Lecture 1974-1975, and the BBC documentary 'Heretic' are available from the website http://www.gyroscopes.org/1974lecture.asp and http://www.gyroscopes.org/heretic.asp, respectively.

[3] I've collected his most important observations into these four rules.

2.2 Rotating Masses:
There has been some work on relativistic rotating masses, Browne (1977) for example. However, the problems addressed are about near velocity of light behavior of rotating masses. In order to understand how the Laithwaite gyroscopic weight loss occurs, a different approach to gravitational fields is required.

2.3 Principle of Equivalence:
Schutz (2003) states that if gravity were everywhere uniform we could not distinguish it from acceleration. A point observer within a gravitational field would not be able to distinguish between a gravitational field and acceleration.

2.4 Time Dilation Gravity:
Taking this a step further, Solomon (2001) had shown that the escape or free-fall-from-infinity velocities are dictated by the time dilation of the gravitational field at that point in space. This presents an interpretation of velocity and acceleration as representations of time dilation or vice versa. Such that, using the Lorentz transformation (Gibilisco 1983) equations,

$$v = c \,.\, \sqrt{(1 - t_\infty^2 / t_v^2)} = c \,.\, \sqrt{(1 - 1 / t_v^2)} \tag{1}$$

The results tabulated in Table 1, for planets in our Solar System. Empirical evidence concurs with the hypothesis that radial velocities are governed by time dilation, and in agreement with Lorentz-FitzGerald transformation result of Special Relativity & the Principle of Equivalence.

Inference 1: The empirical data supports the inference that time dilation and the change in time dilation are alternative manifestations of velocity and acceleration, respectively, and that these two sets of phenomena are interchangeable. This interpretation is consistent with the Lorentz-FitzGerald transformation requirements of Special Theory of Relativity and the Principle of Equivalence.

Solomon (2001) presented the hypothesis that time dilation causes a shift in the center of mass. For a hemisphere, Figure 1, it is given by,

$$S_{CM} = (3/8)\, s_{xo}\, (d_{xd}/d_{xo} - 1) \tag{2}$$

where d_{xd} = duration required to detect particle under time dilation
d_{xo} = duration required to detect particle without time dilation
s_{xo} = space required to detect particle along axis of motion, without time dilation
S_{CM} = shift in the center of mass.

This reduces to,

$$S_{CM} = (3/8)\, s_{xo}\, (t_d - 1) \tag{3}$$

where t_d = time dilation at that point, where the particle is.
= d_{xd}/d_{xo}

$$\text{Since} \quad (t_d - 1) > 0 \tag{4}$$

$S_{CM} > 0$ a shift towards greater time dilation.

Equation (4) presents a mechanism, on how time dilation causes the center of mass of a particle to shift in the direction of increasing time dilation, thereby providing the effect of gravity. A conceptual case, Solomon (2003), for momentum exchange bypass, using this time dilation mechanism, is now possible.

There are two time dilation (vector) parameters in a gravitational field. Radial time dilation, t_r and tangential time dilation, t_t. These correspond to the free fall or escape (radial), v_r, and orbital (tangential), v_t, velocities, respectively. The relationship between velocity and time dilation is governed by Lorentz-FitzGerald transformation such that,

$$t_r = 1 / \sqrt{(1 - 2GM/Rc^2)} \qquad (5)$$

$$t_t = 1 / \sqrt{(1 - GM/ R c^2)} \qquad (6)$$

The respective time dilation gradients, dt/dR, and curvatures, C, (Kline 1977) are, after simplification, given by,

$$dt_r/dR = - (GM/c^2)/R^2 \qquad (7)$$

$$dt_t/dR = - (GM/2c^2)/R^2 \qquad (8)$$

$$C_r = (2GM/c^2)/ R^3 \qquad (9)$$

$$C_t = (GM/c^2)/ R^3 \qquad (10)$$

As with gravitational fields, centripetal force fields have two time dilation parameters. Radial time dilation, t_r and tangential time dilation, t_t. However, radial velocity, v_r, is zero, and therefore, the radial time dilation is unity. Tangential velocity, v_t, is determined by radius, r, and angular rotation ω, such that,

$$v_t = \omega . r \qquad (11)$$

$$t_t = 1 / \sqrt{(1 - k_t r^2)} \qquad (12)$$

where $k_t = \omega^2 / c^2$

The gradient of time dilation with respect to radial distance, r, is given by,

$$dt_t/dr = (k_t r).(1 - k_t r^2)^{-3/2} \approx (k_t r) \qquad (13)$$

Curvature (Kline 1977) of the tangential time dilation, after simplification, is given by

$$C_t = k_t. + 3.k_t^2 . r^2 = d^2t_t/dr^2 \qquad (14)$$

For a gravitational field the relationship between the tangential and radial time dilation is given by,

$$1/t_t^2 - 1/2t_r^2 = 1/2 \qquad (15)$$

2.5 Key Parameters:

If gyroscopic spin is to produce gravity modifications that result in some amount of weightlessness, it has to have a parameter value that is opposite to gravity's, Table 2. This is observed with gradient of time dilation that is of the opposite sign to that of gravity's. The magnitude of the time dilation behaves in the correct manner to increasing or decreasing tangential velocities and therefore, force.

Note, curvature is positive for both fields, and is unable to distinguish attraction from repulsion. Change in curvature has opposite behavior. Time dilation curvature, therefore, is not a useful property for propulsion technology theory development; it cannot distinguish the direction of the increasing time dilation. It has no vector properties.

