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Using a modified Cavendish experiment to measure dynamics of unexpected effect thanks to modern technology

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ABSTRACT

We present the results of our measurements of the dynamics of an unexpected effect, which we have provisionally named the electromagnetic-gravity effect. These results are compared with those of the interaction of the Coulomb force. These measurements were performed using a modified Cavendish experiment controlled by computers. The results of these measurements were then compared with each other, with Newton's laws, with a numerical simulation and with the gravitational hypothesis. Reference experiments using high-voltage electrostatic stimulation agree with Newton's laws and numerical simulations with acceptable accuracy. However, experiments involving the unexpected effect produced significantly different results. These results partially agree with the gravitational hypothesis and the numerical simulations based on it. The timing of the periodic stimulation differs significantly, by a quarter of a period; that is to say, the phase differs by 90 degrees from that of the reference experiments and the results of the numerical simulations. This difference is reproducible. So far, it has not been possible to explain this using known physical laws.

Introduction

The described experiment was developed based on the measurement results of previous long-term experiments. Anomalies were recognised during static pendulum measurements carried out at various locations on the Earth's surface¹. These measurements have been carried out for many years. The apparatus measures relatively slow changes in the local gravity field and deformation of its environment. Experiments with a static pendulum revealed an unexpected effect of solar radiation. This effect was successfully reproduced in a controlled experiment using a torsion pendulum². Further experiments were conducted to verify the dynamic properties of the unexpected effect, during which the experiment was significantly affected by other unexpected behaviour of the torsion pendulum³. The experiment was gradually improved from a technical perspective, particularly with regard to the accuracy and reliability of measuring the pendulum's movement and stabilising the experimental environment. The results of the new measurements are described in the following text. It should be noted that these experiments could only be conducted during a few summer months, when the magnitude of the pendulum's spontaneous movement is acceptable.

Description of the measuring device

The essence of the Henry Cavendish apparatus⁴ is a torsion pendulum. It uses a wooden arm that is 6 feet long. That is 183 cm. In the presented experiments, a torsion pendulum with a 2 m carbon fibre tube arm was used. Therefore, the basis of the apparatus used is very similar to the Cavendish apparatus in terms of dimensions and function (see Fig.1). The significant differences are:

- The second pair of large weights on a rotating arm was not used. Instead, two electrically controlled containers were fixed in place near the weights.
- An isolating box was not used for the arm and weights of the torsion pendulum. The measurements were carried out in a sealed, windowless room located below ground level with double-sealed doors. The room's dimensions were 350 x 300 cm with a height of 210 cm, and the pendulum's suspension length was 140 cm. The suspension was made of 0.5 mm Evек GmbH 99.95% tungsten wire.
- The position of the pendulum arm was not measured by people standing near the pendulum. Instead, fully automatic, computer-controlled laser rangefinders were used. Measurements were taken remotely, with no persons present in the vicinity of the experiment. The speed of measurement, the amount of data collected and the level of accuracy are beyond

anything available to Henry Cavendish in the 18(th) century. The maximum sampling rate was 20 Hz (i.e. 0.05 seconds) with a resolution of $8\text{ }\mu\text{m}$. The measurements described in this text were taken using a standard sampling rate of 1 second. The distance was measured using a Panasonic HL-G112-A-C5 laser sensor.

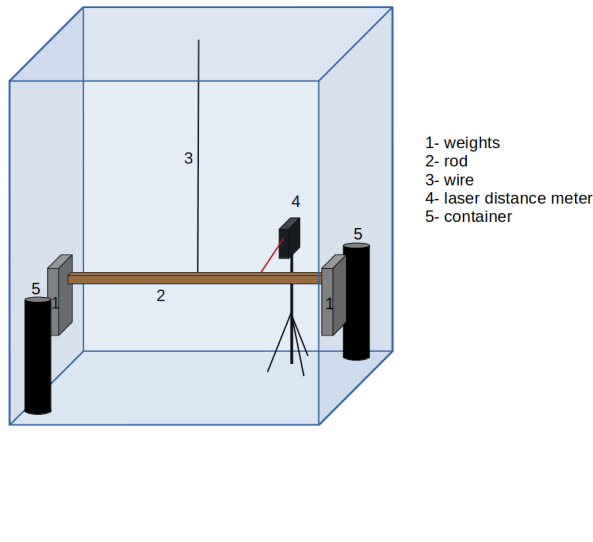


Figure 1. *Schematic representation and photo of the experiment setup*

Containers

The containers allow the experiment to be conducted in two ways (see Fig. 2). The container is made from a 1 m long, 12 cm diameter iron pipe (stove pipe). The experiments described used black pipes.

- The first way of using them is to measure the dynamic of the unexpected effect, provisionally named the electromagnetic-gravity² (B source). For this purpose, a classic (tungsten) light bulb with a power consumption of 105 W was used. The light bulb was placed inside the iron pipe at a point that was approximately the same height as the torsion pendulum weight. When the light bulb was switched on, a faint glow could be seen at the top of the pipe. The light bulb's glow was not visible elsewhere. The light bulbs were controlled by computer-controlled relays. Switching the bulbs on and off was controlled by a computer running measurement programmes. This method of stimulation is referred to as 'B source' in the text.
- The second method involves measuring the dynamic of Coulomb's force⁵. To this end, DC high-voltage source is connected to the iron tube of the container via one pole, with the container itself placed on an insulating pad. The second pole of the high-voltage source is grounded. The pendulum is also grounded. The sources were controlled by computer-controlled relays. Switching the sources on and off was controlled by a computer running measurement programmes. This method of stimulation is referred to as the 'HV source' method in the text.

