[1]A Test for the Existence of Mach Effects With a Rotary Device

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Abstract. Owing to the variation in the results of several experiments designed to produce thrust with devices employing Mach effects, it was decided to design an experiment with the simple purpose of determining whether or not Mach effects actually exist, and if they can be produced when the "bulk" acceleration and internal energy changes required to produce them are separately supplied. In the experiment arrays of eight 500 pf high voltage capacitors are mounted on the end of a rotor and spun to and from speeds of about 60 Hz (3600 rpm) while they are excited with a 40 KHz voltage signal with amplitudes up to 6 KV. The capacitors are sandwiched between two accelerometers and any Mach effect mass fluctuation is detected as a weight fluctuation that produces signals in the accelerometers that are antiphase. Those signals are subtracted with a differential instrumentation amplifier that suppresses other signals as common mode noise. Signals with the properties sought have been found and recorded with video equipment. They suggest that Mach effects are real, and that the bulk accelerations and internal energy changes that produce them can in fact be separately supplied.

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INTRODUCTION

After carrying out a variety of experiments designed to exploit the presumed existence of Mach effects with varying results, it was decided to carry out an experiment to test for the existence of such effects in the simplest of all possible circumstances. The underlying physics suggests that these effects should exist; but in some experiments the effects expected were either not present, or much smaller than predicted. Without experimental evidence that the predicted Mach effects in fact do exist, situations in which they are small or not present may be taken as evidence that Mach effects do not exist, an issue of science rather than one of engineering. With experimental evidence of their existence, when things do not work as expected, the issue one faces becomes one of engineering, rather than one of science.

The underlying physics consists of the observation that in general relativity, when "critical" cosmic matter density is present (as in fact it is), inertial reaction forces arise from the gravitational action of chiefly cosmic matter on local accelerated objects. The local sources of the field that causes inertial reaction forces can be obtained by taking the divergence of the field. When changes in the internal energies of accelerating bodies are allowed, time-varying source terms that correspond to fluctuations in the masses of these bodies are recovered in this calculation. They trace their origin to the derivative with respect to proper time of the four-momentum of the accelerated object, in particular, the time-derivative of the time-like part of the four-momentum, mc. If the internal energy of the accelerated object is changing during the acceleration, then the time-derivative of m does not vanish. Terms arising from the non-vanishing derivative of m end up contributing to the local sources of the field that causes inertial reaction forces – that is, the gravitational field. Note that the internal energy changes take place in the fields in the space between the constituent particles that make up the body. As the fields are changing, this is *not* a vacuum effect, and quantum mechanics is not required to explain what is going on, at least as far as Mach effects are concerned.

Formally, the field equation recovered in the calculation just described is

$$\nabla^2\phi - \frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} = 4\pi G\rho_0 + \frac{\phi}{\rho_0 c^4}\frac{\partial^2 E_0}{\partial t^2} - \left(\frac{\phi}{\rho_0 c^4}\right)^2\left(\frac{\partial E_0}{\partial t}\right)^2 - \frac{1}{c^4}\left(\frac{\partial\phi}{\partial t}\right)^2, \tag{1}$$

where ϕ is the scalar gravitational potential, c the speed of light, G Newton's constant of universal gravitation, ρ_o the local proper matter density, and E_o the local proper energy density. Note that when all of the time-dependent terms are set equal to zero, the Poisson equation for the scalar potential of Newtonian gravity is recovered. Note too that if the accelerated object cannot store internal energy, the chief transient source terms go to zero. It is, naturally, the transient source terms on the RHS of equation (1) that are of interest. They can be written

$$\delta\rho_0(t) \approx \frac{1}{4\pi G}\left[\frac{1}{\rho_0 c^2}\frac{\partial^2 E_o}{\partial t^2} - \left(\frac{1}{\rho_0 c^2}\right)^2\left(\frac{\partial E_0}{\partial t}\right)^2\right], \tag{2}$$

where, as follows from Mach's principle (Sciama, 1953), $\phi/c^2 = 1$ has been used, and the last term in equation (1) has been dropped as it is always minuscule.