"You have to find the window where physics behaves 'differently' "[4]. This window of opportunity, will not be found in known theoretical models, as Laithwaite et al have investigated existing bodies of knowledge thoroughly.

Figures 2 & 3 present gravity as a function of time dilation. The graph shows how time dilation forms a funnel like structure, but unlike General Relativity.

2.6 Rotation Pops:

No radial time dilation is present in a centripetal force, as radial velocity is zero. Therefore, a conic or funnel like structure similar to gravity's, in 3-dimensional space does not exist for a non-rotating spinning disc.

If one were to rotate the spinning disc, a centripetal force is overlaid, on the tangential time dilation field, Figures 4 & 5. The calculated centripetal acceleration, A_r, at any point along the radius of the spinning disc is,

$$A_r = \omega_l \, . \, l / \cos(\theta) \qquad (16)$$

where ω_l = rotational frequency of the spinning disc.
θ = angle between the level arm, from pivot, and the hypotenuse, to a point on the radius of the spinning disc.
l = the lever arm length.

By Inference 1, gravity, acceleration and time dilation are interchangeable. The centripetal radial time dilation can be derived from equation (5), and substituting centripetal acceleration for gravity's, g, one gets,

$$t_r = 1 / \sqrt{(1 - 2.(\omega_l^{2} / c^{2}).r^2)} \qquad (17)$$

Figures 4 & 5, show that time dilation behavior is a conic (and the opposite of gravity's funnel) when a centripetal force causes radial time dilation field to "pop" into existence. This is a key attribute, if rotating-spinning discs are to display gravity modification.

For a rotating centripetal field the relationship between the tangential and radial time dilation is given by,

$$(1/t_t^2).(1/\omega^2) - (1/t_r^2).(1/2\omega_l^{2}) = (1/\omega^2) - (1/2\omega_l^{2}) \qquad (18)$$

[4] Conversations with Bob Schlitters, of Timberline Iron Works, who fabricated the experimental set-up.

Currently there are two problems, (1) To proceed with this theoretical analysis, we require further empirical data, to provide suggestions on how radial and tangential time dilations are combined into a single unified field that can negate or neutralize the surrounding gravitational field. (2) What is the range of this field effect? What properties does this field have? Is it a thrust or is it just gravitational buoyancy?

3 Laithwaite's, NASA's & Solomon's Experiments

3.1 Laithwaite:

Laithwaite[2] presented two different demonstrations of weight change. The first, the Laithwaite Effect[5], was the Big Wheel experiment, which visibly demonstrated weight loss. The Big Wheel was a 50 lb (≈ 22.7 kg) motorcycle wheel, spinning at 5,000 rpm, attached to a 3 ft rod (≈ 1 m), which he held by one wrist, and slowly swung it over and around his head, at about 7 rpm.

The second, the Jones Effect, was the Small Wheel experiment. This experiment consisted of two 2-inch (≈ 5 cm) radius gyroscopes, using gyroscopic motions to create a directed force. Laithwaite and Dawson were granted a US patent (5,860,317[6]) on January 19, 1999, for a device based on the principles of the Small Wheel experiments.

3.2 NASA:

In 2002, NASA[7] investigated this Laithwaite gyroscopic weight loss behavior (Thomas, 2002). NASA's experiment comprised of manually spinning 4 in (≈ 10 cm) radius bicycle wheel. Having reviewed the videos of Laithwaite's demonstration, and reconstructed NASA's experiments, a table of differences in the experiments, Table 3, is documented. It is rather obvious that NASA's experiment was not the same as Laithwaite's. The comparisons suggest boundary conditions, and a window of opportunity, exists.

3.3 Test:

Observed rotation was used to test whether gravity induced precession or conical pendulum centrifugal rotation could explain some of the results.

3.4 Sensitivity Analysis:

As this first phase of experimental analysis consisted of reviewing video documentation (Laithwaite), and verbal commentary (NASA) of experimental designs and results, analysis is

[5] The author has named the effects after the people who first demonstrated or discovered these effects, as best I as could research and determine the original discoverer.

[6] **Abstract:** A propulsion and positioning system for a vehicle comprises a first gyroscope mounted for precession about an axis remote from the center of said gyroscope. A support structure connects the gyroscope to the vehicle. Gyroscopes are used to cause the first gyroscope to follow a path which involves at least one precession-dominated portion and at least one translation-dominated portion, wherein in the precession-dominated portion, the mass of the first gyroscope is transferred and associated movement of the mass of the remainder of the system in a given direction occurs, and, in the translation-dominated portion, the mass of the first gyroscope moves with an associated second movement of the mass of the remainder of the system in substantially the opposite direction, wherein the movement owing to the translation-dominated portion and is larger than the movement owing to the precession-dominated portion of the motion, hence moving the system.

[7] Conservations with Marc G Millis of NASA Glen Research Center on June 22, 2005, regarding the experiment notes for NASA's Laithwaite gyroscopic weight loss investigation

subject to estimation error. How sensitive are the observed effects to estimation error of the experimental design?

Different rotation, $\omega_{precession}$, values for each change in the three parameters were calculated. The length of the torque arm, R, was varied between 1.5m to 2.5m. The radius of the spinning wheel was varied between 26 cm to 34 cm. The spin of the wheel was varied between 4,500 rpm to 5,500 rpm. The results are presented in Figure. 6. The theoretical frequency of precession, $\omega_{precession}$, ranges between 167 rpm and 580 rpm. This is well outside the observed Big Wheel rotation of about 7 rpm.

