

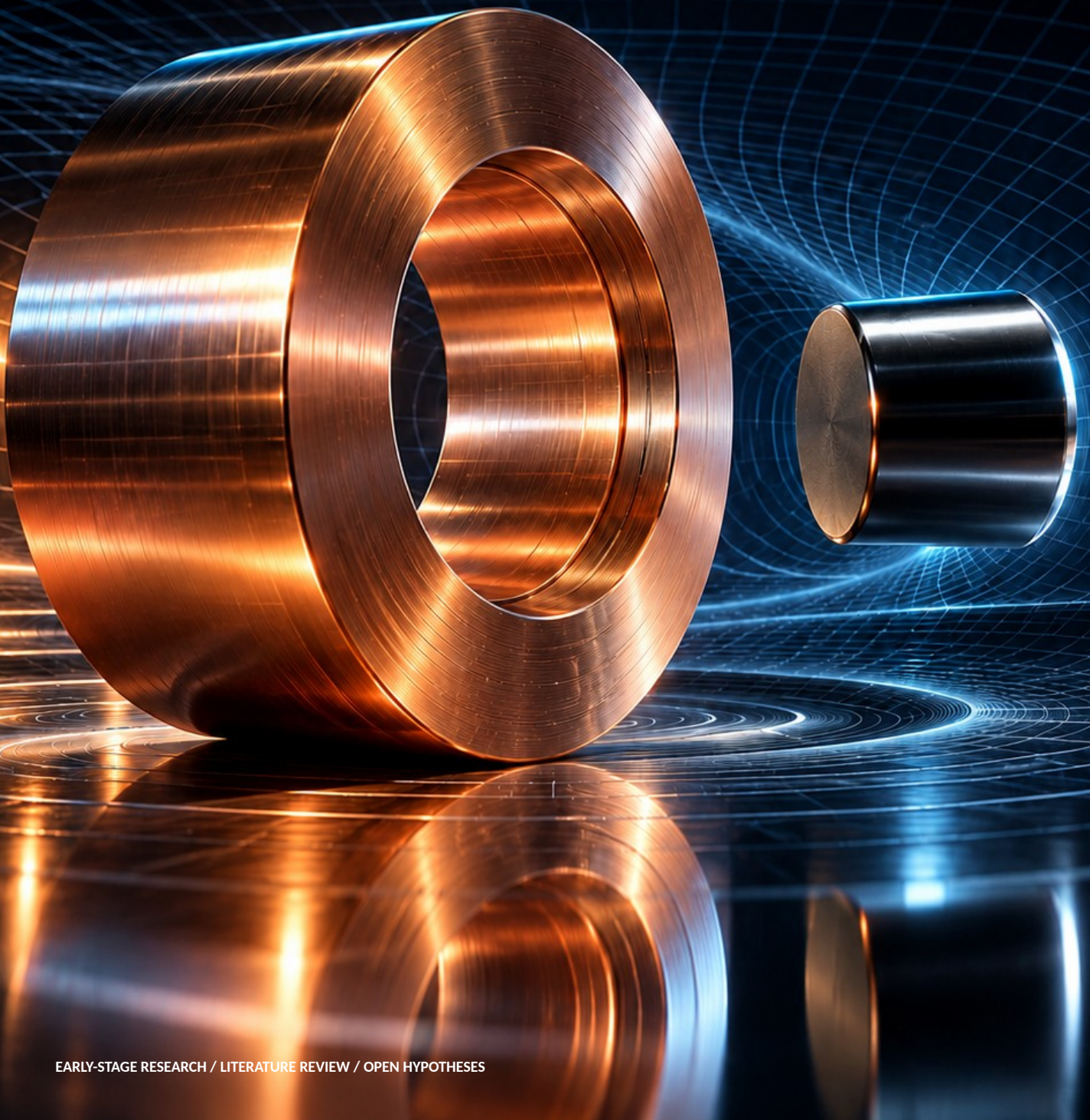
EVERYTHINK JOURNEY / 02

PAVEL KUBÁT

MAGNITACE

Magnetism and gravity

Two of the greatest mysteries



RESEARCH / CONNECTIONS / HYPOTHESES

A map of MAGNITACE

From current knowledge to new research questions

MAGNITACE opens an investigation into a deeper connection between magnetism and gravity. It combines a literature review with the author's questions, several open explanatory directions and mathematical prototypes. Current models provide a comparative baseline. This stage explores possibilities and prepares subsequent measurements.