The dual use of the container meant that the stimulation methods could be alternated without people needing to be present near the experiment. The experiments could be controlled remotely. The output voltage of the high-voltage sources connected to the tube was adjusted to produce deflections in the torsion pendulum similar to those observed during stimulation with a light bulb (i.e. 600 V).

Experiments performed

The research focused on the experimental verification of the properties of the unexpected effect, provisionally named the electromagnetic-gravity interaction (referred to as the 'B source' in the following text)². Experiments using a high-voltage source were carried out to enable direct comparison of the measurement results with those of a known physical phenomenon,

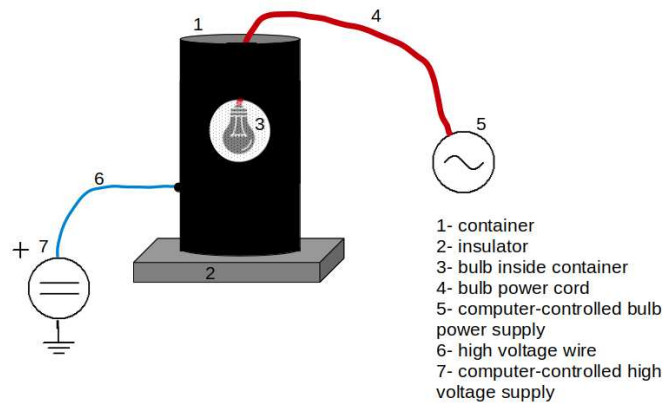


Figure 2. *Container and stimulation control*

such as Coulomb's⁵ and Newton's laws⁶ (referred to as the 'HV source' in the following text). Measurements were taken using a computer-controlled measuring device based on a modified Cavendish experiment⁴. See [Description of the measuring device](#).

Two different stimulation timing methods and two types of stimulation were used in various combinations. In addition, two torsion pendulum modifications were used that differed in the size, and therefore the mass of the weights. The basic pendulum had one weight firmly attached to each side (referred to as 1w). Adding a pair of larger weights created an enlarged pendulum (referred to as 2w). The total mass of the 1w pendulum was 3.2 kg, with a swing time of 390 seconds, while the total mass of the 2w pendulum was 11 kg, with a swing time of 900 seconds. The measurement results were processed so that the relevant pairs of experiments could be compared. The experiments were conducted during the period of low amplitude of the torsion pendulum's spontaneous motion, i.e. in the summer months 2025³. Nevertheless, irregular deviations are evident in the results. Therefore, the experiments were repeated.

Measured data and their evaluation

Static stimulation

The aim of the experiment is to determine how the torsion pendulum responds to a single-unit jump in the stimulation variable. To this end, the stimulation was switched on for 1 hour after a sufficiently long stabilisation period.

Deflection

As shown in Fig. 3, the measured data indicate that the deflection of the heavier pendulum (2w) is significantly greater than that of the basic pendulum (1w) when excited by a light bulb (B source). It is approximately twice as large. However, this does not apply to the high-voltage experiment (HV source). In this case, the deflections of the two pendulums are roughly the same. The deflection of the heavier weight pendulum (2w) is slightly greater.

Velocity when switched on

When excited by a bulb (B source), the velocity of the heavier weight (2w) is significantly greater than that of the lighter weight (1w). It is approximately twice as fast (see 3a and Table 1). However, when excited by a high voltage source (HV source), the opposite is true. The lighter weight (1w) moves significantly faster than the heavier weight (2w). It is approximately twice as fast (see Fig.3b and Table 1).

Stimulation	Velocity 1w [mm/s]	Velocity 2w [mm/s]	Velocity ratio 2w/1w
B source	0.0135	0.031	2.3
HV source	0.042	0.021	0.5

Table 1. *Comparison of velocities when switched on*

Periodic stimulation - Effect of weight change

The aim of the experiment is to determine how a torsional pendulum responds to the periodic synchronised switching on of the stimulation variable. To this end, after allowing for a sufficiently long settling period, the stimulation was switched on and off

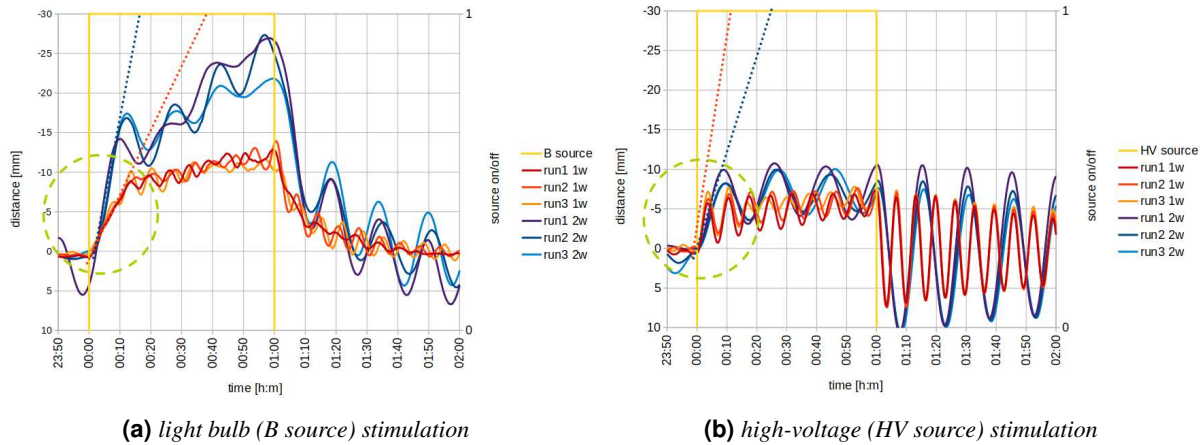


Figure 3. Results of static stimulation measurements for both pendulum variants (1w and 2w), B source and HV source stimulations

for one-eighth of the pendulum's swing time, at a frequency matching that of the pendulum's natural swing. The stimulation had the same timing for both stimulation methods.