Further, the analysis of a bicycle wheel precession[8] is presented in Table 4; and shows that the mathematical relationships, when precession is in effect, and are correct.

3.5 Not Precession:

One concludes that the Big Wheel phenomenon Laithwaite was demonstrating was not gyroscopic precession, because the practical results do not match theoretical results by two orders of magnitude.

3.6 Solomon's Experiments:

The experimental set-up for Solomon's Laithwaite experiment is as shown in Figure. 7. One of the criticisms[9] of Laithwaite rotating the Big Wheel over his head was that he had pushed the wheel into flight, and therefore, the resulting weight loss was due to inertia. This set-up was designed to allow only horizontal rotational motion, thereby ensuring that neither vertical inertia nor nutation was possible.

The second criticism[10] of the original Laithwaite experiment was that total system weight was not measured. The logic was that the weight of the Big Wheel was carried through the wrist and should be observed as Total System Weight. The wrist is not capable of such weight. However, to satisfy the needs of the critics, the weight scale arrangement was such as to measure the Total System Weight.

The analysis in Table 3 shows that mathematically, precession could not have been the source of the weight loss. To further negate the precession hypothesis, the effected rotation was in the opposite sense of precession.

A first step was to note the total system weight without spin or rotation. A second step was to observe any variations in weight if the disc was slowly rotated about the vertical support. The rate of rotation was similar to that during the spinning wheel experiment.

The experimental procedure involved spinning the big flywheel up to 3,000 rpm, and then rotating this spinning flywheel. Observe the total system weight, while spinning and rotating. We noticed that the slow down in the spin was quite fast, so our records are taken from examination of video records.

The individual component weights are documented in Table 5. Two experiments were conducted. See Table 6. Video documentation of the experiments is available at http://www.iSETI.us/. The

[8] How-Stuff-Works video http://science.howstuffworks.com/gyroscope1.htm
[9] Conversations with Bob Schlitters, of Timberline Iron Works, who fabricated the experimental set-up.
[10] Conversations with Marc Millis of NASA Glen

rotation of the spinning disc varied between 0 and 10 rpm, which is significantly less than allowed by precession. Rotation was in the opposite sense of that required of precession.

3.7 Solomon's Results:

We observed that a non-rotating but spinning flywheel did not lose weight, but a rotating-spinning flywheel did. Weight loss was as high as 54 lbs. Note that the weight of the wheel was about 50 lbs, and 55 lbs with bearings included. The observed weight was not steady and was increasing and decreasing, repeatedly, as the rotation was manually sped up and then allowed to slow down.

A review of the videos suggests that weight decreased as rotation increased. Weight increased as spin decreased. We noticed that when the spin and rotation was too slow, the wheel would "crash" back to earth. It would suddenly regain all its weight and the effect would be equivalent to falling. See Figure 8. In other words, there are boundary conditions or threshold values before weight loss would come into effect.

4 Conclusion

4.1 Results:

On the scale of a motorcycle wheel, there is definitely weight change that is down to -100%. This weight change does not conform to either gyroscopic precession or conical pendulum behavior. This paper has presented an approach to explaining this behavior in a manner that enables the development of future gravity based propulsion systems.

4.2 Future Experiments:

In the near future, Solomon is proposing to conduct three sets of experiments. (1) Repeat the original single flywheel experiments with better control. See Figure 9. (2) Conduct the same set of experiments with two spinning flywheels. (3) Conduct a set of experiments with same size flywheel but with different masses, by using different materials, and thickness.

The first set of experiments is to calibrate the weight change behavior with respect to radii, arm length, spin and rotation.

The second set of experiments is to determine whether the sense of the rotation, clockwise or anti-clockwise, would influence the weight loss effect, as per precession, or Hayasaka & Takeuchi (1989). If truly an effect due to precession, two opposite spins should cancel each other. If not, and the Hayasaka-Takeuchi effect is real one should be able to get opposite weight changes with opposite spins (with both flywheel having same spins). Otherwise, time dilation is the cause, as it is not sensitive to spin sense.

The third set of experiments is to determine the effect of mass. If the time dilation model is correct, spatial dimensions will have a significant effect; but since mass is a proxy for number of particles, and density is a proxy for particle size, this may affect the "field strength" observed.

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Object	**Mass**	**Radius**	**Gravity at Surface**	**Gravitational Escape Velocity**	**Time dilation**	**Equivalent Lorentz/Time Dilation Velocity**	**Escape - Equivalent Velocity Error**
	M	**R**	**G**	v_e	t_v	v_f	$v_e - v_f$
	kg	M	m/s^2	m/s	S	m/s	
Sun	2.00E+30	6.90E+08	274.98	621,946	1.00000215195969	621,946	0.0000000%
Mercury	3.59E+23	2.44E+06	3.70	4,431	1.00000000010922	4,431	0.0000153%
Venus	4.90E+24	6.07E+06	8.87	10,383	1.00000000059976	10,383	0.0000018%
Earth	5.98E+24	6.38E+06	9.80	11,187	1.00000000069626	11,187	-0.0000080%
Mars	6.58E+23	3.39E+06	3.71	5,087	1.00000000014395	5,087	0.0000245%
Jupiter	1.90E+27	7.14E+07	23.12	59,618	1.00000001977343	59,618	0.0000002%
Saturn	5.68E+26	5.99E+07	8.96	35,566	1.00000000703708	35,566	-0.0000002%
Uranus	8.67E+25	2.57E+07	7.77	21,201	1.00000000250060	21,201	-0.0000005%
Neptune	1.03E+26	2.47E+07	11.00	23,552	1.00000000308580	23,552	-0.0000019%
Pluto	1.20E+22	1.15E+06	0.72	1,178	1.00000000000772	1,178	0.0001586%