36 CHAPTERS 54 REFERENCES 17 EQUATIONS

01–05 Magnet and copper

The question of altered gravitational interaction

06–11 Two interactions

Quantum magnetism and gravity measurements

12–19 Established and sought-after connections

Field energy, cosmic phenomena and unification

20–23 A first mathematical prototype

Scalar coupling and signal prediction

24–32 The route to an experiment

Measurement, analysis and implications

33–36 New research branches

Memory, state-dependent coupling, boundaries and common origin

How to read the study

Numbered references lead to original papers and reviews in the bibliography. Observations, calculations and open conjectures are distinguished throughout. Chapters 33–36 develop several research branches. The author's hypotheses remain proposals for further work.

Literature cut-off: 22 October 2026. The text has not undergone independent peer review. Hyperrealistic illustrations are generative visualisations; charts use the stated models or published values. The cover is conceptual, and the illustrated pages do not depict measurements carried out for this study.

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01 The research aims of MAGNITACE

Opening possibilities and gradually giving them precise form



Conceptual view of a magnet and copper tube. Generative illustration.

With this study, I want to open a space for questions that may remain hidden when an established account is taken as the last possible explanation. Magnetism and gravity are the starting points of my search for a deeper relationship between matter, motion, fields and space. MAGNITACE names the author's EveryThink JOURNEY research programme. Its purpose is to discover possible connections, formulate alternatives and prepare their subsequent investigation.

We are at an early research stage. A new possibility may begin as a question, an image or an unexpected connection between familiar phenomena. Only gradually may it acquire mathematical form and an experimental programme. Alongside the literature review, I therefore develop open conjectures. At this stage their value also lies in the questions they can raise and the previously separate areas they can help us examine together.

The central example is the slow fall of a magnet through a copper tube. Electromagnetic induction describes the observed motion very well. At the same time, I ask whether this process can inspire a deeper view of the relationship between gravity and the electromagnetic environment. Accepting the established calculation as a baseline and investigating a further explanatory layer are compatible research steps. A deeper theory might explain why current equations work so well while revealing broader connections.

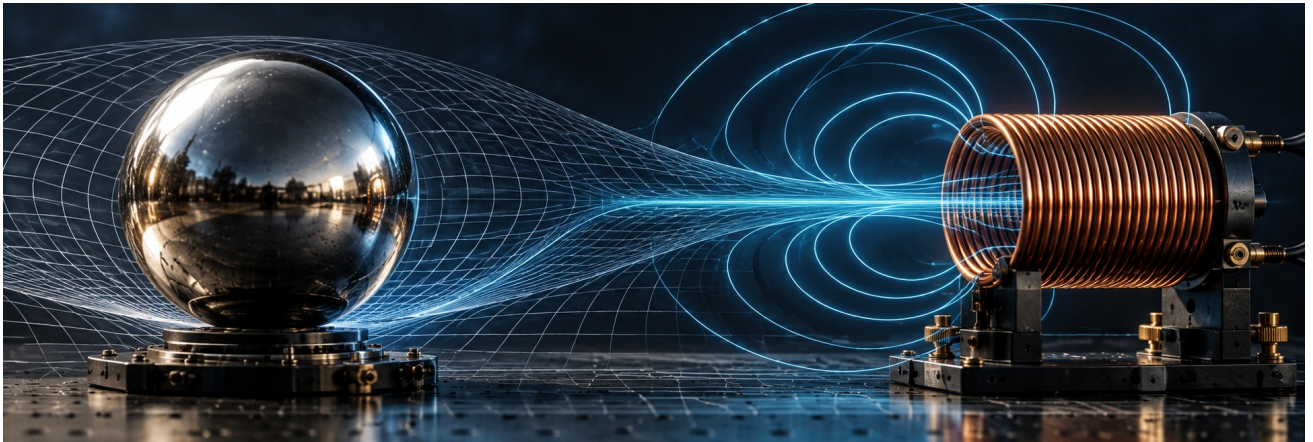
Throughout, I distinguish observation, calculation and the author's conjecture. Observation describes what has been measured. Calculation shows what follows from specified assumptions. A conjecture opens a possibility for which we are still seeking the right language, mechanism or measurement. This distinction allows bold ideas to develop intelligibly and truthfully, without prematurely turning a question into a demonstrated result.