The obvious way to test for the presence of proper matter density fluctuations of the sort predicted in Equation (2) is to subject capacitors to large, rapid voltage fluctuations. Since capacitors store energy in dielectric core lattice stresses as they are polarized, the condition that E_0 vary in time is met as the ions in the lattice are accelerated by the changing external electric field. If the amplitude of the proper energy density variation and its first and second time derivatives are large enough, a detectable mass fluctuation should ensue. That mass fluctuation, δm_0, is just the integral of $\delta\rho_0(t)$ over the volume of the capacitor, and the corresponding integral of the time derivatives of E_0, since $\partial E_0/\partial t$ is the proper power density, will be

$$\delta m_0 = \frac{1}{4\pi G}\left[\frac{1}{\rho_0 c^2}\frac{\partial P}{\partial t} - \left(\frac{1}{\rho_0 c^2}\right)^2\frac{P^2}{V}\right], \tag{3}$$

where P is the instantaneous power delivered to the capacitor and V its volume. Note that despite the fact that P can be both positive and negative, the sign of the second term on the RHS of equation (3) is always negative. As long as the coefficients of the power parts of the two terms are small, that is, $\rho_o \neq 0$, then the second term is negligibly small compared to the first term. If, however, $\rho_o \approx 0$, then the second term dominates and large transient negative masses can be produced. In principle, the magnitude of the first term is sufficiently large in engineerable circumstances that a real prospect of generating the $\rho_o \approx 0$ condition exists. If this is so, then generating very large amounts of negative mass material via the second term on the RHS of equation (3) may prove possible. This seems to be the *only* remotely realistic way to generate the enormous amounts of "exotic" matter required to produce "absurdly benign" wormholes – the only plausible way to achieve serious rapid spacetime transport. [For a recent discussion of these matters see: Woodward, 2009.]

The predicted mass fluctuation in simple circumstances can be computed using equation (3) above which, after differentiation of $P = P_0 \sin(2\omega t)$ and ignoring the second term on the RHS, reads:

$$\delta m_0(t) \approx \frac{\omega P_0}{2\pi G\rho_0 c^2}\cos(2\omega t). \tag{4}$$

Putting only fairly modest values in for the power and frequency, one surprisingly finds that large mass fluctuations seem to be inducible – fluctuations that should be easy to detect in modest laboratory circumstances. Reality, though, is a little more complicated than simply wiring up some capacitors and driving them with an AC voltage.

An important feature of the calculation just mentioned is that the field equation with the transient source terms was recovered assuming that the accelerated test object that experiences the gravitationally induced inertial reaction force was accelerated in "bulk" while internal energy changes took place. So, simply changing the internal energy of an object without subjecting it simultaneously to a "bulk" acceleration does not lead to the prediction of mass fluctuations. Accordingly, the design of an experiment to test the prediction of mass fluctuations must provide for both the acceleration of a test body as well as internal energy changes if mass fluctuations are to be expected. The formal derivation of the Mach effects sought presupposes that the acceleration and internal energy changes both arise from the application of an accelerating force. However, there is nothing in the mathematics that demands that this be the case. So, it may well be that the acceleration and the internal energy changes can be separately supplied. This too is tested in the rotary device used in this experiment.

THE ROTARY SYSTEM APPARATUS

Since no attempt was made to produce thrust that might be put to practical application in this work, the plan of the experiment could be quite simple. A ring of high voltage capacitors was mounted on a rotor arm between a pair of PZT accelerometers and spun at frequencies in the range of 0 to about 65 Hz. During the spinning, an alternating voltage was applied to the ring of capacitors with a frequency of 40 KHz – the tuned frequency of a resonant circuit that steps the amplitude of the voltage of the power source applied to the capacitors up to as much as 6 KV. Any 80 KHz mass fluctuation produced by the conjunction of the AC voltage applied to the capacitors accelerated by their rotary motion is detected by the accelerometers.

FIGURE 1. A ring of eight 500 pf Vishay-Ceramite capacitors used as the test object in this experiment.

The chief element of the apparatus is a ring of eight 500 pf high voltage capacitors (for a total of 4.15 pf) glued and wired into a ring potted with Bondo. See Figure 1. The capacitor ring is clamped between two accelerometers made with thin PZT disks glued to steel washers (1.5 inches OD) on a (1/4 – 28) bolt with a lock nut. (See Figure 2.)