Table 1: Comparison between Escape Velocity and Time Dilation Velocity

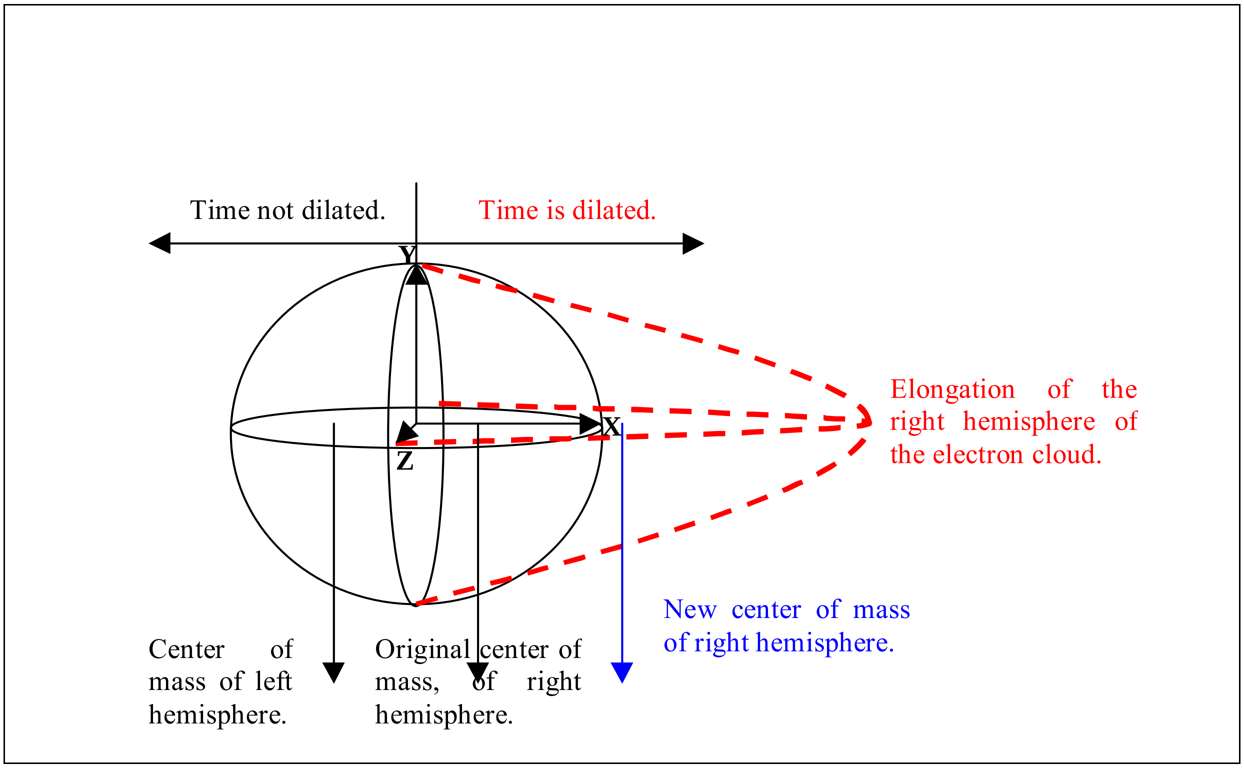

Figure. 1: Time dilation distorts a particle's probability cloud with respect to its own frame of reference

Time Dilation	**Gravitational Field**	**Centripetal Force Field**
Magnitude	Decreases with radius.	Increases with radius.
Gradient	Negative Increases non-linearly with radius.	Positive Increases linearly with radius.
Curvature	Positive Decreases non-linearly with radius.	Positive Increases non-linearly with radius.