The review, current to 22 October 2026, covers classical foundations, original experiments and selected contemporary papers, including scientific disputes. It is not an exhaustive inventory of the literature. Current models serve as carefully developed benchmarks for further inquiry. Their achievements and working assumptions help identify where a new idea might reveal a further distinction.

EveryThink follows two paths here. One preserves the broader question of whether electromagnetic and material environments relate to gravitational interaction more deeply than the usual account captures. The other tries a particular scalar model as a computational prototype. This leaves other possibilities open. It illustrates how a general intuition can lead to relationships between measurable quantities. The evidential stage will follow once a possibility is developed sufficiently.

02 What it means to connect two interactions

From a shared language to a common origin



A shared language of fields and geometry as a research question. Generative illustration.

A connection can mean at least three different things. The first is mutual interaction: an electromagnetic field carries energy, influences the gravitational field and propagates through curved spacetime. The second is a common mathematical description: both interactions can enter one action, yielding equations for their joint evolution. The third is deeper unification in which apparently distinct fields arise from a more fundamental structure. The first two levels have developed physical descriptions; the third leaves room for inquiry.

The history of electromagnetism shows what unification looks like. Electric and magnetic phenomena were not joined merely by resemblance. Shared equations explained induction, coupled time-varying fields and predicted electromagnetic waves. Relativity showed why different observers separate the same field into electric and magnetic components differently. We cannot unify magnetism with gravity by removing electricity from the question. [1, 2]

Substantial differences remain. Electric charge has two signs, and macroscopic bodies can be almost electrically neutral. In general relativity, gravity is sourced by energy and momentum, including pressure and stress. Ordinary matter attracts gravitationally regardless of measurable magnetisation. A quantum photon corresponds to a massless spin-one field; weak gravitational waves have spin two in the usual quantum description. Similar field-line diagrams cannot erase this distinction.

‘Field’ does not answer everything. It denotes physical quantities assigned to space–time events and rules for measurement and evolution. It does not establish whether further microscopic structure underlies them. Likewise, geometry does not require spacetime to be a material mesh. It precisely describes intervals, clocks, light paths and bodies’ relative motion.

This opens different research aims. We can seek a new mechanism, derive known relationships from a deeper foundation or connect previously separate descriptions. A new picture sharing every established prediction is presently a possible interpretation. A next step may identify a situation with different consequences. Later chapters distinguish shared mathematics, physical coupling and common origin.

