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Prediction of a Global Low-Frequency Space-Time Oscillation (~0.06 Hz)

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ABSTRACT

A low-frequency pulsation of the metric structure of space–time with a characteristic frequency of approximately 0.06 Hz is theoretically examined within a structural–informational framework. This oscillatory mode is considered as a global background feature consistent with experimental data within the proposed framework, which may influence the dynamics of particles and macroscopic objects. The phenomenon is treated as having a gravitational origin and is associated, in the proposed model, with variations in the energy density of space–time. The characteristic frequency emerges from the dynamics of a background space–time lattice, representing a deeper structural level governing gravitational interaction. Potential signatures are explored using data of different pendulums, whose oscillation periods and energetic relations are found to be consistent with excitation by such a global mode within the limits of the model. The approach provides a conceptual structural–informational perspective on inertia, mass, and gravitational dynamics.

Keywords: space–time structure, gravitational background mode, metric pulsation, fundamental pressure, Foucault pendulum, Coriolis force

1. INTRODUCTION

The normal space–time lattice discussed in previous sections forms locally in association with matter and governs electromagnetic interactions within the proposed structural informational framework. However, the large disparity between the intrinsic radius of the electron and the characteristic size of the normal lattice cell suggests that this structure may not represent the most fundamental organizational level of space–time. Instead, it motivates consideration of a deeper, globally distributed background space–time lattice, which is treated here as a theoretical construct potentially present even in regions devoid of matter. A key role in the formation of space–time structure is attributed here to the global dynamics of the Universe, potentially realized through collective harmonic oscillations of the underlying medium. Within this perspective, space–time is treated not as a static background but as a dynamically organized system whose structural properties can evolve in time. Investigations of the structure and dynamics of space–time may therefore provide new insights into fundamental physical interactions, opening perspectives for future theoretical and experimental studies.

DEFINITION OF THE BACKGROUND SPACE-TIME LATTICE

The background space–time lattice is introduced as a universal substrate within the structural-informational model. While the normal lattice structure emerges locally in response to mass–energy (e.g., around particles and celestial bodies), the background lattice is considered as an intrinsic property of the vacuum in this theoretical approach. It provides a conceptual reference for metric and topological properties of empty space, upon which local material structures and gravitational fields are superimposed. Within the model, this background structure is assumed to influence fundamental constants and the propagation of interactions.

Dynamically, this background structure is treated as non-static and capable of supporting low-frequency collective oscillations. These oscillations are consistent with experimental data and quantitative analysis presented in the manuscript and may be regarded as analogous to vacuum fluctuations or long-wavelength metric perturbations. Within the structural–informational framework, such oscillations can be formally quantized. The fundamental unit, or "cell," of this lattice is characterized by an energy–momentum relation introduced by analogy with de Broglie matter waves. The energy E_b of a single background cell is defined as the product of a fundamental universal pressure P_f and the cell volume V_b.

$$E_b = P_f V_b \tag{1}$$

The momentum p_b associated with the oscillation of this cell is then introduced in analogy with relativistic kinematics as:

$$p_b = \frac{E_b}{c} \tag{2}$$

Following the standard de Broglie relation $p = h/\lambda$, where h is Planck's constant and λ is the wavelength, this expression may be formally equated to Equation 2

$$\frac{h}{\lambda} = \frac{E_b}{c} \tag{3}$$

The volume of a background cell V_b is hypothesized to depend on fundamental constants and on the characteristic wavelength λ of its oscillation. A proposed form, motivated by dimensional considerations involving h, G, and c, is:

$$V_b = \lambda \frac{hG}{c^3} \tag{4}$$

Substituting Equation 1 into Equation 3 yields:

$$\lambda = \frac{hc}{P_f V_b} \tag{5}$$

Inserting Equation 5 into Equation 4 leads to the following self-consistency condition:

$$V_b = \left(\frac{hc}{P_f V_b}\right)\frac{hG}{c^3} \tag{6}$$

Solving Equation 6 for V_b gives:

$$V_b = \sqrt{\frac{h^2 G}{P_f c^2}} \tag{7}$$

Equation 7 defines a characteristic cell volume within the model. This quantity is interpreted as a theoretical scale emerging from the assumed relations among h, G, c, and the phenomenological pressure parameter P_f. Within the present framework, this value represents a model-dependent minimal spatial scale rather than an experimentally established invariant.

GEOMETRY AND HARMONIC RATIOS OF THE BACKGROUND LATTICE

Evaluating the background cell volume yields a value on the order of 10^{-59} m^3, corresponding to a characteristic radius of approximately 1.3×10^{-20} m. This scale is smaller than the normal lattice cell radius and is comparable to estimates of the intrinsic electron radius.

Within the model, the ratio between characteristic radii of the background lattice and the electron is found to be numerically close to the golden ratio. This relation is not imposed a priori but arises from the adopted structural assumptions. It is interpreted here as a possible geometric indicator of stability within the proposed lattice framework.

Such harmonic ratios commonly appear in variational systems and are treated here as numerical features of the model rather than as fundamental constants. They suggest that matter configurations embedded in a structured space–time may tend toward geometries that locally extremize stability.

BACKGROUND CELLS AS GRAVITATIONAL OSCILLATORS

The effective mass associated with a background space–time cell is introduced by dividing its energy by c^2:

$$m_b = \frac{P_f V_b}{c^2} \tag{8}$$

Although extremely small, this quantity provides an effective inertial parameter for the background cells within the present model. The gravitational interaction between neighboring cells may then be treated as a restoring mechanism, allowing collective oscillatory behavior to be considered within the background lattice. These oscillations are introduced phenomenologically and are interpreted here as low-frequency metric fluctuations of the structured vacuum, rather than as gravitational waves generated by localized astrophysical sources.

The characteristic wavelength associated with these oscillations is estimated to be on the order of 5×10^9 m. Dividing this wavelength by the speed of light yields a corresponding oscillation period, leading to a model-derived frequency of approximately 0.06 Hz.

FUNDAMENTAL FREQUENCY OF SPACE-TIME PULSATION

Within the framework of the proposed model, the characteristic oscillation frequency of the background lattice may be formally expressed in terms of Planck-scale quantities as:

$$\omega = \frac{P_f l_p}{m_p} \tag{9}$$

where l_p and m_p denote the Planck length and Planck mass, respectively. Substitution of numerical values yields $\omega \approx$

$0.0596\,\mathrm{Hz}$. This value is consistent with the frequency estimated independently from the structural wavelength of the background lattice.

The agreement between these two model-based estimates suggests internal consistency of the proposed framework. Accordingly, the resulting frequency is interpreted as a characteristic scale emerging from the assumed structural parameters of space–time, rather than as a directly observed physical eigenmode.

Such low-frequency oscillations are therefore treated as a global background feature consistent with experimental data within the proposed framework. They are not attributed to localized sources and are introduced here as a theoretical construct intended to explore possible collective dynamics of a structured space–time medium.

CONNECTION TO VACUUM IMPEDANCE AND ELECTROMAGNETIC RESPONSE

Within the proposed framework, possible formal connections may be explored between the characteristic background oscillation and the electromagnetic properties of vacuum. In particular, the electric constant ϵ_0 can be expressed, at the level of dimensional correspondence, in terms of the background frequency, electron mass, and fundamental constants. This relation is introduced as a structural analogy rather than as a direct physical causation.