Table 2: Comparison between Gravitational Field and Centripetal Force Field

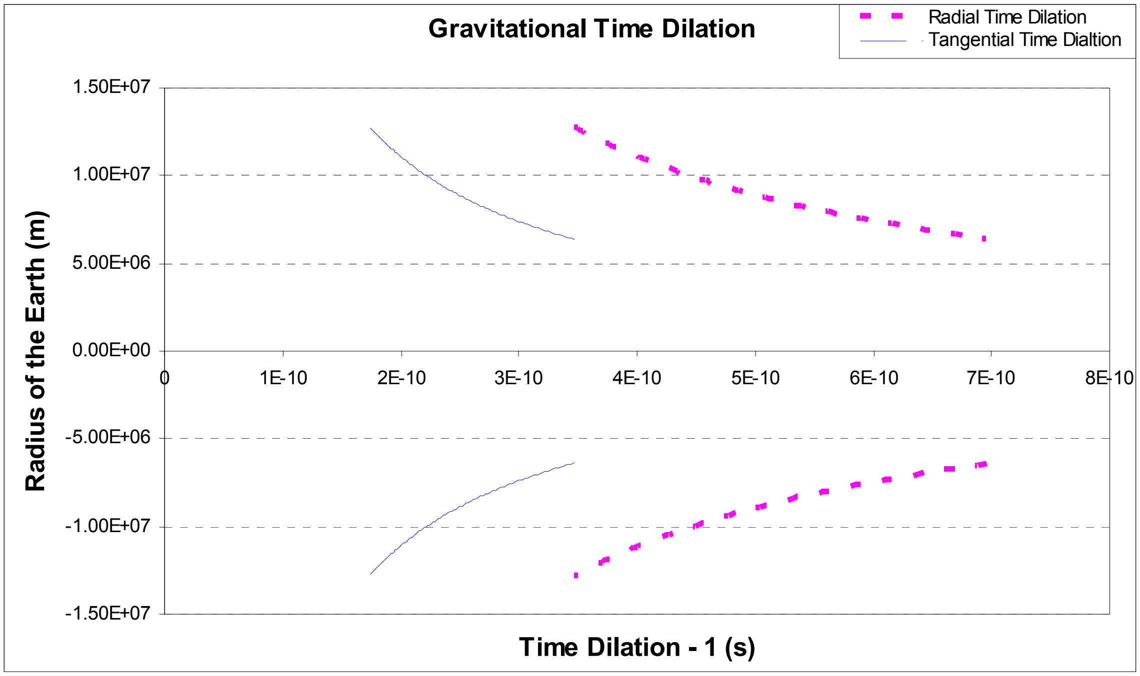

Figure 2: Time Dilation as a Function of the Radial Distance from Earth.

For a Gravitational Field the relationship between tangential and radial time dilation is given by,
$1/t_t^2 - 1/2t_r^2 = 1/2$

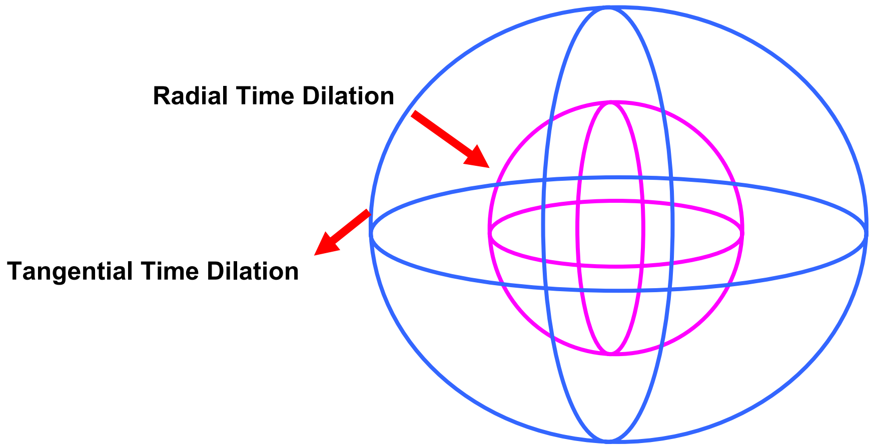

Figure. 3: Relationship between Gravitational Field Radial and Tangential Time Dilation

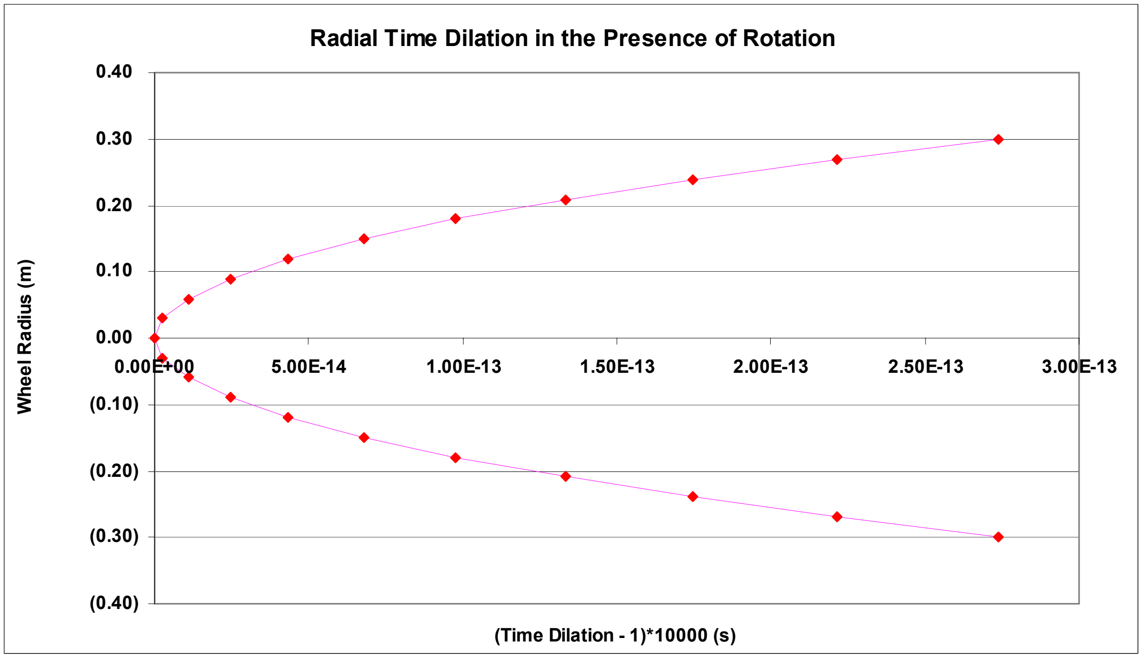

Figure 4: Time Dilation as a Function of the Radial Distance across the Spinning Disc.

For a Gyroscopic Centripetal Field the relationship between tangential and radial time dilation has not yet been determined.