03 A magnet inside a copper tube

A live transfer between motion, fields and heat

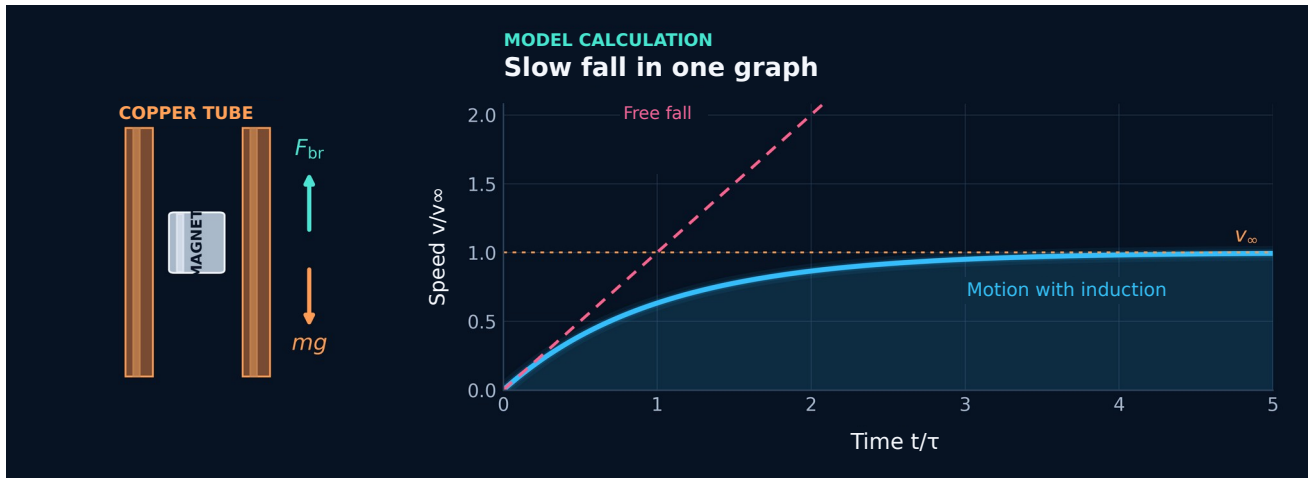


Fig. 1 Falling through copper: weight remains, opposed by electromagnetic braking. Model $v/v_\infty = 1 - \exp(-t/\tau)$, constant k , initially at rest. Neither diagram nor curve represents measured data. Context: [47–49].

A strong magnet is dropped through a vertical copper tube. During coaxial passage it does not touch the walls; copper is not ferromagnetic, yet the magnet descends much more slowly than through the same space without a tube. Gravity and electromagnetism visibly meet in one process. We directly observe altered motion and ask what it reveals about electromagnetic response, gravitational interaction and deeper connections. Distinguishing these levels is the experiment's research task.

In established electrodynamics, the moving magnet changes flux through conducting tube regions. Faraday's law determines induced voltage; Lenz's rule determines current direction: the field opposes the change producing it. Eddy currents exert electromagnetic braking. Contributions above and below the magnet have different spatial arrangements; their sum opposes descent. Quantitative models can be compared with measurements. [47, 48]

$$m \frac{dv}{dt} = mg - F_{br}, \quad F_{br} \simeq kv, \quad v_\infty = \frac{mg}{k}$$

In a simplified slow-motion regime the braking force is approximately kv , with k in kg/s . A sufficiently long tube allows terminal speed mg/k . Zero net acceleration means balanced weight and electromagnetic force. If the magnet stopped in ordinary resistive copper and flux stopped changing, motion-induced currents would decay. An ordinary copper tube therefore cannot permanently suspend a stationary magnet.

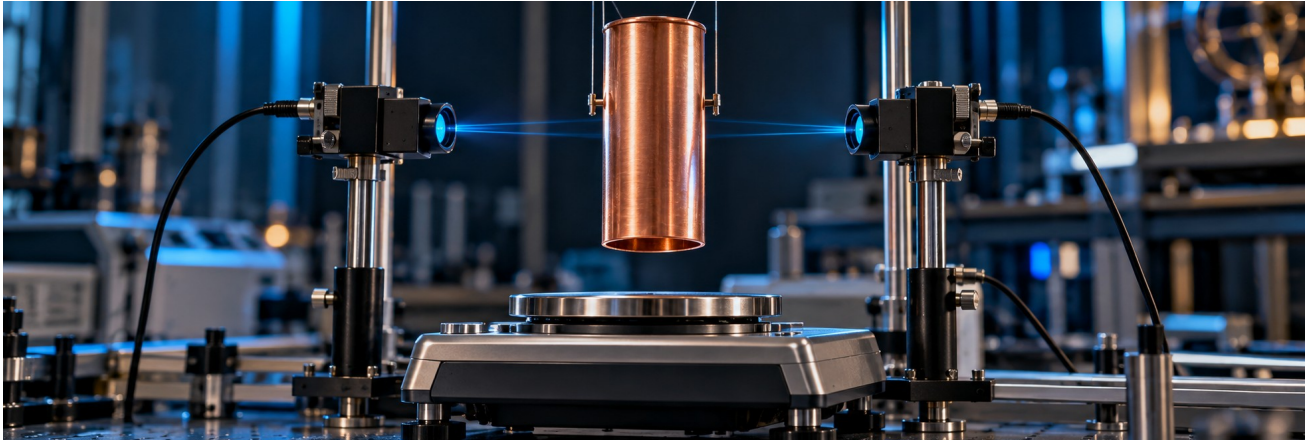
Initially at rest, the linear model gives $v(t) = v_\infty[1 - \exp(-t/\tau)]$, $\tau = m/k$. This is not universally exact at a short tube's entrance and exit, where geometry and force vary. More precise calculations include spatial fields, finite magnet size, wall thickness and speed. Partovi and Morris extend point-dipole and thin-wall approximations to a more general coaxial problem. [48]

Energy balance clarifies the connection. At approximately steady speed, gravitational power mgv becomes mainly Joule heat in the tube, accounting for transient field-energy changes and other small losses. Direct mechanical contact is unnecessary for falling energy to reach the surroundings. Magnetic fields and induced currents mediate the transfer, while their braking force also acts on the tube's supports.