Accordingly, the vacuum impedance $Z_0 = \sqrt{\mu_0/\epsilon_0}$ may be viewed from two complementary perspectives: as a standard electromagnetic response parameter and, within the model, as potentially reflecting dynamic aspects of the structured vacuum. Small discrepancies between frequencies inferred from electromagnetic and gravitational considerations are interpreted here as internal features of the model rather than as experimentally established effects.

PHYSICAL INTERPRETATION AND IMPLICATIONS

Within the structural–informational approach, the background lattice is introduced as a hypothetical deeper level of space–time organization. The normal lattice associated with matter and electromagnetic phenomena is treated as a localized manifestation of this background. In this conceptual picture, mass, charge, inertia, and gravitation are regarded as different phenomenological expressions of how energy interacts with the underlying structured space–time.

The characteristic frequency near 0.06 Hz obtained in the model suggests the possibility of large-scale modulation effects, discussed here as a theoretical consequence that can be explored experimentally.

CRITERIA FOR DETECTING BACKGROUND SPACE–TIME OSCILLATIONS

As possible phenomenological indicators of background space–time oscillations, correlations with biological and geophysical rhythms are briefly considered. Cardiological studies reported by Rekhtina et al. (2010) indicate that frequencies in this range appear in neurogenic and myogenic regulation, while medical studies by Li et al. (2010) identify the $\sim 0.06\,\mathrm{Hz}$ band as an upper limit of normal neurogenic rhythmic activity. These observations are interpreted here as suggestive correlations rather than as direct evidence of gravitational or space–time effects.

From the standpoint of classical mechanics, the Foucault pendulum provides a well-characterized macroscopic system for examining rotational dynamics. First demonstrated in 1851 at the Pantheon in Paris, it offers a non-astronomical demonstration of Earth's rotation. The pendulum consists of a massive bob suspended by a long cable and oscillating in a vertical plane. While Earth rotates, the oscillation plane remains approximately fixed relative to inertial space, producing an apparent precession.

For the Paris pendulum, the oscillation period is approximately $16.4\,\mathrm{s}$, corresponding to a frequency near $0.06\,\mathrm{Hz}$. The period is given by Newton's formula $T = 2\pi\sqrt{l/g}$, where l is the suspension length and g is the local gravitational acceleration ($g = 9.809\,\mathrm{m/s^2}$, $l = 67\,\mathrm{m}$). Since this frequency depends on l, the numerical proximity to the model-derived background frequency may initially appear coincidental.

Within the present framework, the Foucault pendulum is considered as a possible sensitive probe of large-scale geometric effects in space–time. Long-term observations of its precession may therefore provide phenomenological insight into rotational dynamics and effective Coriolis geometry. In this context, analogies based on Bohr's correspondence principle are employed to illustrate potential continuity between microscopic and macroscopic dynamical descriptions.

In the structural informational model, the motion of physical objects is analyzed in relation to the underlying space–time structure. For the Foucault pendulum, the known trajectory of the bob allows an estimate of the number of normal space–time lattice cells participating in its motion, formally written as $N = \lambda m v/h$. Assuming each cell contributes an energy scale $h\omega$, the total associated energy may be written as:

$$E = \frac{\lambda m v}{h} h\omega = \lambda m v \omega \tag{10}$$

This expression leads to an effective force term proportional to $m v \omega$, which may be compared with the Coriolis contribution in rotating systems. Within the present model, the Coriolis force is interpreted as arising from the geometry of space–time in non-inertial frames. While classical mechanics treats the Coriolis force as performing no work, here it is introduced phenomenologically as part of an effective energy balance within the proposed structural framework. The potential influence of background oscillations on pendulum dynamics is evaluated mathematically via the Lagrangian formalism and treated as a regular physical mechanism within the model.

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Location of pendulum	Description (l is lenght, Tp is period, m is mass)
1 Paris	l = 66.72: Tp = 16.4: m = 28: Latitude = 48.52
2 Saint Petersburg	l = 93: Tp = 19.8: m = 54: Latitude = 59.94
3 Chicago	l = 20: Tp = 8.98: m = 300: Latitude = 41.88
4 Boulder	l = 39.3: Tp = 12.6: m = 166: Latitude = 40.02
5 Los Angeles	l = 12.2: Tp = 7.01: m = 108.8: Latitude = 34.05
6 Mexico *	l = 28: Tp = 9.3: m = 280: Latitude = 19.43
7 Ottawa	l = 16.764: Tp = 8: m = 104.78: Latitude = 45.42
8 Grenoble	l = 15.08: Tp = 7.8: m = 25: Latitude = 45.07
9 New York *	l = 22.9: Tp = 8.5: m = 91: Latitude = 40.71
10 Oregon (r)	l = 27: Tp = 10.4: m = 408: Latitude = 44.94
11 Glasgow (w) *	l = 4.359: Tp = 4.187: m = 2.525: Latitude = 55.86
12 Edmonton	l = 23.4: Tp = 9.7: m = 29.7: Latitude = 53.55
13 San Francisco (i)	l = 9.14: Tp = 6.1: m = 106.6: Latitude = 37.46
14 Alaska	l = 15.8: Tp = 7.9: m = 108.8: Latitude = 61.22
15 Arizona (z)	l = 21.5: Tp = 9.3: m = 108: Latitude = 33.45
16 Iowa (y)	l = 12: Tp = 7: m = 107: Latitude = 41.59
17 Mineola (x)	l = 9: Tp = 6: m = 90: Latitude = 32.67
18 Pitsburg (d) *	l = 7.3: Tp = 5.4: m = 8.2: Latitude = 40.44
19 Phyladelphia (f)	l = 27: Tp = 10: m = 80: Latitude = 39.95
20 Kyiv	l = 22.061: Tp = 9.4: m = 43: Latitude = 50.45
21 Murmansk (q)	l = 21: Tp = 9.19: m = 30: Latitude = 68.97

Figure 1. Input parameters for Foucault pendulums and the results of computational modeling of their oscillation periods (TP).

Table 1. Theoretical calculations of geometric and energetic parameters of Foucault pendulums. Here, A is the oscillation amplitude, Δh is the vertical rise of the bob. T_x is the fictitious oscillation period, and T_x/T characterizes the deviation from the classical period, $r_\emptyset$ is the calculated section radius of the bob, E_p and E_c are the potential and kinetic energy of the bob, respectively. The quantity W_S represents the generalized work associated with the space–time background and encoded via the Coriolis term. Energies and work are expressed in joules, $L(A)$ is the Lagrangian taken as $E_p - W_S$. Saint Pet. *) — Saint Petersburg (The negative value of $L(A)$ corresponds to the phase reversal of the Coriolis work relative to the potential energy.), Los Ang. — Los Angeles, **San Franc. — San Francisco, Phyladelp. — Philadelphia.**

