Revised theory of transient mass fluctuations.

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Abstract

Several publications during the last 10 years by Woodward and colleagues have indicated a theory**,** based on general relativity, that has: (1) predicted transient mass fluctuations; (2) cited a specific embodiments where a net average force would be present; (3) suggested a few ways that this theory might be tested in the laboratory; and (4) have reported such test results incorporating these embodiments. In this paper we show that: (1) the average force predicted by Woodward occurred only because of a neglected term in a product derivative, and that when the neglected term is correctly returned, the average force vanishes; (2) this vanishment of the average force occurs for arbitrary forcing functions, not just the sinusoidal one considered by Woodward; (3) the transient mass fluctuation, predicted by Woodward, was developed in a theory which neglected local gravitational and electrodynamic forces which are several dozen orders of magnitude greater; (4) a less incomplete theory considering local gravitational forces produces a vastly smaller transient mass fluctuation; (5) an alternate interpretation of the experiments purported to confirm the theory is proposed that can entirely explain the findings in terms of momentum contributions due to time varying thermal expansion, without invoking any general relativistic effects.

1. Introduction

It would be a major advance in space travel if a rocket could be made that would require no fuel to be ejected as the source of the rocket's momentum. This would appear to be a flagrant violation of momentum. One approach has been taken by Woodward et al [1,5] whereby non-conservation of classical momentum is justified by the assertion that the momentum imbalance is made up by a corresponding momentum change in the rest of the universe. This assertion is made in the context of an analysis consisting of a flat-space non (special) relativistic force balance using Machs' principle and a theoretical result by Sciama [6]. From this proposition, several publications during the last 10 years by Woodward and colleagues have: (1) predicted transient mass fluctuations; (2) cited a specific embodiments where a net average force would be present; (3) indicated how this might be tested in the laboratory; and (4) have reported such test results incorporating these embodiments. In this paper we will comment on these findings.

2. Reconsideration of the average force for the case considered by Woodward

The average force predicted by Woodward can be shown to occur only because of a neglected term in a product derivative, and that when the neglected term is correctly returned, the average force can be shown to vanish along with the proposed experimental tests. The offending term can be seen most clearly in Mahood [5] in the equation above Eq. (A.28) where

$$\mathrm{F} = \mathrm{m}\frac{\mathrm{dv}}{\mathrm{dt}} + \mathrm{v}\frac{\mathrm{dm}}{\mathrm{dt}} \tag{1}$$

Unfortunately, the rocket term or **vdm/dt** was neglected in [1-5]. It turns out that at least for the case considered by Woodward [1-5], the vdm/dt term is exactly the same magnitude as the mdv/dt term, but of opposite sign causing a complete cancellation of the average force arising from transient mass fluctuations. According to this result, any transient mass effect would not be observed, at least for the sinusoidal driving forces considered.

3. Reconsideration of the average force for arbitrary forcing functions

The conclusion of the previous section is true for the specific case that Woodward considers, namely that of a sinusoidally driving force.

$$\mathrm{F} = [m_0 + d\,m_0 \cos(2wt)][-4w^2 d\,l_0 \cos(2wt + g)] \tag{2}$$

Therefore, a Fourier expansion of the forcing function

$$\mathrm{F} = \sum_k \sum_j a_k b_j [m_0 + d\,m_0 \cos(2w_j t)][-4w_k^2 d\,l_0 \cos(2w_k t + g_k)] \tag{3}$$

can be grouped in such a way such that a term by term cancellation can be demonstrated analytically. This verifies and extends Mathematica calculations done by the present authors (at least to showing cancellation to within one part in 10^{4300}) and [7] independently and contemporaneously after the alert of section 2 above [9]). Therefore this vanishment of the average force occurs for arbitrary forcing functions, not just the sinusoidal one considered by Woodward. However these arguments do not change any conclusion about the transient mass effect itself. In the next section we will consider the development of the theory leading to a transient mass effect.