This experiment is central to MAGNITACE's starting question. It connects gravitational energy, motion, electromagnetic response and heat in one observable process, guiding a search for deeper description. Slow passage alone does not distinguish every interpretation; further research can examine new configurations, precise measurements and theoretical connections.

04 Turning the tube into a discriminating experiment

Measure reaction force and independent gravitational acceleration too



Passage and support-reaction measurements are two parts of the experiment. Generative illustration.

First compare the same magnet in tubes with identical internal geometry: copper, another good conductor and an electrical insulator. Light gates or a camera with verified timebase record motion. The magnet must not rub walls, touch sensors or act as an uncontrolled pneumatic piston. Measure temperature, mass, dimensions and magnetic moment. A single transit time cannot identify the entire mechanism.

A longitudinal slit is useful because it changes possible current paths. Promising complete removal of braking would nevertheless be mistaken: local loops may remain in a real split tube, and the magnet may rotate. Comparison needs a spatial model and verified motion. EveryThink stresses this approach: simple controls have limits too. [50]

Second examine the reaction force. Suspend the tube from a force sensor independently of the place eventually catching the magnet. At steady speed the magnet's upward braking force is about mg , with an opposite downward force on the tube. Its support can thus carry additional force equivalent to the magnet's weight without contact. Field-momentum transients and sensor response require separate analysis. Behroozi published direct braking-force measurements. [49]

$$F_{\text{br}} = mg - m\dot{v}, \quad P_{\text{Joule}} \simeq F_{\text{br}}v \longrightarrow mgv \quad (v = v_{\infty})$$

Third separate magnet acceleration from local gravitational acceleration. Measure an independent weakly magnetic object beside the apparatus or in a control channel, limiting electric polarisation and susceptibility. If only the strong magnet's motion changes and the tube's reaction agrees with induction, this is not evidence of changed g . A gravitational anomaly needs another independent signature and ordinary-force controls.

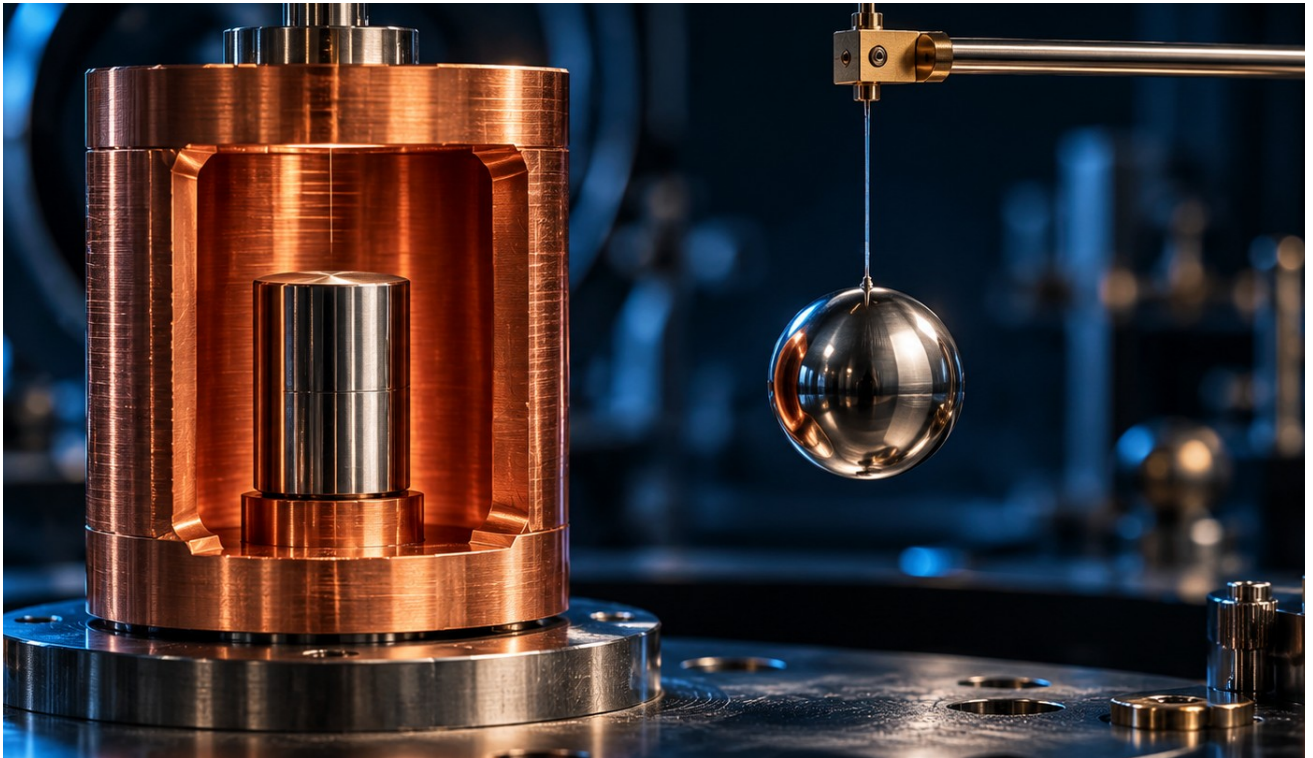
In the idealised point-dipole limit, with moment μ and a long thin tube of radius a , wall thickness d and conductivity σ , the coefficient below can be derived. It assumes slow coaxial motion and negligible current back-reaction on source flux. It is not general for arbitrarily conductive, thick or superconducting tubes. [47, 48; derivation in this limit]