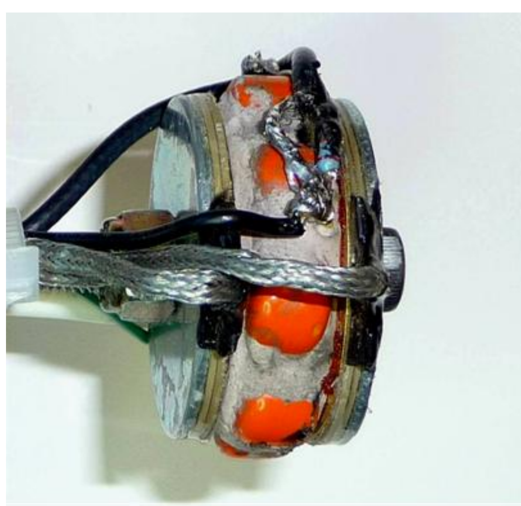

FIGURE 2. The ring of capacitors clamped between the two PZT disk accelerometers.

The bolt on which these parts are mounted is one of the two rotor arms in the assembly. The transformer that matches the capacitor array to the Carvin audio power amplifier is mounted with the same type of washers on a second bolt that counter balances the bolt with the capacitor ring. The two bolts are screwed into an aluminum hub on the shaft of the device. (See Figure 3.)

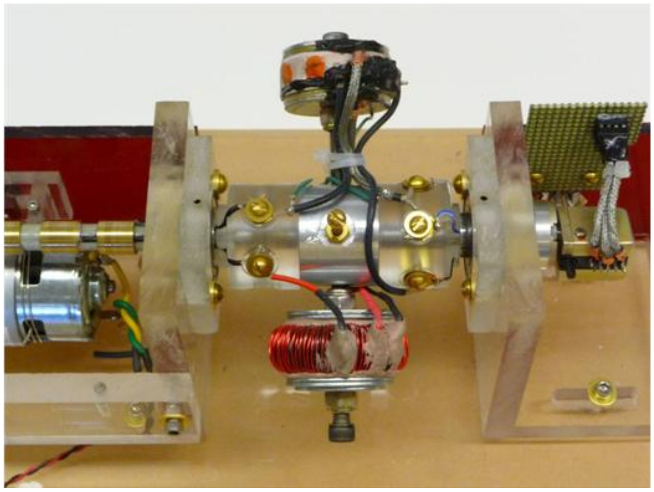

FIGURE 3. The rotor and aluminum hub on the drive shaft of the apparatus.

One end of the shaft, the left end in Figure 3, is devoted to the drive motor and power circuit slip rings. Special Fabricast brushes are used here to handle the currents of several amps commonly present. At the other end of the shaft a special Northrop-Grumman (PolyScientific) instrumentation slip ring assembly carries the signals from the two accelerometers and a resistive voltage divider that monitors the voltage across the capacitors to buffer amplifiers and the rest of the signal processing circuitry. (See Figure 4.) Owing to large currents in the ground return parts of the circuits, it was found necessary to separately buffer both the "high" and "ground" leads from the signal sense circuits as instrument ground was often different from the local ground of the signal sense circuit.

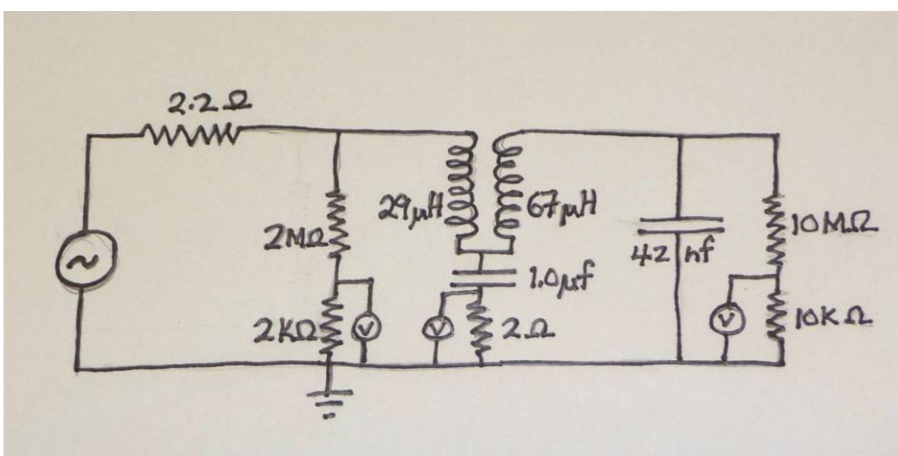

FIGURE 4. The power circuit diagram. The voltage across the 4.2 nf capacitor ring is stepped up by the transformer in the center of the diagram. The voltage sense circuits are resistive voltage dividers.