4. Reconsideration of the proposed transient mass fluctuations

Examination of the Woodward theory [1-5] leading to the transient mass fluctuation indicates that <u>only</u> non-local gravitational forces were considered and all other forces, which are vastly larger, were neglected. This gratuitous restriction in the theory is illustrated explicitly in Eq. (A.18) of [5], replicated below,

$$-\frac{1}{c^2}\frac{\partial^2 f}{\partial t^2}-\frac{f}{r_0 c^2}\frac{\partial^2 r_0}{\partial t^2}-\nabla\cdot\mathrm{F}=4p\,G\,r_0-\frac{1}{c^4}\left(\frac{\partial f}{\partial t}\right)^2-\left(\frac{f}{r_0 c^2}\right)^2\left(\frac{\partial r_0}{\partial t}\right)^2 \qquad (4)$$

$$\mathrm{F}=-\nabla f \qquad (5)$$

where the forces acting on the test body are equal to the gradient of the same non-local gravitational scalar potential (Eq. 5). All of the terms in Eq. (4), except the divergence term, refer to a non-local gravitational potential. The divergence term refers to any forces acting on the system that might contribute to the force balance.

Eqs. (4-5) directly lead to the wave equation, below for the non-local gravitational potential:

$$\nabla^2 f-\frac{1}{c^2}\frac{\partial^2 f}{\partial t^2}=4p\,G\,r_0+\frac{f}{r_0 c^2}\frac{\partial^2 r_0}{\partial t^2}-\frac{1}{c^4}\left(\frac{\partial f}{\partial t}\right)^2-\left(\frac{f}{r_0 c^2}\right)^2\left(\frac{\partial r_0}{\partial t}\right)^2 \qquad (6)$$

which is the essential result of Woodward's transient mass theory. The second term on the RHS is the transient mass term and the last two terms on the RHS are argued to be smaller and are eventually neglected.

Since not even local gravitational forces entered the fray, this determination of transient mass fluctuation neglects all commonly observed and far larger forces including even those required to test the concept in the laboratory. As an example, in spite of the enormous precision trajectory calculation required to send a satellite out to the distant planets, no consideration of non-local gravitational forces need ever be made — only a very precise calculation of local gravitational forces. In addition, after neglecting all other forces in the development of the theory (Eqs. 4-5), one can't just stick them in at the end without alert, as was apparently done (Eq. A31 [5], essentially replicated as Eq. 2 above.

5. Extension of Woodward's theory to include experiential forces

Alternatively, to consider other forces at the beginning rather than at the end, one needs to at least consider the simplest alternative:

$$-\frac{1}{c^2}\frac{\partial^2 f}{\partial t^2}-\frac{f}{r_0 c^2}\frac{\partial^2 r_0}{\partial t^2}-\nabla\cdot\mathrm{F}=4p\,G\,r_1+4p\,G\,r_0-\frac{1}{c^4}\left(\frac{\partial f}{\partial t}\right)^2-\left(\frac{f}{r_0 c^2}\right)^2\left(\frac{\partial r_0}{\partial t}\right)^2 \qquad (7)$$

$$\mathrm{F}=-\nabla(\Psi+f) \qquad (8)$$

Now this differs from Eqs. (4-5) in two ways: local gravitational forces are considered, at least in an ideal way by introduction of a new potential, whose spatial dependence can be significant on laboratory scales and second, a source term for local mass densities.

This reduces to:

$$\nabla^2\Psi = 4p\, G\, r_1 + 4p\, G\, r_0 + \frac{f}{r_0 c^2}\frac{\partial^2 r_0}{\partial t^2} - \nabla^2 f + \frac{1}{c^2}\frac{\partial^2 f}{\partial t^2} - \frac{1}{c^4}\left(\frac{\partial f}{\partial t}\right)^2 - \left(\frac{f}{r_0 c^2}\right)^2\left(\frac{\partial r_0}{\partial t}\right)^2 \qquad (9)$$

Which is essentially a Poisson equation instead of a Hyperbolic wave equation.