Location	A (m)	Δh (m)	T_x (s)	T_x/T	$r_\emptyset$ (m)	E_p	E_c	W_S	$L(A)$
Paris	2.715	0.055	14.75	0.899	0.08	15.186	7.5928	13.35	1.836
Saint Pet. *)	3.245	0.057	17.42	0.88	0.107	29.993	14.996	31.131	-1.14
Chicago	2.818	0.199	8.057	0.897	0.185	587.1	293.55	281.94	305.2
Boulder	2.837	0.103	11.32	0.898	0.152	166.95	83.474	112.59	54.36
Los Ang.	3.093	0.398	6.257	0.897	0.132	425.23	212.61	158.58	266.6
Mexico	1.004	0.018	9.556	0.999	0.181	49.477	24.734	28.174	21.303
Ottawa	2.112	0.134	7.382	0.923	0.13	137.24	68.621	60.369	76.87
Grenoble	3.021	0.306	6.978	0.895	0.089	74.953	37.476	31.173	43.78
New York	1.008	0.022	8.641	0.999	0.15	19.792	9.8958	10.193	9.599
Oregon	2.661	0.131	9.374	0.901	0.205	526.14	263.07	293.94	232.2
Glasgow	1.101	0.141	3.74	0.99	0.042	3.4972	1.7486	0.7796	2.717
Edmonton	2.846	0.174	8.721	0.899	0.094	50.595	25.298	26.298	24.29
San Franc.	3.315	0.622	5.367	0.88	0.131	650.87	325.44	208.19	442.7
Alaska	2.576	0.211	7.155	0.906	0.132	225.68	112.84	96.242	129.5
Arizona	2.649	0.164	8.359	0.899	0.132	173.55	86.773	86.457	87.09
Iowa	3.365	0.482	6.194	0.885	0.13	505.37	252.68	186.55	318.8
Mineola	3.061	0.536	5.337	0.89	0.124	473.55	236.77	150.64	322.9
Pittsburgh	1.044	0.075	4.868	0.995	0.063	6.035	3.0175	1.7508	4.284
Philadelp.	1.809	0.061	9.38	0.938	0.119	47.6138	23.807	26.618	20.99
Kyiv	2.648	0.159	8.468	0.901	0.106	67.246	33.623	33.94	33.31
Murmansk	2.902	0.202	8.257	0.899	0.096	59.293	29.646	29.18	30.11

A quantitative assessment of the effective Coriolis contribution requires an estimate of the intrinsic oscillation amplitude of the pendulum.

In practice, such values are not directly available and cannot be uniquely defined, since large-amplitude oscillations of real pendulums are externally initiated and decay in the absence of sustained excitation. Empirically, the lateral displacement amplitude of typical Foucault pendulums ranges from approximately one to three meters.

A theoretical estimate of the amplitude can be obtained from a simplified energy-balance consideration. At the center of its swing, the bob has minimal potential energy. When displaced, it rises to a height determined by $\Delta h = l - \sqrt{l^2 - A^2}$, where A is the horizontal displacement from the vertical and l is the suspension length. The average horizontal velocity may be approximated as the ratio of four times the amplitude to the oscillation period, $v = 4A/T$.

Alternatively, this velocity can be expressed in terms of the kinetic energy of the bob as $v = \sqrt{2E_k/m}$. Since the kinetic energy arises from the change in gravitational potential energy, the average velocity may also be written as $v = \sqrt{g\Delta h}$.
Equating these expressions for the velocity and substituting Δh yields a transcendental equation for the oscillation amplitude:

$$A = \frac{T}{4}\sqrt{g\left(l - \sqrt{l^2 - A^2}\right)} \tag{11}$$

where A is the oscillation amplitude of the Foucault pendulum, T is the oscillation period, g is the gravitational acceleration, and l is the suspension length.
From Eq 11, a practical expression for estimating the amplitude may be obtained by introducing an auxiliary (fictitious) oscillation period. This allows the amplitude to be determined iteratively, with convergence achieved through optimization of the auxiliary period:

$$A = \sqrt{\frac{32lgT_x^2 - g^2T_x^4}{16}} = \frac{\sqrt{gT_x^2(32l - gT_x^2)}}{4} \tag{12}$$

where T_x denotes the auxiliary oscillation period.
The auxiliary period T_x is always smaller than the physical period T and depends on the actual amplitude of the pendulum. It may be estimated from:

$$T_x = 4\sqrt{\frac{l}{g}} + \sqrt{\frac{\sqrt{l^2 - A^2}}{g}} \tag{13}$$

This relation shows that the auxiliary period differs from the classical pendulum period $T_p = 2\pi\sqrt{l/g}$ through a pronounced amplitude dependence. Within the present framework, this procedure enables a model-based estimation of oscillation amplitudes for Foucault pendulums located at different latitudes, providing a phenomenological basis for exploring possible large-scale geometric influences on their dynamics.

Table 2. Approximate spatial-temporal geometric parameters of the pendulum (All values are order-of-magnitude estimates based on geometric and kinematic parameters of the experimental setup. Typical relative uncertainties of individual quantities do not exceed 5–10%.): N is the large quantum number, $\mathfrak{R}$ is the effective space-time number, A is the amplitude of pendulum oscillations, v is the average velocity of the pendulum bob relative to the ground, Rl is the radius of the trajectory of the free pendulum (Rl=v/2Ωsinφ), RC is the radius of the Coriolis force.

Location	N (pcs/cbm)	R (pcs/cbm)	A (m)	v (m/s)	R_l (m)	R_C (m)	E_p/W_S
Paris	1.583×10^{51}	3.327×10^{35}	2.734	0.7306	6687	5972	1.138
Chicago	1.904×10^{52}	6.815×10^{36}	2.753	1.366	14036	13458	2.082
Boulder	1.094×10^{52}	2.585×10^{36}	2.702	0.955	10181	11457	1.482
Los Ang.	8.232×10^{51}	3.512×10^{36}	2.894	1.847	22623	11423	2.677
Mexico	3.566×10^{52}	5.235×10^{36}	2.720	1.138	23468	26393	1.756
Ottawa	6.232×10^{51}	2.663×10^{36}	2.785	1.512	14553	8875	2.276
Grenoble	1.496×10^{51}	6.833×10^{35}	2.812	1.610	15597	4559	2.402
New York	5.911×10^{51}	1.905×10^{36}	2.735	1.268	13329	6342	1.944
Oregon	2.447×10^{52}	7.782×10^{36}	2.721	1.161	11271	14057	1.790
Edmonton	1.564×10^{51}	6.149×10^{51}	2.734	1.254	10692	4273	1.924
San Francisco	7.425×10^{51}	4.769×10^{36}	3.157	2.348	26467	10445	3.119
Alaska	5.259×10^{51}	2.881×10^{36}	2.799	1.567	12258	7286	2.347
Philadelphia	5.278×10^{51}	1.526×10^{36}	2.721	1.161	12396	8998	1.789
Murmansk	1.362×10^{51}	6.626×10^{35}	2.747	1.332	9783	3530	2.033

These results suggest that, within the present framework, the Coriolis contribution may be treated as an effective term in the energy balance when a system is considered in the presence of a hypothetical global background mode. This interpretation emphasizes its geometric origin in rotating frames rather than implying literal mechanical work.
The input parameters used in the calculations for the pendulums (Fig.1) were obtained from various public sources and may not fully coincide with official technical specifications. This constitutes an important limitation, since Foucault pendulums, as precision instruments, require either direct measurements or verified data for their oscillation amplitudes.
Nevertheless, the results in Tab 2 indicate that for the majority of pendulums considered, the ratio of the calculated oscillation period to the listed period (T_x/T) is approximately 0.9. For several pendulums (Mexico, New York, Glasgow, and Pittsburgh), this ratio approaches unity, indicating internal consistency of Eq 11 within the adopted modeling assumptions. In more than half of the cases, the effective Coriolis-associated term becomes comparable in magnitude to the kinetic energy. An anomalous case is the Foucault pendulum in Saint Isaac's Cathedral (Saint Petersburg), where the model yields an effective contribution exceeding the gravitational potential energy of the bob.
Within the limitations of available data, these results are interpreted as model-dependent indications that a characteristic frequency near 0.06 Hz may provide a useful scale for describing large-scale geometric influences on pendulum dynamics. No direct experimental detection is implied at this stage.