Amplitude

When stimulated by a light bulb (B source), the measurement results (see Fig. 4a) show that the pendulum with the heavier weight (2w) has a greater swing amplitude than the pendulum with the lighter weight (1w). The amplitude ratio is approximately 1:2.5. It was measured at the same time and with the same total stimulation duration. When stimulated by a high-voltage source (HV source), the amplitudes of both pendulum variants are roughly the same (see Fig. 4b). Thus, the amplitude ratio is approximately 1:1. This was also measured under the same conditions.

Phase

When stimulated by a bulb (B source), the measurement results show that both pendulum variants (1w and 2w) exhibit the same phase response to the timing of the stimulation (see green circle Fig. 4a). The stimulation is switched on when the weight is at its maximum distance from the container, i.e. when the weight velocity is at its minimum. However, the swing time, and thus the absolute timing of the stimulation, differ between the pendulum variants. Similarly, for high-voltage stimulation (HV source): both pendulum variants (1w and 2w) have the same phase response to the timing of the stimulation (see green circle Fig. 4b). However, the phase is different compared to stimulation with a bulb (B source). Stimulation is switched on when the weight is halfway between the maximum and minimum distance from the container, i.e. when it is moving towards the container and its velocity is at its maximum. In this case, the swing time and thus the timing of the stimulation also differ for different pendulum variants. Therefore, the phase remains constant in both cases, regardless of the weight, but it depends on the stimulation method. The difference is $\frac{1}{4}$ circle, i.e. 90 degrees.

Periodic stimulation - The effect of the method of stimulation

Amplitude

When the measurement results (Fig. 5) for the same pendulum are compared for different stimulation methods, it is found that for the pendulum with heavy weights (2w), the amplitudes of the swings are comparable for both types of stimulation (Fig. 5b). For a pendulum with light weights (1w), however, the amplitude of the swings during high-voltage stimulation (HV source) is more than double that during bulb stimulation (B source) (Fig. 5a). The measurement results show that the dependence of amplitude on the mass of the weight depends on the method of stimulation, with different methods resulting in different outcomes.

Phase

A comparison of the phases for both pendulum variants shows that the phase difference between high-voltage stimulation (HV source) and bulb stimulation (B source) is the same for both pendulum variants (1w and 2w). This difference is approximately one quarter of a circle, i.e. 90 degrees. The time difference between the maximum deflections (HV source and B source responses) for the pendulum with light weights (1w) is around 120 seconds, and for the pendulum with heavy weights (2w) it is around 240 seconds. So, the time difference between the two types of pendulums is around 120 seconds. This means that the