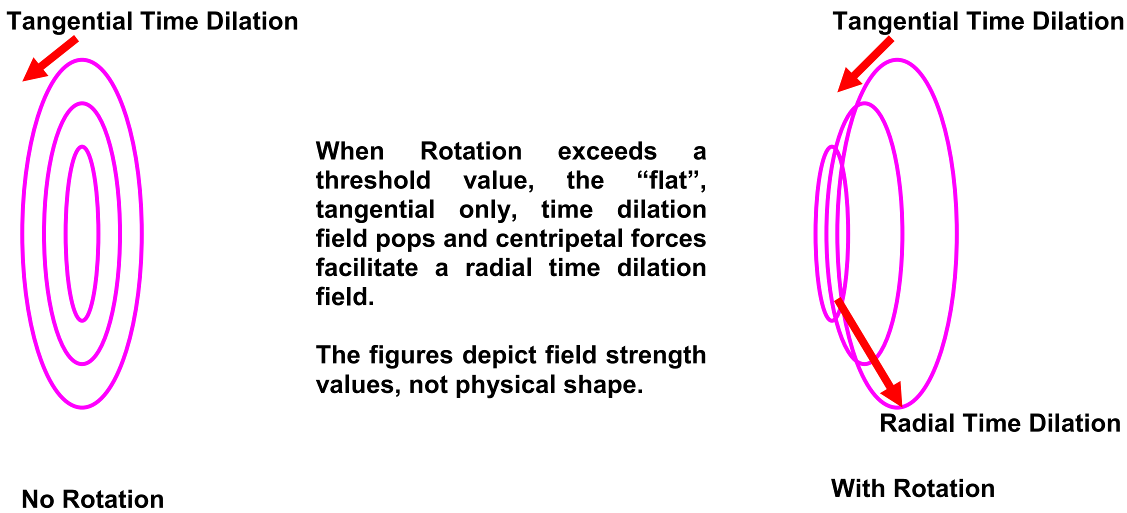

Figure. 5: Relationship between Centripetal Force Field Radial and Tangential Time Dilation

Experimental Parameters	**Laithwaite**	**NASA**
Wheel Mass	23 kg (≈ 50 lbs)	1 kg (≈ 2 lbs)
Wheel Radius	30 cm (≈ 1 foot)	10 cm (≈ 4 inches)
Non-Rim Rotating Plane Mass	20% - 30%	< 2%
Spin	5,000 rpm	60 to 200 rpm?
Lever Arm Length	2 m (≈ 6 ft)	2 cm (≈ 1 in) ??
Precession/Rotation Rate - Theoretical (conical pendulum) - Theoretical (gyroscopic precession) - Actual Observed	 450-637 rpm 157-314 rpm 7 rpm	 - ? - ?
Estimated new g' - Theoretical (conical pendulum) - Theoretical (gyroscopic precession) - Actual Observed	 0.002 - 0.001 m/s^2 0.220 – 0.440 m/s^2 9.81 m/s^2	 9.81 m/s^2 9.81 m/s^2
Estimated New Weight - Theoretical (conical pendulum) - Theoretical (gyroscopic precession)	 2.0 - 6.0 g (≈ 0.1 – 0.2 oz) 0.5 - 1.0 kg (≈ 1.1 – 2.2 lbs)	 1 kg (≈ 2 lbs)