In classical mechanics (Landau, Lifshitz, 1976), the energy of the pendulum is defined through the Lagrangian as the difference between potential and kinetic energies, $L = E_p - E_c$, for natural systems (Aizerman, 1980). However, more general systems allow the Lagrangian to be an arbitrary function of coordinates, velocities, and time. In the present structural–informational framework, an effective Lagrangian is introduced in which the potential energy of the pendulum is supplemented by a phenomenological Coriolis-related term, written formally as $L = E_p - W_s$.

Depending on latitude and modeling parameters, this effective Lagrangian may take positive or negative values. This behavior reflects the chosen energy functional rather than a physical instability. The variation of the Coriolis-associated contribution with geographic latitude is particularly pronounced for the Saint Petersburg pendulum within the model. Such sensitivity suggests that Foucault pendulums may serve as potential probes of large-scale geometric effects in rotating frames, although this interpretation remains exploratory.

The behavior of the Foucault pendulum in a rotating reference frame may therefore be described using an effective Lagrangian that includes gravitational potential energy together with a phenomenological Coriolis-related contribution. For a pendulum of amplitude A, bob mass m, suspension length l, and gravitational acceleration g, the Lagrangian is written in approximate form as:

$$L(A) = mg\left(l - \sqrt{l^2 - A^2}\right) - W_{\text{Coriolis}}(\omega) \tag{14}$$

where the first term represents the gravitational potential energy at maximum displacement, and W_{Coriolis} denotes an effective model-dependent contribution associated with rotational geometry. In this formulation, kinetic energy enters implicitly through the amplitude and period of motion. The Coriolis-related term is introduced phenomenologically as an external perturbation within the structural framework, and the resulting Lagrangian is treated as an effective energy functional depending on pendulum geometry and assumed background parameters. The physical trajectory is then obtained from the principle of least action. The action over one oscillation period T is approximated by:

$$S = \int_0^T L\, dt \approx L_{\text{avg}} T \tag{15}$$

with the stable amplitude A determined from $\partial S/\partial A = 0$. This procedure yields an energetically optimal configuration within the model that fixes the amplitude, precession rate, and effective Coriolis contribution.

For the Paris pendulum at the instant of maximum kinetic energy (approximately 15 J), and adopting $v \approx 0.732\,\text{m/s}$ at latitude $\phi = 48.86°\text{N}$ with Earth's rotation rate $\Omega = 7.292 \times 10^{-5}\,\text{rad/s}$, the Coriolis parameter is $f = 2\Omega\sin\phi$, giving a characteristic radius $R = v/f \approx 9.4\,\text{km}$. In the rotating frame, the bob therefore follows an approximately circular local trajectory of this radius, while in an inertial heliocentric frame it continues Earth's orbital motion. This coexistence of local rotational curvature and global inertial motion illustrates the geometric nature of non-inertial dynamics in structured space–time.

As a formal consistency check, the bob may be associated with a large quantum number N, interpreted here as a model-dependent count of background space–time cells participating in its motion over a precession period. This quantity is estimated (via Eq 2) by the ratio of the product of the bob mass m, Earth's orbital speed $v_\oplus$, and orbital path length $L_\oplus$ to Planck's constant h, yielding $N = mv_\oplus L_\oplus/h$. Multiplication by the normal cell volume V_n gives a total activated volume $V_{\text{tot}} = NV_n \approx 1.1 \times 10^3\,\text{m}^3$.

For a Paris-type pendulum bob of radius $r_B \approx 0.08\,\text{m}$, the cross-sectional area is $A_B = \pi r_B^2 \approx 0.02\,\text{m}^2$. The effective path length associated with the local Coriolis motion is then estimated as $l = V_{\text{tot}}/A_B \approx 5.5 \times 10^4\,\text{m}$. This value is close to the circumference of the Coriolis circle $2\pi R_l$ (for $R_l \approx 9.4\,\text{km}$), giving approximately $5.9 \times 10^4\,\text{m}$, which represents reasonable agreement given the approximations involved.

This correspondence is interpreted as internal consistency of the structural informational description, indicating that the macroscopic local trajectory inferred from Coriolis geometry can be reproduced, within the model, from the discrete cell count and the bob cross-section. This agreement is treated as phenomenological rather than as direct physical proof of discretization.

Another consistency estimate may be obtained by considering the maximum vertical displacement h of the bob, determined by the suspension length and oscillation amplitude. For a bob of mass m, the potential energy at maximum displacement is $U = mgh$. This energy is converted into kinetic energy as the pendulum passes through equilibrium, yielding a mean velocity estimate $v = \sqrt{2U/m}$. Dividing this velocity by the oscillation period T provides an effective path length per cycle, equivalent to four oscillation amplitudes according to Eq. 11.

A formal estimate of the number of participating space–time cells may then be written using a de Broglie-type relation $N = mvl/h$, where $l = vT$.

Within this framework, an effective Coriolis-associated energy scale may be introduced phenomenologically as $W_{\text{Coriolis}} \sim h\omega N$, where $\omega \approx 0.06\,\text{Hz}$ is the characteristic frequency emerging from the model. Using available pendulum parameters, this quantity is found to be of the same order of magnitude as the kinetic energy for several cases listed in Tab 2. Deviations in other cases are attributed to uncertainties in input data and to the effective Lagrangian structure discussed earlier. These results are interpreted as model-dependent consistency checks rather than as experimental confirmation.

Accordingly, the Foucault pendulum is viewed here primarily as a sensitive macroscopic system for exploring rotational geometry in space–time within the adopted framework, rather than as direct evidence for discrete space–time or background gravitational waves.

The Coriolis effect becomes most apparent when evaluated over the full precession period of the oscillation plane. The precession period is given by $T_{\text{prec}} = 2\pi/(2\Omega\sin\phi)$, where Ω is Earth's angular velocity and ϕ is geographic latitude. Defining an effective power scale $p = W_{\text{Coriolis}}/T$, the total associated energy over one precession cycle is:

$$E_C = pT_{\text{prec}} = 4\pi m v^2 \qquad (16)$$

When compared with the kinetic energy, one finds $E_C \sim K$ within the accuracy of the model. This correspondence is interpreted geometrically, reflecting the structure of rotating reference frames rather than implying mechanical energy transfer. The Foucault pendulum also provides a useful macroscopic analogy for certain quantum phenomena. As shown by Linck (2013), the Lagrangian formulation of the pendulum reproduces several features analogous to electron dynamics, including precession and frequency splitting.

In this interpretation, the two directions of oscillation-plane precession correspond formally to spin-like states, illustrating Bohr's correspondence principle and the continuity between classical and quantum descriptions.