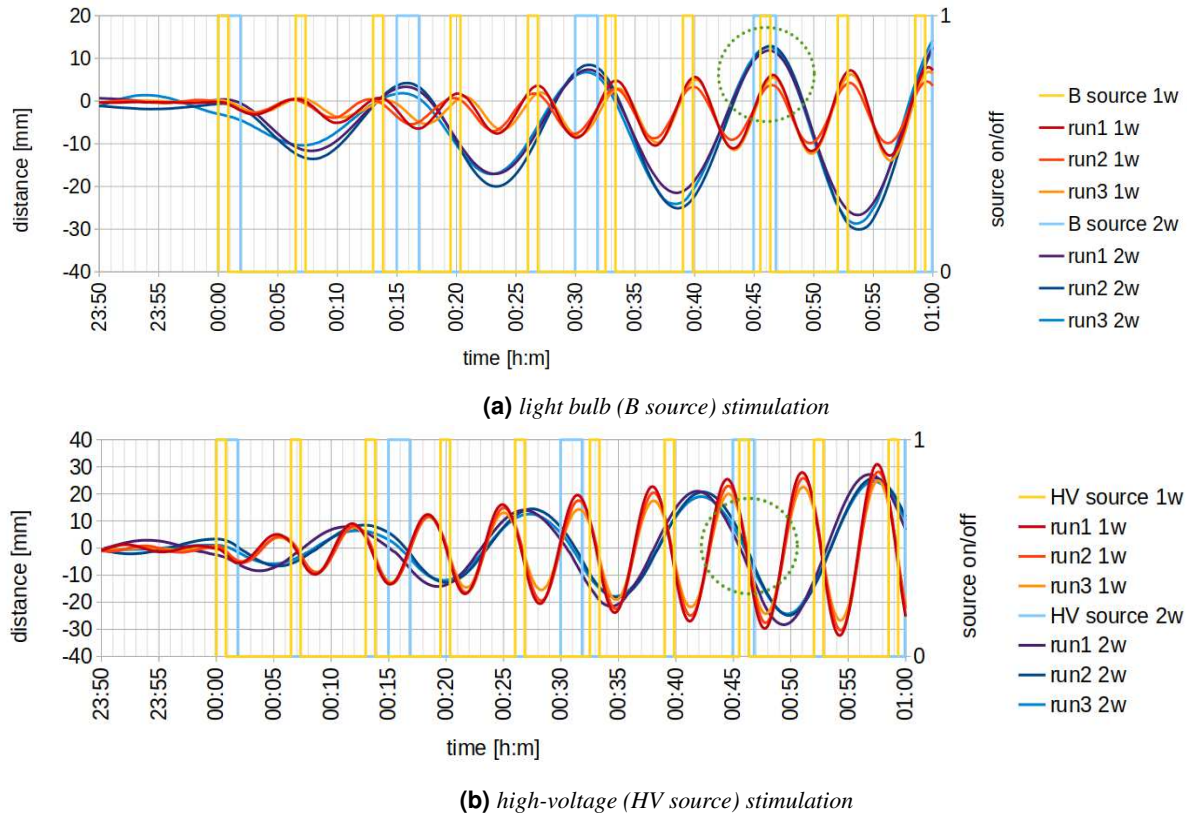


Figure 4. Results of periodic stimulation measurements for both pendulum variants (1w and 2w), B source and HV source stimulations

time difference is not caused by the properties of the devices used for stimulation. See [Distinguishing between B source delay and pendulum phase shift](#) for more information.

Comparison of measured results

HV source

In this section, we will compare the measured results with each other, as well as with the independent force hypothesis and with the gravitational hypothesis. Please refer to [Torsion pendulum dynamics – independent force hypothesis](#), and [Torsion pendulum dynamics – gravitational hypothesis](#) for more information.

Deflection

According to independent force hypothesis, the deflection is independent of the mass of the weights. The measured amplitude ratio is approximately 1.2.

Velocity

According to independent force hypothesis, the ratio of velocities is inversely proportional to the ratio of swing times, i.e. inversely proportional to the square root of the ratio of masses. The velocity of the lighter weight (1w) was measured to be 0.042 mm/s. The velocity of the heavier weight (2w) is 0.021 mm/s. The ratio is $\frac{v_1}{v_2} = 2.0$. The oscillation period of the lighter weight pendulum (1w) is 390 seconds. The period of oscillation with the heavier weight (2w) is 900 seconds. The ratio of the periods is $\frac{T_2}{T_1} = 2.3$.

Amplitude

According to independent force hypothesis and the results of a numerical simulation based on these hypothesis, the ratio of amplitudes is inversely proportional to swing time. The measured data show almost identical amplitudes. The reduction in the amplitude of the pendulum with the heavier weight (2w) is comparable to the variation in the measurement results. Please note that at the time of measuring the movement of the pendulum with a lighter weight (1w), the weight was not properly

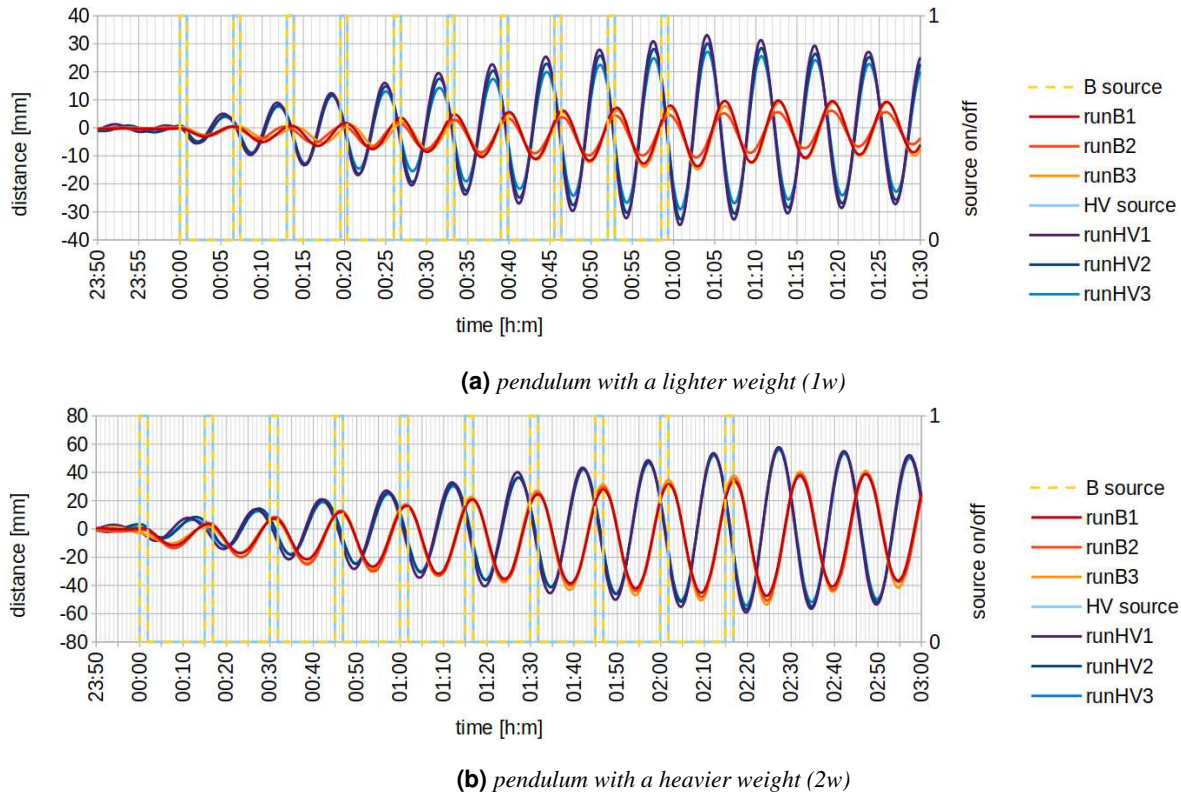


Figure 5. Results of periodic stimulation measurements for both stimulation variants (B source and HV source) and both pendulum variants (1w and 2w)