If a mass fluctuation results from the rotational acceleration accompanied by the AC voltage applied, it is recorded by the "weight" variation of the capacitors sensed by the accelerometers at twice the frequency of the voltage signal applied to the capacitors (80 KHz). Note that the signals that the two accelerometers record if a "weight" fluctuation occurs in the capacitors are antiphase, so their signals are processed by making them the inputs (after buffering as mentioned above) of a differential instrumentation amplifier. The differencing procedure for antiphase weight signals doubles the amplitude of the signal of each accelerometer. But, in principle, this differential technique should suppress all conventional sources of signals as they should be present in equal magnitude in the two accelerometer sensor circuits and cancelled as common mode noise by the differential amplifier.

In practice, complete conventional signal cancellation at the frequency of interest doesn't happen. The problem is not electromagnetic pickup and the like. Those noise/signal sources are suppressed by careful design and shielding. Indeed, the only signals of significance recorded by the accelerometers are the electromechanical signals they were designed to detect. The dominant signal for both accelerometers is a 40 KHz signal produced by the expansion/contraction of the capacitors due to their piezoelectric properties (at 6 KV applied capacitor voltage, the accelerometer signals have an amplitude of a bit more than 100 mV). However, the response of the two accelerometers is not exactly the same. The amplitudes of the two signals depend on the particular responses of the PZT disks used, so provision for trimming both accelerometer signal amplitudes was made so that the amplitudes could be adjusted to be equal in circumstances where there is no reason to expect any difference in the amplitudes – that is, at 0 Hz rotation frequency.

When the amplitudes of the accelerometer signals are adjusted to minimize the differential signal as just mentioned, the net output signal of the differential amplifier becomes a small fraction of either of the accelerometer signals, but it does not vanish into the noise in the system. The reason is that the relative phase of the two signals is not exactly zero, as one would expect it to be in an ideal system. In order to compensate for this state of affairs, matched phase shifting circuits were inserted into the accelerometer signal paths between the buffer amplifiers and the differential amplifier. With careful successive adjustments of the phase and amplitude of the accelerometer signals it was possible to drive the net signal to levels approaching the apparent noise in the system, especially after the net signal was processed through a bandpass filter with a broad pass band (10 KHz to 150 KHz in fact so that the second and third harmonics of the 40 KHz operating frequency were not suppressed). The amplitude and phase adjustments of the two accelerometer signals were facilitated by their display as the two channels of a digital oscilloscope (which made trace discrimination simple as cute colors – yellow and blue – distinguished them).

The signals resulting from the processing described so far were displayed in real time during operation of the system on an analog oscilloscope and fed into a Picoscope (12 bit resolution) run in FFT power spectrum mode so that the magnitudes of the components of the net signal could be discriminated. Since the Mach effect of interest is expected at the second harmonic of the frequency of the voltage signal applied to the capacitors, in order to view it in real time it must be filtered from the other parts of the net signal. This was done with a narrow pass band filter consisting of high and low pass parts rolled off at 72 KHz and 90 KHz respectively. The output of this filter was displayed on an analog oscilloscope. Should there be changes in the amplitude and phase of the second harmonic part of the signal – as the presence of a Mach effect that depends on the rotation frequency of the rotor suggests should be the case – they should be manifest in this signal (as well as in the power spectrum recorded by the Picoscope).

SIGNAL ANALYSIS

If the application of an AC voltage to the spinning capacitor array does in fact produce a Mach effect mass fluctuation, then the two accelerometer signals will be 180 degrees out of phase (as the capacitor array will be accelerated toward the outer accelerometer and away from the inner accelerometer), and, as mentioned above, the difference of these signals will not be zero. So, if the 0 Hz rotation frequency signal is minimized by adjustments of the amplitude and phase of the accelerometer signals, then any Mach effect signal – presumably 0 at 0 Hz rotation frequency as the capacitors have no bulk acceleration – will progressively modify the 0 Hz residual signal as the rotation speed is increased. How in detail that takes place will depend on the particulars of the Mach effect supposed to be present and the fact that the residual electromechanical signal itself may be affected by the increasing rotation speed, an issue yet to be discussed. Before turning to the interplay of electromechanical and Mach effects, we examine issues relating to Mach effects alone.