The dynamics of the Foucault pendulum may be written in variational form using the standard Lagrangian.

$$L(\theta, \dot{\theta}) = \frac{1}{2} m l^2 \dot{\theta}^2 - mgl(1 - \cos\theta) \qquad (17)$$

where θ is the angular displacement and $\dot{\theta}$ its time derivative. In a rotating reference frame, an additional Coriolis term appears:

$$L_{\text{cor}} = 2m(\vec{\Omega} \times \vec{r}) \cdot \vec{v} \qquad (18)$$

This term does not alter the instantaneous mechanical energy but produces a geometric phase manifested as precession of the oscillation plane. Thus, the Coriolis contribution is understood as a geometric effect associated with rotation, consistent with classical mechanics, and is incorporated here only as part of the effective structural description.

STRUCTURAL CORRESPONDENCE BETWEEN THE LAGRANGIANS OF THE FOUCAULT PENDULUM AND THE HYDROGEN ELECTRON

The Coriolis term produces a geometric phase interpreted as precession of the oscillation plane (Fig. 2). In both systems, dynamics follows from the principle of least action and is described by the difference between kinetic and potential energy, $L = T - V$. For the pendulum, the gravitational potential $V = mgl(1 - cos\theta)$ defines the equilibrium configuration, while for the electron the Coulomb potential $V_C = -ke^2/r$ establishes the bound orbital state. Each system possesses an additional geometric correction: the Coriolis Lagrangian term $L_{cor} = 2m(\Omega \times r) \cdot v$ produces precession of the oscillation plane, whereas in the atomic case spin–orbit coupling and Thomas precession generate precession of the orbital angular momentum. Thus, the Foucault pendulum and the electron represent formally isomorphic dynamical systems, where precession behavior emerges from a geometric phase determined by the structure of space-time.

The electron in the hydrogen atom may be described by an analogous Lagrangian:

$$L_e = \frac{1}{2} m_e r^2 \dot{\phi}^2 - \frac{ke^2}{r} \qquad (19)$$

where the Coulomb potential serves as a formal analogue of the gravitational potential in the pendulum system. In the atomic case, additional geometric corrections arise through spin–orbit coupling and Thomas precession. These effects may be viewed formally as geometric contributions to the electron's motion, and are introduced here only as mathematical analogues to the Coriolis-induced precession observed in the macroscopic pendulum.

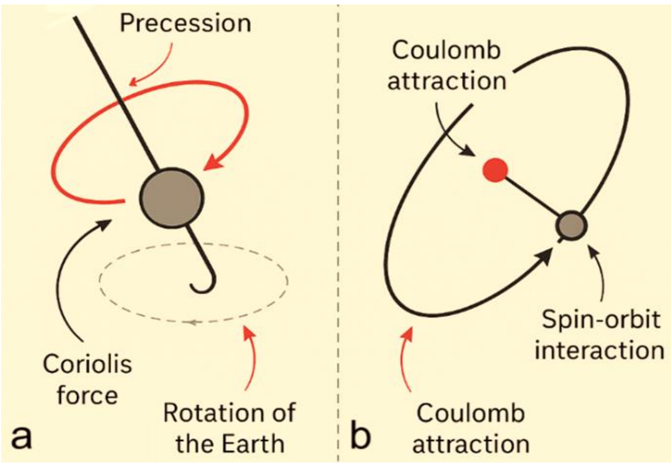

Figure 2: Structural correspondence between the Lagrangians of the Foucault pendulum and the hydrogen electron.

Spin–orbit coupling and Thomas precession therefore provide a useful conceptual parallel, illustrating how geometric structure influences dynamical behavior across microscopic and macroscopic systems, without implying physical equivalence between the underlying mechanisms. In this representation, spin–orbit coupling and precession behavior appear as geometric corrections to the equations of motion, analogous to the Coriolis effect in rotating frames. These corrections do not introduce new forces but modify the phase-space geometry, leading to closed, shifted trajectories and precession without net work being performed (Fig. 3)

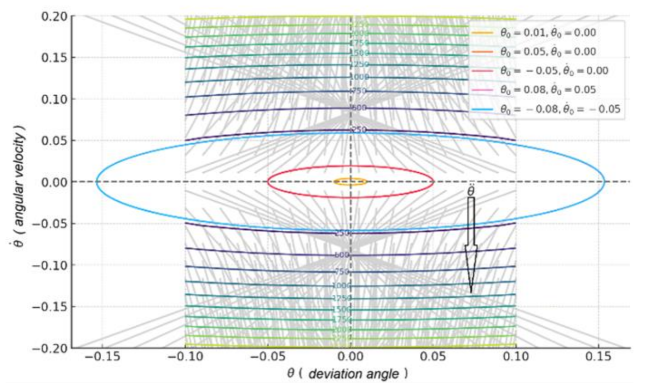

Figure 3: *Phase-space trajectories and total energy levels of the Foucault pendulum.* The axes represent the angular displacement θ and angular velocity $\dot{\theta}$. The grey vector field illustrates the local gradient of the Lagrangian and indicates the instantaneous direction of angular acceleration. The contour lines correspond to the total energy $E = T + V$, defining the dynamical boundaries of motion. The colored trajectories show experimentally accessible oscillation

regimes: yellow small amplitude (θ≈0.01rad), red intermediate (θ≈0.05rad), and blue large amplitude (θ≈0.08 rad, $\dot{\theta}$.≈−0.05 rad/s).

Although the physical motion is sinusoidal, its representation in phase space forms closed orbits, reflecting the conservation of action. The stable orbital structure of the phase portrait is an explicit manifestation of the geometric phase responsible for Foucault precession. Accordingly, the following formal analogies may be drawn:

- the gravitational potential $mgl(1-\cos\theta)$ serves as a formal analogue of the Coulomb potential $-ke^2/r$,
- pendulum precession provides a macroscopic analogue of orbital angular momentum precession,
- Earth's rotational frame plays a role mathematically analogous to geometric contributions such as spin–orbit interaction.

In this sense, the Foucault pendulum may be viewed as a classical analogue of a bound quantum system, illustrating Bohr's correspondence principle: large-scale classical motion can reproduce qualitative features of quantum dynamics when described variationally. Within this analogy, the pendulum may be associated with a large effective quantum number, introduced here purely as a modeling parameter. Just as orbital quantum numbers characterize electronic states, this large parameter reflects the geometric stability of the pendulum's oscillation plane.

The plane in which the pendulum is initially released remains approximately fixed in the inertial frame, producing the observed Foucault effect. Classical mechanics accounts for this behavior through Newton's first law and rotational kinematics. In the rotating Earth frame, the Coriolis force appears as an inertial term, while in the inertial frame the conservation of direction follows from standard dynamical principles.

Within the structural–informational framework, the pendulum motion is described phenomenologically in relation to large-scale geometric features of space–time. Its effective trajectory may be characterized by a large dimensionless parameter encoding rotational geometry. The equation of motion in the rotating frame is written as:

$$m\ddot{\vec{r}} = m\vec{g} + m\vec{v}^2 + \vec{F}_c \tag{20}$$

where $\vec{F}_c = 2m(\vec{\Omega} \times \vec{v})$ denotes the Coriolis force. Gravity and tension balance in the vertical direction, leaving the Coriolis term as the dominant horizontal contribution, producing precession of the oscillation plane at rate $\Omega\sin\phi$. Although this force performs no instantaneous mechanical work, its cumulative effect appears as a geometric phase, analogous to Berry-phase phenomena in quantum systems and to ponderomotive effects in oscillatory fields.