grounded. Grounding was only installed before measuring the heavier weight (2w) pendulum. Previous experiments using an older version of the pendulum with a wooden arm show that the amplitude is inversely proportional to the period of oscillation. This measurement imperfection does not affect the conclusions.

Phase

It was found that the stimulation switches on when the weight is halfway between the maximum and minimum distances from the container and is moving towards it, i.e. when the weight's velocity is at its maximum. According to the numerical simulation based on independent force hypothesis, when the external force is applied, the deflection is around 0 (equilibrium position) and the speed is maximum in the direction of the external force (see Fig.6). Thus, for the three measured scenarios, the measurement results are consistent with independent force hypothesis. The deviation in the fourth scenario may be due to different experimental conditions. Older experiments show agreement with the Coulomb force and independent force hypothesis.

B source

Deflection

The measured data show that, when stimulated by a light bulb (B source), the deflection of the heavier pendulum (2w) is significantly greater than that of the basic pendulum (1w). In fact, it is approximately twice as large. According to independent force hypothesis, however, the deflection is independent of the mass of the pendulum. However, according to the gravitational hypothesis, the deflection is directly proportional to the mass of the weight. The ratio of the masses of the pendulums (2w/1w) is 3.4. However, the measured result is inconsistent with both independent force hypothesis and the gravitational hypothesis.

Velocity

When excited by a light bulb, the heavier weight (2w) moves significantly faster than the lighter weight (1w). The velocity of the lighter weight was measured at 0.0135 mm/s, while that of the heavier weight was measured at 0.031 mm/s. According to independent force hypothesis, the ratio of velocities is inversely proportional to the ratio of swing times — that is to say, it is inversely proportional to the square root of the ratio of the masses. Therefore, the speed of the heavier weight (2w) should be approximately half that of the lighter weight (1w). However, according to the gravitational hypothesis, the ratio of velocities is

directly proportional to the ratio of swing times. Therefore, the velocity of the heavier weight (2w) should be approximately twice that of the lighter weight (1w). The measured velocity ratio is 2.3. The ratio of swing times is also 2.3. These results are not consistent with independent force hypothesis. However, they are consistent with the gravitational hypothesis.

Amplitude

The pendulum with the heavier weight (2w) swings with a greater amplitude than the pendulum with the lighter weight (1w). The amplitude ratio 1w/2w is approximately 1:2.5. However, according to independent force hypothesis and the simulation based on these laws, the opposite should be true: the pendulum with the heavier weight (2w) should have a smaller amplitude than the pendulum with the lighter weight (1w). This would be inversely proportional to the swing times, giving a ratio of 2.3:1. According to the gravitational hypothesis and its simulation (see Fig. 7), the amplitude ratio is directly proportional to the ratio of swing times. This is 1:2.3. These results are not consistent with independent force hypothesis. However, they are consistent with the gravitational hypothesis.

Phase

When stimulated by a light bulb (B source), the measurement results show that both pendulum variants (1w and 2w) exhibit the same phase response to the timing of the stimulation (see green circle Fig. 4a). The stimulation is activated when the weight is at its maximum distance from the container, i.e. when its speed is at its minimum. This behaviour differs from the results of numerical simulations. This applies to simulations based on both independent force hypothesis and the gravitational hypothesis. The difference is $\frac{1}{4}$ of a circle, i.e. 90° . The measured results are inconsistent with both independent force hypothesis and the gravitational hypothesis (see Fig. 6,7). So, for all scenarios in which the B source was used, the measurement results were not in agreement with independent force hypothesis. Conversely, for two scenarios, the measurement results roughly correspond to the gravitational hypothesis. There is no hypothesis for the other two scenarios (deflection and phase).

Discussion

This paper deals with the results of experiments and their analysis. The experiments were not motivated by the author's hypothesis, but by an effort to experimentally determine the properties of anomalies that had been observed in previous experiments. Two basic methodologies were used: experimental and analytical. The experimental methodology led to the construction of a measuring device. The goal was to design and construct the measuring device that would allow for a direct comparison of the results of experiments conducted using two different stimulation methods (B source and HW source), where one method is the subject of research and the other is an application of known physical laws. The analytical method aimed to verify the accuracy of the measurements and analytical methods for the known stimulation method (HW source) (see [Torsion pendulum dynamics – independent force hypothesis](#)) and to compare the analytical results with the measurement results of the stimulation method under investigation (B source).

Since the measurement results of the under-investigation stimulation method do not agree with the analytical results verified using the known stimulation method (HW source), an alternative hypothesis inspired by Newton's law of gravity (the independence of gravitational acceleration on the mass of the falling body, i.e., the linear dependence of gravitational force on the mass of the falling body) was also used in the analysis (see [Dynamics of a torsional pendulum – gravitational hypothesis](#)). This hypothesis showed better agreement with the measured results than the original hypothesis, but it did not hold true in all of the analyses performed.