Of these issues, the trickiest is how Mach effects should depend on rotation frequency in this experiment. When the acceleration in question is also so source of the mass-energy fluctuation in the Mach effect calculation, things are simple. If one starts at the predicted mass fluctuation in the "impulse" term and backtracks through the calculation of the effect, one finds that the acceleration of the body that causes the effect is implicit in the dP/dt factor. Indeed, it is the source of P itself as P follows from the $dm/dt = (1/c^2)dE/dt = (1/c^2)P$ in the time-like part of the four-momentum. The time-derivative of P in the impulse term comes from the time-like part of the four-divergence.

This, however, is not the case in the rotary device experiment. The P in the capacitors is produced completely independently of the acceleration that arises from the rotation and is not causally linked to any bulk acceleration of the dielectric. That is supplied separately by the rotation. Now, it may be that in these circumstances no Mach effects appear – and should they not appear, that would not be a demonstration of their non-existence. But should any effects appear, it would seem that the magnitude of such effects ought to be linked to magnitude of the acceleration produced by the rotation. The simplest way to proceed seems to be to write:

$$\delta m(a) = k\delta m \bullet a\,,$$

where k is a constant with dimension of inverse acceleration to be determined from experiment. Other assumptions are possible, but they are all more complicated and seem significantly less likely. Now, since the forces on the accelerometers will be proportional to $\delta m.a$, the forces recorded by the accelerometers should be:

$$F(a) = k\,\delta m \bullet a^2$$

and since $a = \omega^2 R$,

$$F(a) = k\,\delta m \bullet \omega^4\, R^2\,.$$

Evidently, the dependence of Mach effects (with the simplest assumption regarding acceleration) is quite strong if they are present. The question then is: how do everyday electromechanical effects depend on the speed of the rotor in this experiment?

Two types of electromechanical signals can be expected in systems like that under consideration. The first is simple, linear *piezoelectric* expansion and contraction of the dielectric material in the capacitors in the direction of the electric field applied between the plates. Being linear, this effect has a frequency equal to that of the applied field. Since this is half the frequency of the Mach effect signals sought, it is easily separated from the sought signals and will not be considered further here. The second *electromechanical* signal to be expected arises from ***electrostriction***. This effect is quadratic in the applied voltage, and as such will have the same frequency as the sought Mach effect. In fluids, electrostriction is displayed as a volumetric effect. In solids it is a little more complicated. It is usually a contraction in the direction of the applied field and a coupled expansion in the directions orthogonal to the applied field. It is worth remarking that whereas the piezoelectric effect has an inverse – that a mechanical deformation of the material will induce a voltage across the faces of the stressed dielectric – the electrostrictive effect, being quadratic in the voltage and not depending on the polarization of the material, does not.

The chief thing to keep in mind about electromechanical effects is that they produce either an expansion or contraction of the dielectric material in the capacitors. They do *not* produce a fluctuation in the mass of the capacitors. Since the capacitors are clamped by the two accelerometers and "float" between them, expansions or contractions of the dielectric will affect the accelerometers equally. Accordingly, to the extent that the accelerometers are matched in their responses, electromechanical effects in the capacitors will produce accelerometer signals that are the same. As a result, these signals will be removed by the differencing affected by the instrumentation amplifier. Moreover, as long as preload compression of the accelerometers and capacitors, and acceleration induced forces do not produce non-linear behavior, there is no reason to expect piezoelectric signals to depend on rotation of the device.

In the case of electrostriction, ferroelectric materials are known to sometimes display dependence on the extent of the compression of the material. While the chief compressional force on the capacitors is due to the preloading of the assembly with the lock-nut on the rotor arm bolt, rotation will induce a rotation frequency dependent loading force that will compress the capacitors further. The presence and sign of any compressional effect can be determined, however, with a simple static loading test carried out with clamps like those shown in Figure 5.

The result of a static loading test depends, for a particular array of capacitors, on how much preload is applied and how heavy the clamping force is. In the case of the capacitors shown in the figures here, with the usual preload, increasing the clamping force led to increases in the 0 Hz rotation, 80 KHz net accelerometer signal. It is worth remarking, though, that the clamping force is larger than the force expected from the acceleration of the inner accelerometer and its backing washer.

FIGURE 5. The clamps used in the static loading test for compressional electrostrictive effects.