Thus, the Foucault pendulum provides a macroscopic illustration of how geometric structure influences dynamics, offering a correspondence-based analogy to electron motion in atomic systems.

The present results indicate that the Coriolis effect is the principal geometric mechanism responsible for pendulum precession. Depending on latitude and modeling parameters, the effective Lagrangian may reach extrema corresponding to stable oscillatory configurations (Tab. 2). Variations in amplitude are interpreted here within the adopted effective-energy framework and are not attributed to physical energy transfer from space–time.

The Coriolis force is independent of the material properties of the bob and is treated in classical mechanics as an inertial effect arising from rotation.

The interaction between pendulum motion and rotational geometry may be parameterized by a large quantum number N, written formally as (Eq. 34):

$$2\pi^2 r_\theta^2 R\, sin\phi \cdot N \cdot \left(\frac{mv\lambda}{\hbar}\right) \tag{21}$$

where r_θ is the effective cross-sectional radius of the bob (Tab. 2), $R\sin\phi$ represents the radius of the circular trajectory traced during one precession cycle, ϕ is latitude, m is bob mass, v is Earth's orbital velocity, and λ is Earth's orbital path length.

In this formal expression, the left-hand side characterizes the geometric configuration, while the right-hand side represents the dynamical state of the pendulum. Their relationship is introduced as a model-dependent consistency condition.

$$\frac{mv\lambda}{2\pi^2 r_\theta^2 \hbar R\sin\phi} = 1 \tag{22}$$

which serves as a scaling relation within the structural framework rather than as a fundamental physical law. The behavior of the pendulum within this formal equality may be interpreted phenomenologically as follows. In its resting state, the pendulum is in equilibrium within Earth's reference frame and moves together with the planet along its orbital trajectory. When an impulse is applied, the bob begins to oscillate with corresponding kinetic energy, tracing a toroidal region in space characterized by a cross-sectional area and a trajectory length $2\pi R$. For the Paris pendulum, the effective volume swept by the bob within the normal space–time structure may be written as $V = 2\pi^2 r_\theta^2 R\sin\phi$. Multiplying this volume by the number density of background cells yields a large dimensionless parameter associated with the pendulum motion.

The path traversed by the bob during one full precession cycle is denoted by R_l. Within the present framework, the pendulum motion is described as sampling a subset of background degrees of freedom along this path. The associated quantities are introduced as formal bookkeeping parameters rather than as literal microscopic processes. The large quantum number is linked to Earth's orbital motion and may be expressed as

$$N = \frac{mv_E\lambda}{\hbar\sin\phi} \tag{23}$$

where m is the bob mass, v_E is Earth's orbital velocity, λ is the orbital path length, and ϕ is latitude. This expression follows from Eq. 2 with inclusion of the geometric latitude factor. Within the structural framework, this parameter serves as a scaling quantity characterizing rotational geometry and pendulum dynamics; no direct physical identification with inertia or mass generation is implied.

The product of this large parameter with the volume of a normal space–time cell defines an effective toroidal volume $\Sigma V_n = NV_n$. Dividing by the bob cross-sectional area yields an effective circumference $l = \Sigma V_n/(\pi r_\theta^2)$ and corresponding radius $R_C = l/(2\pi)$. This radius is comparable to the characteristic curvature radius obtained from Coriolis kinematics, $R_l = v_{\text{aver}}/(2\Omega\sin\phi)$. The close correspondence of these quantities for most pendulums (Tab. 3) is interpreted as internal consistency of the model. An auxiliary parameter $\mathfrak{R}$ may be introduced to characterize the effective number of background cells sampled during one oscillation cycle.

$$\mathfrak{R} = \frac{16A^2m}{\hbar T} \tag{24}$$

This quantity is employed as a phenomenological measure within the adopted framework. An associated effective energy scale may be written formally as $W_s = \mathfrak{R}\hbar\omega$, where ω denotes the characteristic background frequency introduced earlier. This expression is used only for comparative modeling purposes.

Accordingly, the ratios reported in Tab. 3 are interpreted as relative scaling measures rather than as efficiencies of physical energy transfer. Differences among installations primarily reflect geometric factors and uncertainties in experimental parameters.

Within this perspective, the Coriolis force acting on a Foucault pendulum depends on rotational geometry and latitude. The large quantum number introduced above functions as a convenient descriptor of this geometry. Inertia is treated here in its standard classical sense, while the structural quantities introduced serve only as effective parameters within the model. Within the amplitude approximation, the pendulum dynamics may be summarized by the effective Lagrangian.

$$L(A) = mg\left(l - \sqrt{l^2 - A^2}\right) - \frac{16A^2m\omega}{T_f} \tag{25}$$

where A is the linear amplitude, l the pendulum length, g the gravitational acceleration, ω the characteristic background frequency, and T_f an associated effective timescale. This expression represents an approximate phenomenological energy functional used to explore possible geometric influences on pendulum motion.

The first term represents the gravitational contribution, while the second term is introduced as an effective, time-averaged contribution associated with rotational geometry, scaling quadratically with amplitude. This term, $16A^2m\omega/T_f$, corresponds formally to the previously defined effective quantity $W_s = \mathfrak{R}\hbar\omega$.

These two contributions originate from different components of the model: the first depends on the pendulum's mechanical parameters, whereas the second represents a phenomenological geometric term associated with rotation. According to Eq. 25, the stationary amplitude follows from the extremum condition $dL/dA = 0$, yielding:

$$\frac{mgA^*}{\sqrt{l^2 - A^{*2}}} - \frac{32A^*m\omega}{T_f} = 0 \tag{26}$$

For a nontrivial solution $A^* \neq 0$ one obtains:

$$\frac{g}{\sqrt{l^2 - A^{*2}}} = \frac{32\omega}{T_f}, \quad \sqrt{l^2 - A^{*2}} = \frac{gT_f}{32\omega} \tag{27}$$

and therefore

$$A^{*2} = l^2 - \left(\frac{gT_f}{32\omega}\right)^2 \tag{28}$$

A nonzero stationary amplitude exists only if

$$l \geq \frac{gT_f}{32\omega} \tag{29}$$

Within the present framework, this condition represents a balance among gravity, pendulum geometry, and the effective rotational term introduced in the model. The Lagrangian acts here as a variational tool connecting mechanical parameters with geometric contributions arising in a rotating frame. In the structural–informational approach, the Lagrangian implies that a pendulum with given mass, length, and initial impulse follows a trajectory that extremizes the effective action. This is reflected in the dependence of the oscillation amplitude on system geometry and on the model parameters introduced above. Accordingly, the performance of the Paris Foucault pendulum is attributed primarily to its mechanical design and low dissipation, with additional geometric effects entering only through the variational formulation. The characteristic frequency ω is introduced phenomenologically through the relation:

$$\omega = \frac{W_s}{\mathfrak{R}\hbar} \tag{30}$$

which serves as a consistency condition within the adopted model rather than as a direct physical measurement.

Overall, modeling of Foucault pendulums within this framework:

1. suggests the possible presence of a characteristic low-frequency scale in rotational dynamics;
2. supports the internal consistency of describing space–time using effective structural parameters;
3. illustrates how geometric effects may be incorporated into variational descriptions of macroscopic motion.