Methods used for analysis

Torsion pendulum dynamics – independent force hypothesis

A simplified equation of motion for a torsion pendulum is

$$\frac{d^2x(t)}{dt^2}m + \frac{x(t)}{dt}k_a + \frac{k_w}{r^2}x(t) = f_{ext}(t) \quad (1)$$

where:

- $x(t)$ is the measured time dependence of the weight's position;
- m is the weight's mass;
- r is the arm's length;
- k_a is the aerodynamic drag coefficient;

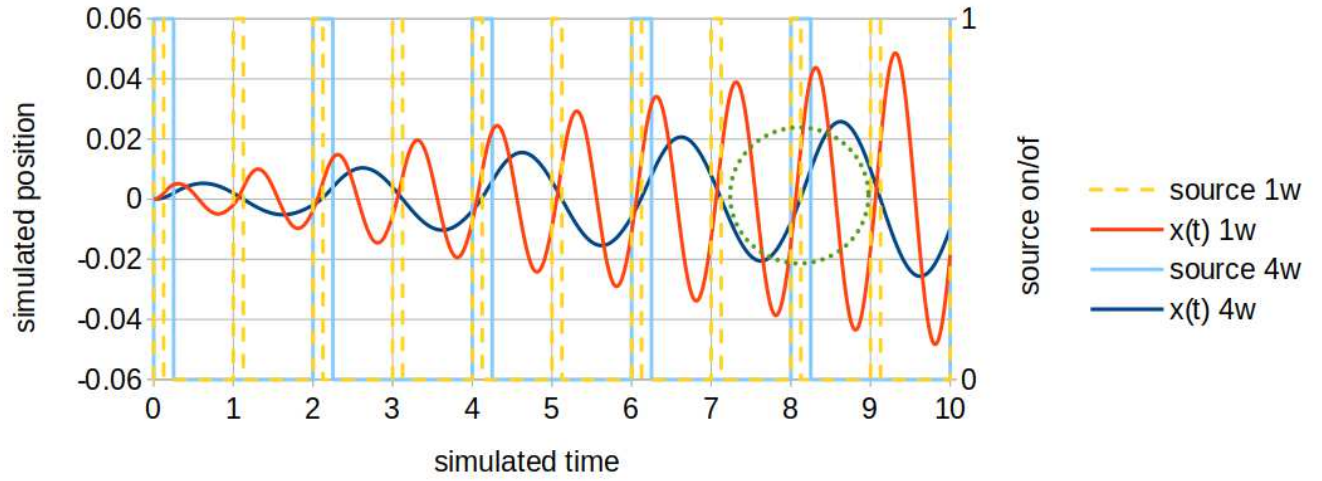


Figure 6. Results of numerical simulation of periodic stimulation for two pendulum variants (1w – basic mass of the weight, 4w – four times the mass of the weight). The external force is independent to the mass of the weight - equation 1.

- k_w is the torsional constant of the pendulum suspension; and
- $f_{ext}(t)$ is the external force acting on the weight. **Force is independent of the mass of the weight.**

This simplified model does not take into account the mass of the pendulum arm and assumes that the weight is a material point (i.e. it does not account for the size of the weight). It assumes small deflections in relation to the length of the pendulum arm and thus neglects the curvature of the weight's trajectory.

Deflection in slow processes

For slow processes, we can neglect air resistance and the inertia of the weight. We obtain $\frac{k_w}{r^2}x(t) = f_{ext}(t)$ i.e. $x(t) = \frac{r^2}{k_w}f_{ext}(t)$. For slow processes, this means that the deflection of the pendulum's arm is directly proportional to the external force acting on it, regardless of the mass of the weight.

Velocity

The equation of motion (equation 1) where $f_{ext}(t)$ is single-unit jump has a known analytical solution $x(t) = \alpha(1 - \cos(\omega t))e^{-\beta t}$ where $\omega = \frac{2\pi}{T}$ where T is the period of natural oscillations of the pendulum. Thus, the maximum velocity is $v_{max} = \alpha\omega = \frac{2\pi\alpha}{T}$. Because the period of oscillation is $T = 2\pi r\sqrt{\frac{m}{k_w}}$ the theoretical ratio of maximum velocities at the same amplitude of external stimulation (force f_{ext}) i.e. the same amplitude α and different mass of the weights is $\frac{v_{max1}}{v_{max2}} = \frac{T_{max2}}{T_{max1}} = \sqrt{\frac{m_2}{m_1}}$, i.e. heavier weights move more slowly than lighter ones. The speed ratio is inversely proportional to the ratio of the swing times.

Amplitude during periodic stimulation

A stimulation pulse of length $T/8$ with constant force f causes acceleration of the weight $a = \frac{f}{m}$. The velocity changes by $\Delta v = a\Delta t = \frac{f}{m}\Delta t$. For the total time T_i , there are N stimulation pulses $N = \frac{T_i}{T}$ the total velocity due to stimulation is $v = Na\frac{T}{8} = N\frac{f}{m}\frac{T}{8} = \frac{T_i}{8}\frac{f}{m}$ therefore the amplitude $\alpha = \frac{v_{max}}{\omega} = \frac{T_i}{8\omega}\frac{f}{m}$. Therefore, the ratio of amplitudes is $\frac{\alpha_1}{\alpha_2} = \frac{\omega_2}{\omega_1}\frac{m_2}{m_1} = \frac{\omega_1}{\omega_2} = \frac{T_2}{T_1}$. The ratio of amplitudes is inversely proportional to the ratio of swing times.