Table 3: Comparisons between Laithwaite & NASA Experiments

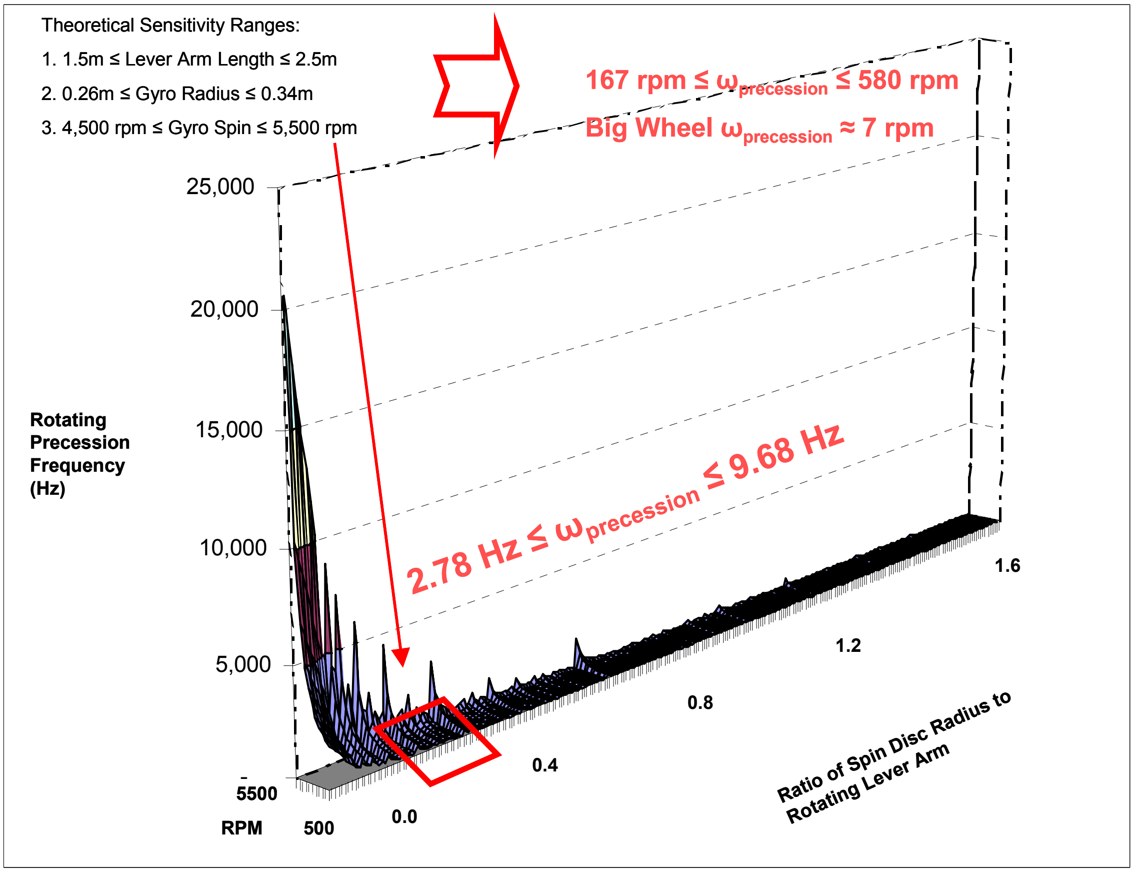

Figure. 6: Sensitivity of Parameter Estimation to Precession Frequency

Estimated Parameters	How Stuff Works Video Deconstruction			
Lever Arm Length, l	0.020	m		
Wheel Radius, r	0.660	m	26	inches
Wheel Spin, w	5.000	Hz	300	rpm
Gravitational Acceleration, g	9.810	m/s2		
Mass of Wheel, m	2.273	kg	5	lb
Moment of Inertia of Wheel, I	0.991			
Angular Momentum, L	4.956			
Theoretical Results				
Precession Frequency, wp	**0.090**	Hz	**5.40**	rpm
Observed Results				
Duration of 1/2 cycle	7	s		
Precession Frequency, wp	**0.071**	Hz	**4.29**	rpm

Table 4: Deconstruction of How-Stuff-Works video.