Accordingly, the Paris Foucault pendulum is treated here as a mechanically optimized classical system whose behavior reflects Earth's rotation and rotational geometry. Its length, mass, and period represent a practical balance between mechanical feasibility and sensitivity to non-inertial effects.

Direct detection of hypothetical low-frequency gravitational backgrounds would require interferometric instruments operating near 0.06 Hz. Such frequencies lie within the planned sensitivity range of the LISA space interferometer (European Space Agency, 2024), which is designed to detect gravitational waves in the 10^{-4}–10^{-1} Hz band using three spacecraft separated by millions of kilometers. This capability offers a future experimental avenue for exploring low-frequency gravitational phenomena.

EXPERIMENTAL STUDIES FOR DETECTING PERIODIC LOW-FREQUENCY OSCILLATIONS

Direct physical experiments were carried out by the author using a torsion pendulum and equal-arm lever balances with a beam, which effectively represent a pendulum oscillating vertically relative to Earth's surface. The aim of the experiment is to investigate the behavior of pendulums depending on their construction and the possible influence of the dynamics of the embedding medium space-time.

EXPERIMENT WITH A HORIZONTAL TORSION PENDULUM

Unlike the Foucault pendulum, the oscillation period of a torsion pendulum suspended on a string depends not on the string length but primarily on its elasticity, which determines the resistance to twisting around its axis. The pendulum is constructed as a bowl-shaped glass vessel, which during the experiments was filled with various nonmagnetic materials (Fig. 4).

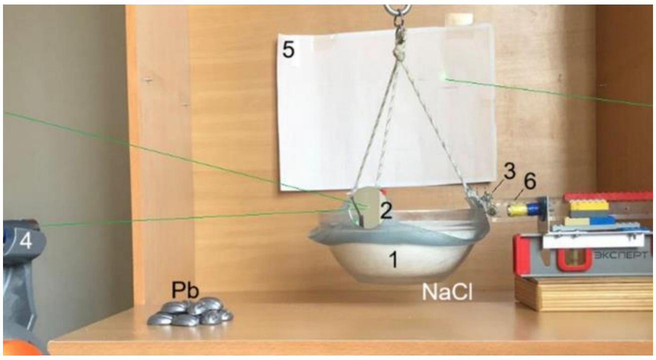

Figure 4: Horizontal torsion pendulum. The photograph shows the trajectory of a laser beam reflected by a mirror system and projected onto a distant screen.

The materials used as fillers in different runs included water, lead, sodium chloride (NaCl), and vegetable oil. The experimental pendulum consists of a glass vessel (1) suspended on a polyester fiber folded several times (the number of folds is even). A mirror (2) and a ferrimagnetic hanger (3) are attached to the outer rim of the vessel on opposite sides. In some experiments, the setup was equipped with a water heater. As shown in a previous experiment, such a pendulum can exhibit sustained oscillations induced by the action of the Coriolis force on the filler material. The goal of the present study is to examine the regularities of torsion pendulum oscillations depending on the composition of the filler and the possible interaction with the matter of space-time. This goal is achieved by investigating the periodicity of low-frequency oscillations of the torsion pendulum under the action of the Coriolis force (space-time), the reaction of the suspension thread to mechanical twisting, gravity, magnetism, and temperature. At the initial stage, it is necessary to estimate the resistance of the suspension thread to twisting. For this purpose, the vessel is manually rotated by 2–3 turns and the time required for it to return through the same number of turns to its initial position or to come to rest is measured. The empirical resistance force is in the range of $10^{-5}÷10^{-4}$ N. The initial resistance is almost zero. In the classical torsion experiments of Charles de Coulomb (1785–1789), the initial resistance did not exceed 1/30 grain, i.e., less than 10^{-8} N. To improve precision at low oscillation amplitudes, the rim of the vessel is projected onto a distant screen using a mirror and a laser beam. The experiment was conducted indoors under standard conditions.

Preliminary theoretical studies and calculations indicated that observable particles and macroscopic objects are constantly in a state of forced low-frequency oscillations. The only plausible source of energy for these oscillations is the embedding medium the matter of space-time. This was also confirmed during instrument setup: the torsion pendulum bowl, having a single degree of rotational freedom in the horizontal plane, exhibits persistent oscillations that can always be detected when the observation scale is sufficiently increased. The period of these oscillations is specific to each torsion pendulum and is independent of amplitude. The period is affected by temperature, depending on the phase state and material composition of the filler.

Theoretically, the oscillations arise from the combined contributions of the hypothesized background gravitational waves of space-time and the Coriolis force, counteracted by the elastic resistance of the suspension thread.

During the experiment, the bowl of the torsion pendulum was filled with different substances of known mass and left at rest. Due to a *heating effect*, the bowl spontaneously began circular motion in the horizontal plane and rotated to an angle at which the Coriolis force matched the resistance force of the suspension thread. As the thread's resistance returned the bowl toward its initial orientation, the Coriolis force reinitiated the motion, producing a cycle that transitioned into sustained oscillations. To amplify the observable motion, a laser and mirrors (off-frame) were used, with the reflected beam of which projected onto a millimeter-grid screen (Fig. 5). Oscillation periods for various fillers were measured using a stopwatch. The results are summarized in Tab. 3.

Table 3. Oscillation periods of the torsion pendulum with various fillers

Substances (kg)	Average values (s)	Spread (s)	Character of oscillation
Lead	65.5	64 - 67	stable
Salt (NaCl)	76.5	76 - 77	stable
Water	58.5	54 - 63	unstable
Oil (1 kg)	84.5	55 - 114	unstable

The instability observed for liquid fillers is likely due to convection within the vessel. Stable oscillations were demonstrated by solid-phase fillers such as lead and salt, with their periods differing by about 15%.

The oscillation period of the horizontal torsion pendulum depends on: angular velocity, resistance of the suspension thread to twisting, pendulum mass and thread length. With very low thread resistance, depending on the thread diameter, the oscillation period extended to several minutes. Heating the filler induced clockwise rotation of the pendulum; observations of dye droplets in water confirmed that convection did not contribute to this motion. The thermal twisting force increased with temperature and occasionally caused the pendulum to "hover" at the equilibrium point where the Coriolis force matched the torsional resistance. In this equilibrium state, periodic oscillations were observed, presumably synchronous with background oscillations of space-time. Since such cycles occurred rarely and unpredictably, it was decided to artificially reproduce the equilibrium via a magnetic field. A ferrimagnetic hanger was attached to the bowl rim, and a permanent magnet (position 6) was placed at a controlled distance. An inverse proportionality was found between oscillation frequency and magnet-to-hanger distance. The distance was adjusted so that the oscillation frequency matched the expected background wave frequency *≈0.06 Hz***.** Under these conditions, the magnetic force was expected to reproduce the balance between the Coriolis force and the thread's torsional resistance. After removing the hanger, its attraction force at this distance was measured with a balance scale.

Comparison of this magnetic force with the calculated torsional resistance of the thread supports the hypothesis that the *0.06 Hz* signal corresponds to the postulated background gravitational waves of space-time.

EXPERIMENT WITH A "PENDULUM" OSCILLATING IN THE VERTICAL PLANE (LEVER BALANCE)

The acceleration due to gravity at Earth's surface may be interpreted as a phenomenon associated with longitudinal gravitational waves of space-time. To test this hypothesis, an experiment was conducted using a balance scale treated as a torsion pendulum operating in the vertical plane. This pendulum consists of equal-arm mechanical balances with a beam and bowls made of nonmagnetic materials (aluminum, plastic, wood) (Fig. 5).