Aside from electrostriction, the only electromechanical signal present at the double frequency of the voltage waveform driving signal is any second harmonic that might be present in that signal. This is easily detected by performing a power spectrum analysis of the applied voltage. And distortion in that signal can be suppressed by filtering the signal with a high power passive filter. But, in any event, like piezoelectric effects (at half the frequency), such signals should not produce pronounced effects after the differencing process (as they affect the accelerometers equally), and they should be insensitive to the rotation frequency of the device. Reality is more complicated in that the differencing process is not ideally exact. But the insensitivity to rotation for these signals can be checked by monitoring the amplitude of the residual signal at the base frequency of 40 KHz. It is rotation independent.

In practice, one should be prepared to detect any, and perhaps all of the signals discussed here. Unwanted signals can be suppressed by the techniques mentioned above, but their complete elimination may prove difficult, if not impossible.

SCALING

The chief scalings worth mentioning are capacitor voltage frequency and capacitor voltage amplitude. We ignore capacitor voltage frequency as this has not yet been explored as the power circuit is tuned to a particular frequency that is not easily changed. As far as capacitor voltage amplitude scaling is concerned, the dependence is on the power (actually, the time-derivative of the power), and that is equal to the product of the voltage and current in the capacitors. Since the current is proportional to the voltage, the dependence turns out to be the square of the voltage. Alas, this is the same scaling as that expected for electrostrictive effects. So, while checking for expected scaling should be done to make sure that any signal found passes this test, the test cannot be used to demonstrate the unique nature of any signals found. Nonetheless, though both effects scale with the square of the capacitor voltage, they are discriminable. It turns out that the time-derivative of the power and the square of the voltage, relative to the exciting voltage signal are anti-phase with respect to each other. So these effects compete with, rather than abet each other. This means that if the dependences of these two signals on rotation frequency are different and their amplitudes are roughly comparable, then one may expect to see complex amplitude and phase behavior of the composite signal due to the two effects as the rotation frequency is changed. This type of behavior, in fact, is not difficult to produce.

RESULTS

It is customary in work of this sort to provide graphs and other displays to report the results of an investigation of this sort. One might plot, for example, the strength of the differential accelerometer signal versus rotation frequency, and then do several plots of this sort for various capacitor voltage amplitudes. This sort of data display, however, does not capture the dynamic nature of the variation of the variables involved. Modern video techniques make it possible to record the actual operation of the system, and the various signals can be displayed on oscilloscopes and spectrum analyzers that can be recorded on video so that their behavior can be virtually observed in real time. A final report would properly contain the traditional sorts of data displays. But this is not a final report. Rather, it is a progress report. Accordingly, I choose to report such progress as has been made in the form of two video files. This way, you can see for yourself how the system operates, and how the various signals monitored behave during operation.

The videos related to this experiment that have been uploaded to Zshare are listed here below. Description of the videos and important things to note in the videos are included in brief comments accompanying each listing.

THE DEVICE IN OPERATION

This video comes in two parts (see: http://www.zshare.net/video/ 59506760a6754bd2/). The first part shows a typical run of the actual physical apparatus. The second part shows the responses of the instrumentation to a typical run.

Part 1: starts with a zoom in to the stationary rotor with the capacitor array and accelerometers on the left and the matching transformer on the right. As the rotor begins to spin, the picture is widened to include the entire device. In the foreground are the power slip rings and brushes, and to their right is the cable from the power amplifier. The Northrop-Grumman instrumentation slip ring module is at the other end of the shaft; and just to the left of the module is the cast aluminum box housing the accelerometer buffer amplifiers (easily identified by the red "Big Flasher" on its left hand side. Note the smooth operation of the device as it is spun up to 60 Hz and then back down.

Part 2: the run displayed on the instruments in this part of the video was done with two noteworthy conditions. First, no power filter was used to suppress any second (or higher) harmonic component of the driving voltage applied to the capacitor array. Second, the device had relaxed for more than a month after the securing nut on the rotor arm was torqued to provide a preload on the accelerometers and capacitor array.

The instruments are:

- *Center bottom:* a frequency counter that records the spin frequency of the rotor.
- *Right:* the display of the Picoscope functioning in power spectrum mode.
- *Left:* Three oscilloscopes that display various versions of the capacitor voltage and accelerometer signals.