It is important to note that while the nonlocal potentials are vastly larger than the local potentials, the gradients of the local potentials are vastly larger than the local potentials. In fact by 26 orders of magnitude, as deducible in [6] Taking Sciamas theory to second order so that the local potential appears, instead of just the nonlocal potential and inserting into Woodward's theory, one gets:

$$\nabla^2\Psi - \frac{1}{c^2}\frac{\partial^2\Psi}{\partial t^2} + \frac{1}{c^4}\left(\frac{\partial^2\Psi}{\partial t^2}\right)^2 = 4p\, G\, r_0 - \nabla^2 f + \frac{f}{r_0 c^2}\frac{\partial^2 r_0}{\partial t^2} + \frac{1}{c^2}\frac{\partial^2 f}{\partial t^2} + 0\,\frac{1}{c^4} \qquad (11)$$

This is a hyperbolic wave equation, as in Eq (6) but in terms of the local potential instead of the nonlocal potential. Also there is a term of order c^{-4} involving the local potential retained on the left hand side. All derivative terms on the left hand side involve the nonlocal potential and so are judged to be exceedingly small. To be consistent with keeping terms of order $c^{-}4$ one must extend Woodward's theory to include special relativity [11], and include formulation in de Sitter [12], or other curved space —a clear discussion of which appears in [13].

To provide a falsifiable, or scientific [8], theory, one needs to instead stipulate that the forces acting on the test body are equal to the gradient of <u>all</u> the scalar potentials acting on the system (assuming these forces to also be irrotational) including the local gravitational potentials, electro dynamic potentials and whatever else. Additionally, including for example local gravity produces classical source terms, which are 10^{26} times larger than the transient mass fluctuation terms produced in [1]-[5]. In order to resolve transient mass fluctuations in the laboratory, one would have to measure quantities to a precision of 1 part in 10^{26}, or cleverly arrange a cancellation to this degree.

6. An alternate interpretation of the Woodward experiments

An alternate interpretation of the Woodward experiments is herewith proposed that may entirely explain the findings in terms of actually occurring purely classical incidental effects without invoking any general relativistic principles.

There are two experiments we will consider, both of which are claimed to exhibit artifacts explained by a transient mass principle. It is perhaps worth noting that the experiments originally appeared to exhibit only a small faction of the effects predicted by the original theory [1-5]. Now that the original theoretical development has been shown to produce no average force due to transient mass fluctuations **(**Sect. 2,3), it is no surprise that there was a disagreement. But there is still some anomaly in the present interpretation of the experiments and so it is useful to reconsider them to see if a simple explanation can be found. The two experiments we will entertain are the torsional pendulum [3?, 5], and the spring in earth gravitational field [2?, 10].

In both experiments, the offending mass was excited by a piezoelectric device providing motion and, incidentally, becoming hot in the mode of operation chosen to produce the greatest anomalies.

An artifact eliminating experimental interpretation is as follows: when the pendulum heats up and expands, there is initially a momentum jerk due to the onset of thermal expansion. Thus a transient force giving rise to a torque about the axis of interest,

$$\Gamma = r \times \mathrm{F} = r \times \frac{d(m\mathbf{v})}{dt} \tag{12}$$

for each element expanding.

A simple formulation is

$$\frac{\partial^2 \mathrm{T}(x,t)}{\partial x^2} - \frac{1}{a(x)}\frac{\partial \mathrm{T}(x,t)}{\partial \mathrm{t}} = \frac{Q(x)}{k} \tag{13}$$

$$\mathrm{dl} = a(x)\mathrm{ldT}, \qquad \mathrm{a} = \frac{\mathrm{d}^2 l}{\mathrm{d}t^2} \tag{14}$$

$$\mathrm{F} = ml\int a(x)\frac{\mathrm{d}^2 T(x)}{\mathrm{d}t^2}\mathrm{d}x \tag{15}$$

Which for certain, especially asymmetric, distributions can yield a net force as shown in Fig 1.

A parabolic diffusion equation for the evolution of the temperature evolving from a finite width distribution of heat flux.

To the extent that the center of mass expands with constant velocity, the force vanishes. However the dielectric and piezoelectric materials used in the experiments increase their dielectric constant with temperature which means the power absorbed is yet higher (runaway) and then the concomitant heat conduction causes a non-linear thermal expansion and thus a changing momentum and net force. After the temperature rise stops, the mass stops expanding and slows down to zero. At this point a transient force in the opposite direction appears and an equal and opposite torque appears. Eventually, the temperature starts to decrease and the mass compresses. At this point, a momentum in the opposite direction, although much smaller, appears and a small negative torque is generated. This is finally cancelled out later when the mass fully contracts.