The arms are mounted on a low-friction precision bearing (1), which significantly increases sensitivity to mechanical impulses. Two such pendulums were used simultaneously, improving the robustness of the experimental results regarding both construction and location.

For the Foucault pendulum the determining factor is the cable length, whereas for the lever pendulum the key parameter is the *arm length*. Increasing the arm length enhances detectability of vertical oscillations of the suspended load. In the apparatus designed to detect gravitational waves, the total arm length (aluminum tubing) reached 2 m, and the observed amplitude was further magnified by the mirror system.

A laser beam was directed onto a mirror attached to the end of one arm. The arm lengths were 75 cm and 110 cm. In separate runs the pendulums were oriented north–south or west–east. The first orientation introduced slight horizontal modes, but otherwise orientation had no effect on the vertical oscillations.

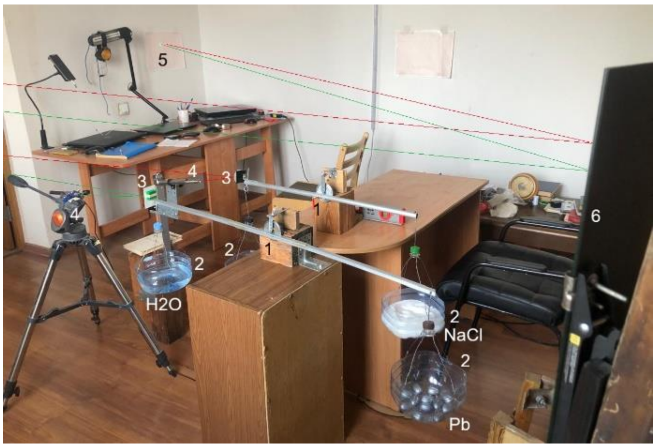

Figure 5. An experiment with two vertical pendulums. The photograph shows trajectories of two laser beams reflected by a system of mirrors and projected onto a common screen (5).

To minimize external disturbances, the setup was carefully isolated from ambient man-made vibrations.

EXPERIMENTAL PROCEDURE:

- The balance cups (2) were brought into equilibrium.
- A laser beam was directed onto the pendulum mirror (3).
- The reflected beam passed through the mirror system and was projected onto a millimeter-grid screen (5).

One of the mirrors is visible in the photograph (6). The total distance from the mirror to the screen was 75 meters, allowing microscopic vertical oscillations of the cups to be magnified to observable scales. Oscillation periods were measured using an interval timer. Based on previous experiments, the fillers selected were water, lead, and NaCl (each 2 kg), placed into different cups. It was expected that their differing responses to the Coriolis force might enhance the effect of the hypothesized space-time waves on the pendulum. The pendulum motion was monitored by tracking the movement of the laser beam spot on the screen.

Periodic vertical bursts of the reflected laser beam were observed, with amplitudes gradually decreasing over time. The average period of these bursts was *≈ 17 seconds*, suggesting that the observed oscillations represent the response of the pendulum to a space-time wave excitation. The maximum amplitude of the vertical oscillations on the screen was ≈ 2 mm. Considering the projection distance, the actual oscillation amplitude of the pendulum cup was estimated using geometric similarity and found to be approximately *≈ 10 μm*, which we adopt as the real mechanical amplitude of the vertical motion.

ANALYSIS OF THE EXPERIMENTAL RESULTS

The torsion pendulum and vertical oscillation (lever balance) experiments have an important advantage over the Foucault pendulum: friction forces need not be taken into account. Their primary purpose is to detect the presence or absence of undamped low-frequency oscillations of any amplitude. The force exerted on the pendulum's cup by the hypothesized background waves of space-time can be estimated using $F = M\omega^2 A$. For the measured average amplitude of the vertical oscillations, this force was approximately *100 nN*. This estimate implies that the matter of space-time interacts with substances at the level of their electrons and nuclei where forces of this magnitude are typical. For example, this value matches the Lorentz force or the centrifugal force of an electron moving $F = m_e v_c^2 / R_B$ with the classical velocity $v = c\alpha$ (α is the fine-structure constant) in the hydrogen atom at the Bohr radius R_B. Such forces operate at the scale that binds electrons in atomic orbits. At this force level, the work performed over a distance of one micron reaches ≈5 MeV, which is comparable to proton–neutron binding energies. Because the pendulum bowls are balanced, such small forces cannot be ruled out as the cause of the observed oscillations. The experiments were repeated many times, supporting the reliability of the findings. The periodic bursts with ≈17 s intervals appear systematic. In some trials no bursts were recorded, likely due to local damping.

Two independent vertical pendulums were operated simultaneously, with their reflected laser beams projected onto a common screen or computer monitor. The pendulums were placed either side by side or up to 13 km apart**.** Pendulums placed close together exhibited synchronization with ≈17 s periodicity**.** Self-synchronization is excluded, since the pendulums were mounted on different supports. Pendulums separated by large distances did not exhibit clear synchronization. This likely indicates that as the Universe's pulsation signal propagates through different media, its direction becomes scattered. Such scattering may prevent a global resonance of all particles and objects with the pulsation frequency. Experiments conducted at remote locations show that the observed frequency is not associated with man-made sources. No global artificial sources are known that emit persistent vibrations at ≈0.06 Hz. Mechanical interaction with the atmosphere was eliminated by performing the experiments indoors.

Monitoring indicates that the likely source of the impulses generating the observed frequency is the embedding medium itself space-time**.** Thus, the measured oscillations are ponderomotive in nature. Therefore, the experiments demonstrate the existence of periodic forced oscillations at ≈0.06 Hz, independent of observers and of technological environment. In the framework of a closed Universe, where the matter of space-time is a continuous medium, such oscillations can be interpreted as a manifestation of the global pulsation of this medium**.** This pulsation corresponds to longitudinal waves capable of modulating multiple carrier frequencies that define the composition, structure, and dynamics of particles and macroscopic objects. By their nature, these waves are gravitational, as they act mechanically upon matter through the space-time medium itself.

CONCLUSION

Within the structural–informational framework, a characteristic low-frequency scale near 0.06 Hz emerges from the adopted model of a discretely structured space–time background. This frequency is consistent with experimental data and has preliminary experimental indications. At the same time, it represents a model-derived parameter associated with large-scale geometric features of space–time. The analysis of Foucault pendulums at different latitudes illustrates how rotational geometry and Coriolis effects can be incorporated into a variational description of macroscopic motion. Within the present framework, the characteristic frequency emerges as a model-derived scale consistent with the phenomenology of different pendulums and with the experimental observations discussed above. While these observations do not constitute a direct detection of a global background pulsation, they provide indirect experimental indications compatible with the proposed framework and motivate further targeted investigations. The present work treats the Coriolis force as a geometric effect arising in rotating reference frames and explores its role using effective structural parameters. The approach provides a unified variational perspective linking classical mechanics with geometric aspects of space–time, while maintaining consistency with established physical principles.

Although the results are model-dependent and exploratory, they suggest potential avenues for investigating low-frequency gravitational phenomena using future space-based interferometric missions such as LISA. Further experimental and theoretical studies are required to assess the physical significance of the proposed structural features of space–time.

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