The top digital oscilloscope displays the two buffered, amplitude and phase adjusted accelerometer signals (yellow and blue) and their difference (red). The bottom analog oscilloscope displays the capacitor voltage signal – used as a phase reference – and the net accelerometer trace after it has been filtered by a broad bandpass filter and amplified. This trace is the processed version of the red difference trace on the top digital oscilloscope. The center analog oscilloscope displays, again, the capacitor voltage trace, and the second harmonic component of the net accelerometer signal so that its amplitude and phase can be viewed uncomplicated by the presence of signals at other frequencies.

The run:

The Picoscope spectrum display is not helpful as it is running in "normal" mode – without averaging to suppress noise – and the signals of interest are hard to pick out from the noise.

The rotation frequency can be read off of the frequency counter. An antique, it was programmed to show each count (at roughly one second intervals) and the result of the count is only very briefly displayed before the next count commences.

Both of the digital (top) oscilloscope channels are set to 200 mV/div. During the course of the run, while there is some quasi DC jitter in the traces (that likely come from brush noise), there is no easily detectable change in either of the accelerometer traces or their difference. This means that any signal present is small and reassures one that the apparatus is performing as it was intended to. In particular, there are no large mechanical signals and pickup is likely not present.

The net accelerometer trace displayed on the bottom analog oscilloscope reveals that the amplitude and phase compensation for the 0 Hz rotation frequency signal have worked quite well. While there is some periodic structure to the trace, it does not display pronounced variations at either 40 or 80 KHz. As the rotation speed is increased, this changes in the range of 35 to 45 Hz, and the signal that emerges in this frequency range increases in prominence as the rotation frequency rises to 60 Hz. As the rotor is spun down, the signal decreases in prominence, though not exactly in reverse order from spinup. This means that secular thermal effects are present.

The accelerometer signal displayed on the center oscilloscope where the 80 KHz second harmonic is isolated and amplified is not in the noise at 0 Hz rotation frequency. As the rotor is spun up, this signal remains mostly unchanged until 35 Hz is reached. At 35 Hz the signal first decreases, and then begins to increase in the 40 to 45 Hz region. This amplitude change is accompanied by fluctuations in the relative phase of the 80 KHz signal. The amplitude continues to rise as spinup continues to 60 Hz. The accelerometer signal changes are the approximate reverse of the spinup changes during spindown, but the hysteresis noted above is also present.

It is clear that a net accelerometer signal of the sort expected from the predicted Mach effect is present in the data from this run. It is complicated by the presence of two electromechanical signals: electrostriction and piezoelectric responses. Nonetheless, since electromechanical signals are not expected to have appreciable dependence on the rotation speed, and the main signal present clearly does have strong dependence, it seems reasonable to infer that the signal seen is due to the Mach effect sought.

CAPACITOR VOLTAGE SCALING

This video shows (see: http://www.zshare.net/video/6093935653908fa9/) three runs of the device taken in succession with the capacitor voltage set first at 6 KV (as can be ascertained from the phase reference trace of the capacitor voltage knowing that the scale is 2 KV/div). The second and third runs are at 4 KV and 2 KV respectively. When the accelerometer trace amplitudes are compared, one finds that the 4 KV amplitude is a bit smaller than half of the 6 KV amplitude; and the 2 KV accelerometer amplitude is about a tenth of the 6 KV amplitude. V^2 scaling expected on the basis of Mach effects predicts that the 4 and 2 KV accelerometer amplitudes be factors of 0.44 and 0.11 of the 6 KV amplitude. Evidently, the predicted scaling is present. Unfortunately, the predicted Mach effect capacitor voltage scaling is not unique. One may reasonably expect that any electromechanical effect will have the same scaling as they should scale with the power delivered to the capacitor array. The voltage scaling test, however, does eliminate pickup as a candidate explanation for the accelerometer responses as pickup should scale linearly with voltages present.

CONCLUSION

The results obtained to date with the rotary apparatus described here suggest that Mach effects may well be real – and that they may be producible with separately supplied accelerations and internal energy changes. More work is required to establish this with certainty. But given the significance of real mass fluctuations for revolutionary rapid spacetime transport, more effort seems justified.

NOMENCLATURE

c = vacuum speed of light (m/s)
δm_0 = mass fluctuation amplitude (kg)
E_0 = proper energy density (J/m^3)
G = Newtonian constant of universal gravitation (Nm^2/kg^2)
m_0 = proper mass (kg)
ω = angular frequency (rad/s)
P = power (W)
ϕ = scalar gravitational potential (m^2/s^2)
ρ_0 = proper mass density (kg/m^3)
V = voltage (V); or volume (m^3)

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