Phase during periodic stimulation

By numerically integrating the equation of motion (equation 1), we can determine how a theoretical torsional pendulum responds to a periodic external force. The simulation was performed for masses of 1 and 4, i.e. a swing time ratio of 1:2 (see Fig. 6).

The phase is independent of the mass of the weights. At the time of stimulation, the weights pass through the rest position (0). This means the weights move at maximum speed (see green circle in Fig.6).

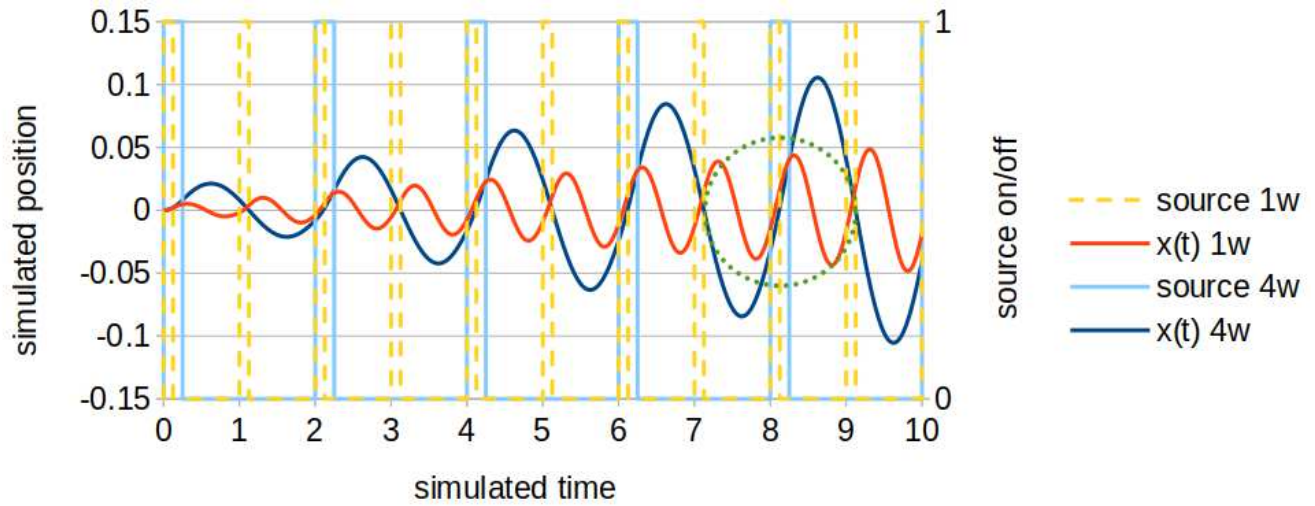


Figure 7. Results of numerical simulation of periodic stimulation for two pendulum variants (1w – basic mass of the weight, 4w – four times the mass of the weight). The external force is proportional to the mass of the weight - equation 2.

Torsion pendulum dynamics – gravitational hypothesis

This analysis is based on the hypothesis that the external force is directly proportional to the mass of the weight like Newton's gravitation⁷, i.e. that the acceleration (g_{ext}) is independent of the mass of the weight. The simplified equation of motion describing a torsion pendulum is as follows:

$$\frac{d^2x(t)}{dt^2}m + \frac{x(t)}{dt}k_a + \frac{k_w}{r^2}x(t) = mg_{ext}(t) \quad (2)$$

where

- $g_{ext}(t)$ is the external acceleration acting on the weight. **Force is directly proportional to the mass of the weight.**

Deflection in slow processes

For slow processes, we can neglect air resistance and the inertia of the weight. We obtain $\frac{k_w}{r^2}x(t) = mg_{ext}(t)$ i.e. $x(t) = \frac{r^2}{k_w}mg_{ext}(t)$. This means that, in slow processes, the deflection of the pendulum arm is directly proportional to the external acceleration acting on it, as well as to the mass of the weight. Therefore, for the same acceleration, the deflection is directly proportional to the mass of the weight. The ratio of deflections is proportional to the ratio of masses.

Velocity

The equation 2 where $g_{ext}(t)$ is single-unit jump has a known analytical solution $x(t) = \alpha(1 - \cos(\omega t)e^{-\beta t})$ where $\omega = \frac{2\pi}{T}$ and where T is the period of the pendulum's natural oscillations $T = 2\pi r \sqrt{\frac{m}{k_w}}$. Thus, the maximum velocity is $v_{max} = \alpha\omega = \frac{2\pi\alpha}{T}$.

For steady state $t \rightarrow \infty$ the following applies $\alpha = mg_{ext} \frac{r^2}{k_w}$ so the amplitude of the deflection α is directly proportional to the mass m for the same $g_{ext}(t)$. Therefore $v_{max} = \sqrt{\frac{m}{k_w}}g_{ext}r$. The ratio of maximum velocities at the same amplitude of external stimulation (acceleration g_{ext}) and different masses is $\frac{v_{max1}}{v_{max2}} = \sqrt{\frac{m_1}{m_2}} = \frac{T_1}{T_2}$, i.e. heavier weights move faster than lighter ones. The ratio of velocities is directly proportional to the ratio of swing times.