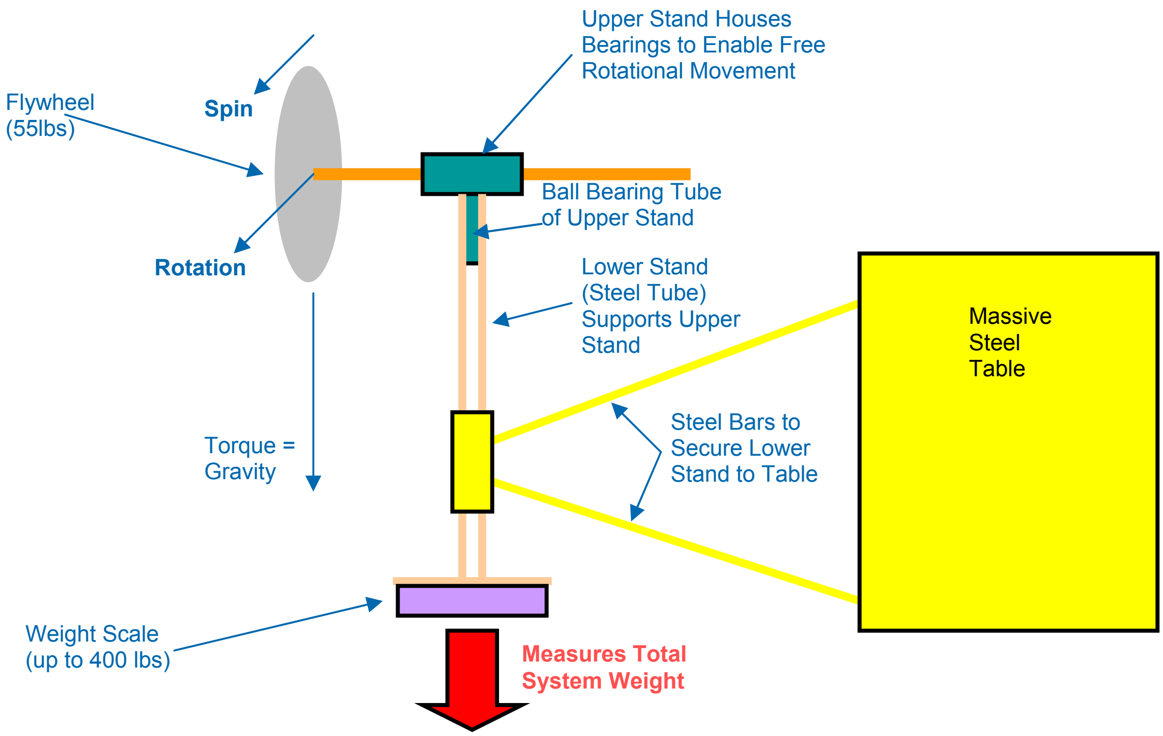

Figure 7: Solomon-Laithwaite Experimental Set-Up

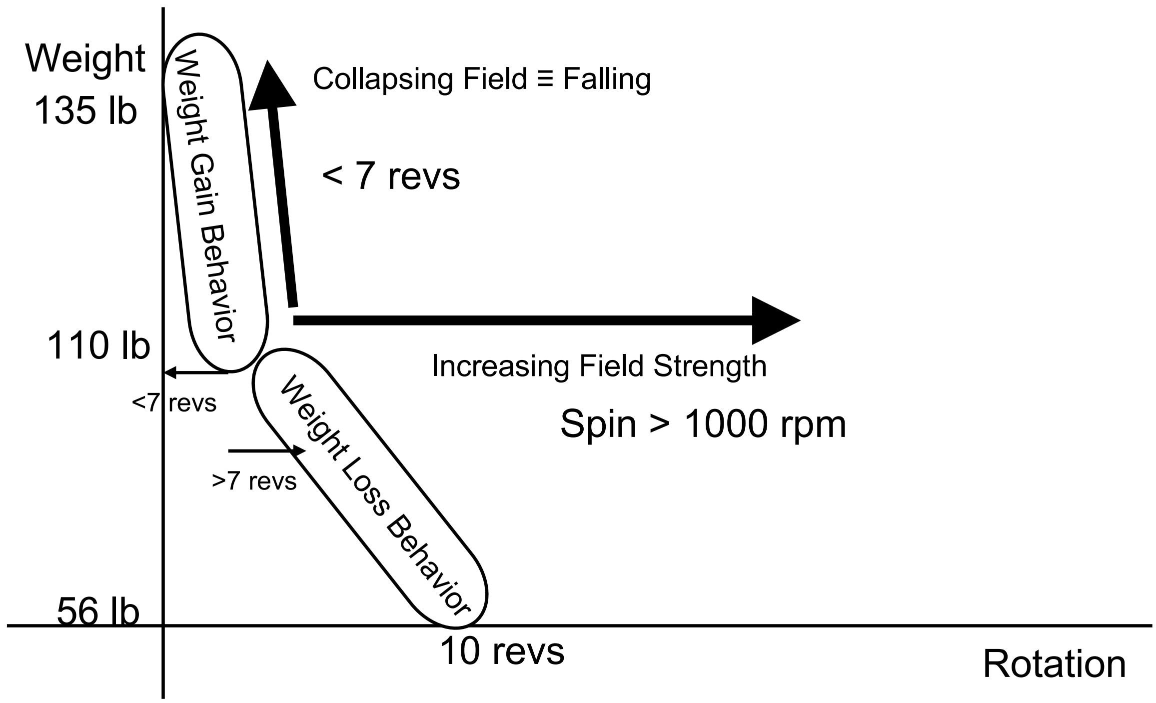

Figure. 8: Boundary Conditions for Weight Loss

Static Weights		
Lower Stand	36	lb
Wheel Upper & Lower Stands	111	lb
Wheel + Upper Stand	75	lb
Wheel (+ Bearings)	55	lb

Table 5: Individual Component Static Weights

Dynamic Weight	**Lowest**		**Highest**		**Average**	
Not Spinning	105.5	Lb	114.5	lb	110	lb
First Experiment (Spinning)	65	Lb	120.5	lb	92.75	lb
Change	-45	Lb	10.5	lb		
Second Experiment (Spinning)	56	Lb	135	lb	95.5	lb
Change	-54	Lb	25	lb		

Table 6: Experimental Results

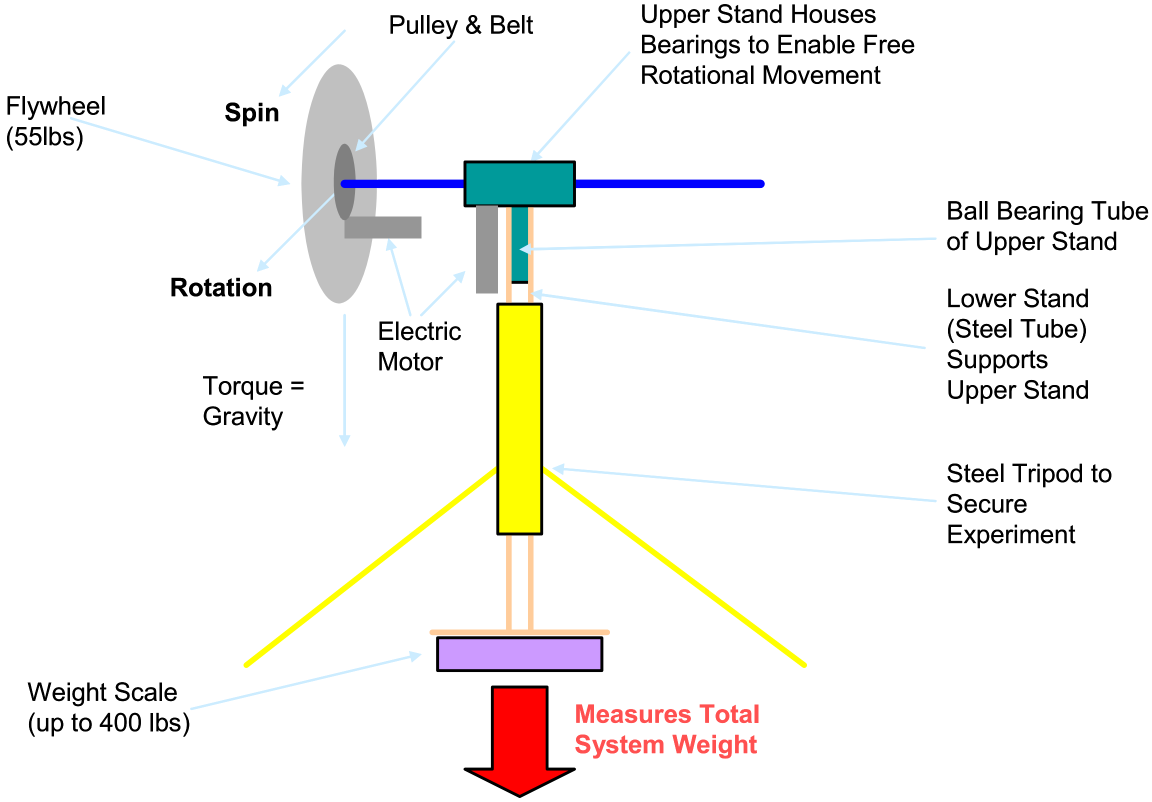

Figure. 9: Proposed New Experimental Set-Up (Safety Features Not Shown)