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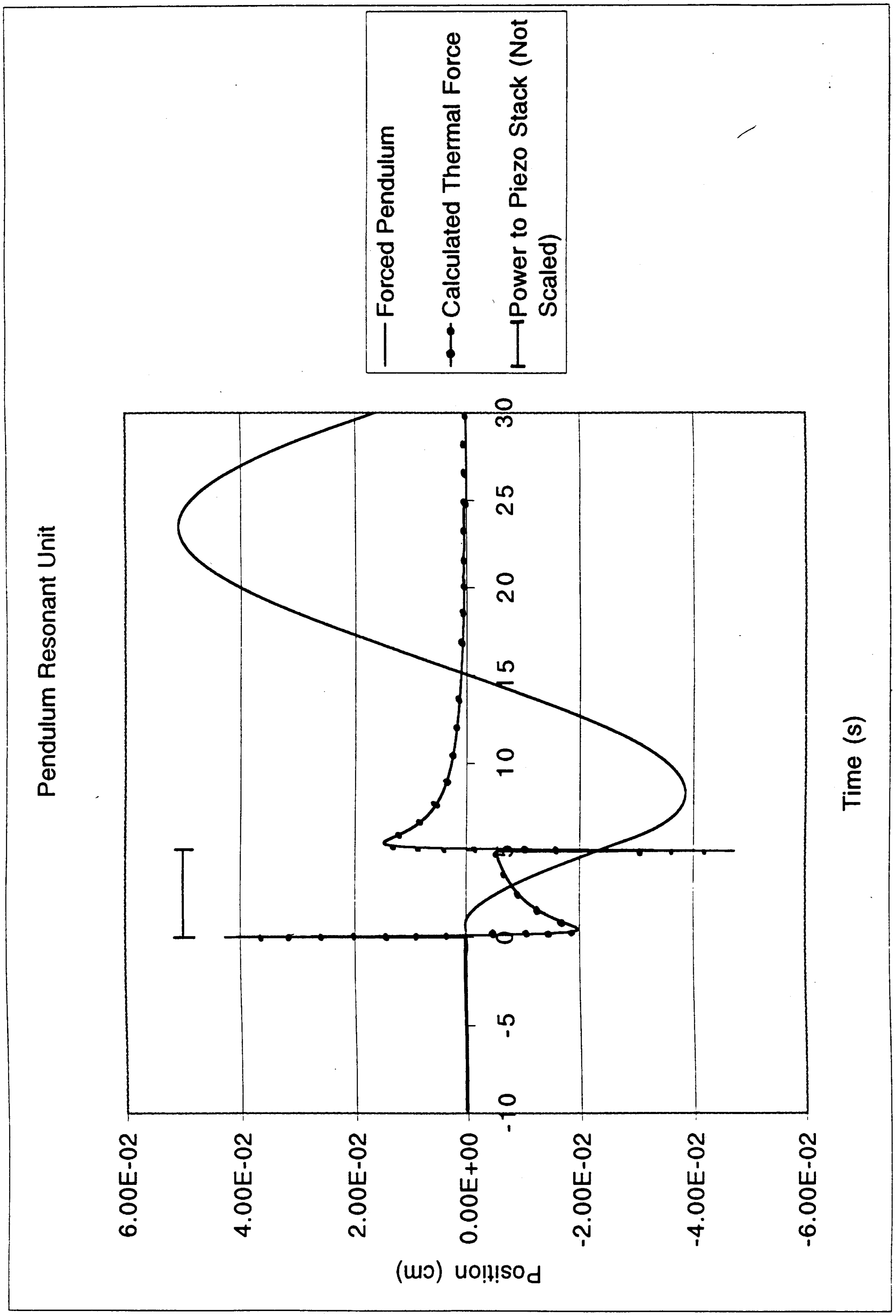

Pendulum Resonant Unit
Forced Pendulum
Calculated Thermal Force
Power to Piezo Stack (Not Scaled)
Position (cm)
6.00E-02
4.00E-02
2.00E-02
0.00E+00
-2.00E-02
-4.00E-02
-6.00E-02
-10
-5
0
5
10
15
20
25
30
Time (s)