Amplitude during periodic stimulation

Stimulation pulse of length $T/8$ with constant acceleration $a = const$ causes a change in velocity $\Delta v = a\Delta t$. The total change in velocity is $v = Na \frac{T}{8} = \frac{T}{8}a$. The amplitude is $\alpha = \frac{v}{\omega} = \frac{T}{8\omega}a$. The amplitude ratio is $\frac{\alpha_1}{\alpha_2} = \frac{\omega_2}{\omega_1} = \frac{T_1}{T_2}$. The ratio of amplitudes is directly proportional to the ratio of swing times.

Phase during periodic stimulation

A numerical simulation using an excitation force proportional to the mass of the pendulum (see Fig. 7) produces the same timing results as an excitation force that is independent of the pendulum's mass (see green circle in Fig.7). However, the amplitude of the oscillations differs.

Distinguishing between B source delay and pendulum phase shift

The time shift of the pendulum's oscillations when stimulated by B source may also be the result of a delay caused by the design of B source. Since we do not yet know the exact physical properties of the interaction that B source exerts on the pendulum, we need to use another method to distinguish the unknown delay of B source from the unknown phase shift of the pendulum's response. We will use Black Box analysis⁸, i.e., we will not deal with the physical possibilities of such a delay occurring. We will only assume that such a delay exists and that it is a property of B source. Furthermore, we will assume that there is a phase shift in the pendulum's response when stimulated by B source and that this is a property of the pendulum. Let us denote t_1 as the moment of the average time of turning on the light bulb and t_2 as the moment of the average time of the theoretical reaction of the pendulum. Experiments with a HV source have verified that t_2 is identical to the average moment of reaction of the pendulum stimulated by high voltage. Let us denote D as the delay caused by the properties of B source between the switching on of the power supply and the beginning of the effect on the weight. Let us assume that this delay is the same for the mean times, i.e. that the delay does not depend on the time of switching on the source. Let us denote α as the angle of difference between the interaction of the pendulum with the force (HV source) and the interaction with the stimulation by B source. From this we get the relationship between times: $t_2 = t_1 + D + \alpha_r T_x$ where α_r is the relative angle (part of the circle), i.e., the angle in degrees/360, T_x is the swing time of the pendulum in question. For two measurements with two different pendulums, we have two equations for two unknowns:

$$t_{2a} = t_{1a} + D + \alpha_r T_a$$

$$t_{2b} = t_{1b} + D + \alpha_r T_b$$

therefore

$$\alpha_r = \frac{t_{2a} - t_{2b} - t_{1a} + t_{1b}}{T_a - T_b} \text{ and } D = t_{2a} - t_{1a} - \alpha_r * T_a$$

Measured (read from the graph) – Fig. 4a:

- 1w - $T_a = 390s, t_{1a} = 46min, t_{2a} = 48min, \Delta t = 2min = 120s$
- 2w - $T_b = 900s, t_{1b} = 46min, t_{2b} = 50min, \Delta t = 4min = 240s$

By substituting, we calculate $\alpha_r = \frac{48min - 50min - 46min + 46min}{390s - 900s} = 84.7deg, D = 48min - 46min - \frac{84.7}{360} * 390s = 28.2s$

The time difference for a pendulum with two weights (2w) is twice that of a pendulum with one weight (1w). The dominant influence on this time shift is the phase shift, which is approximately 90 degrees. The calculated delay D corresponds to a phase of 11.3 degrees for the 2w pendulum, which is more than 7 times smaller than the calculated phase shift. The phase shift is dominant.

Conclusions

- When stimulated by a light bulb (B source, unexpected effect, electromagnetic-gravity effect), the measured results show that the dependence of velocity on mass is the opposite of that observed for high-voltage excitation (HV source) and as predicted by Coulomb's and independent force hypothesis. The measured dependence of velocity (B source) is consistent with the gravitational hypothesis.
- When stimulated by a light bulb (B source), the measured dependence of dynamic amplitude on mass is opposite to that observed with high-voltage excitation (HV source) and as predicted by Coulomb's law and independent force hypothesis. The measured results for dynamic amplitude (B source) are consistent with the gravitational hypothesis.
- When stimulated by a light bulb (B source), the dependence of static deflection on mass shows different results to those of high-voltage excitation (HV source) and according to Coulomb's law and independent force hypothesis. However, the measured results of static deflection (B source) are not consistent with the gravitational hypothesis.
- When periodically stimulated by a light bulb (B source), the timing of the deflection (phase) differs from that observed with high-voltage excitation (HV source) and from that predicted by independent force and gravitational hypothesis. This effect is independent of the mass of the weights. Attempts to formulate a hypothesis and to simulate the measured time behaviour numerically have so far been unsuccessful.

Thus far, it has not been possible to explain the measured results of unexpected effect (provisionally named the electromagnetic-gravity effect) using known physical laws. This raises the question of whether the interaction has the character of a Newtonian force. Only basic experiments have been conducted so far. Many questions remain unanswered. For instance, it has been found that the container's design affects the size of the deflection. The question of material dependence remains unresolved, particularly with regard to the design of the container and the torsion pendulum, especially the weight. Conducting the experiment in a vacuum is also challenging and fraught with difficulties. A major challenge lies in solving the mystery of interaction dynamics (i.e. the different phases), which are inconsistent with Newtonian force dynamics in B source experiments.

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Data availability

The datasets generated and/or analysed during the current study are available in the Zenodo repository: <https://doi.org/10.5281/zenodo.18900397>

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Additional information

Competing interests

The author declares that he have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.