$$k = \frac{45\mu_0^2\mu^2\sigma d}{1024a^4}, \quad v_{\infty} = \frac{mg}{k}$$

Conductivity and geometry changes predict changed motion in induction. MAGNITACE can compare data with these dependencies in detail while developing deeper mechanisms. How would consequences vary with finite geometry, temperature, orientation and contacts? A repeatable discrepancy from the complete known balance would be especially significant. The conjecture of a deeper trace gains a concrete route towards testing.

05 The open question of altered gravitational interaction

What difference a new interpretation would need to predict



An additional gravitational response requires a separate test. Generative illustration.

Consider the alternative HC_u: interaction between a magnet and copper changes its gravitational interaction. Induction predicts the same motion, so further distinguishing questions are needed. What does 'gravity' denote in HC_u: a local field change for all bodies, a change only in this magnet's coupling, or a rewriting of net acceleration?

For downward motion, $m \dot{v} = mg - kv$ formally becomes $\dot{v} = g_{\text{eff}}$, where $g_{\text{eff}} = g - kv/m$. Thus defined, g_{eff} is the magnet's net acceleration, not independently measured gravitational field strength. It depends on speed and the particular magnet and tube. HC_u needs physical content beyond rewriting: a common source, altered matter coupling or a new field-motion relationship. Until specified, both formulations describe the same trajectory, leaving deeper interpretation open.

One variant reverses motion. Induction points downwards when a magnet is pulled slowly upwards, opposing motion again. Simple weakening of Earth's attraction instead reduces downward weight regardless of velocity. This distinguishes a simple gravitational explanation. A velocity-dependent HC_u requires its energy source, reaction on the tube and relationship to induced currents to be developed.

Another test places the tube horizontally and uses an external drive. Electrodynamics predicts braking without any longitudinal component of weight. Vertical gravity can affect guidance and contact, but does not source longitudinal induction. These cases show why prescribed-motion force measurements help beyond observing free fall. [48]

If HC_u changes the actual local gravitational field, it must predict independent objects' and clocks' responses after subtracting known electromagnetism and the tiny standard gravitational effect of current energy. If only the magnet changes, a precise material- and velocity-dependent law is needed, subject to universality and energy-conservation tests. Slow fall alone does not establish these conditions.

Common origin remains open even if induction perfectly explains the experiment. HCu therefore asks whether the electromagnetic environment merely adds a force or relates to a broader rule of motion and gravitational coupling. The later scalar H1 is one mathematical prototype; slow fall in copper has neither derived nor confirmed it.

Another branch can investigate conductivity, delayed material response and momentum transfer, asking whether a deeper microscopic description reveals new relationships between known quantities. Another may ask whether geometry changes with electromagnetic invariants or boundary arrangement. A third can seek a shared emergent foundation from which magnetic and gravitational properties arise as different manifestations of a collective state. These are directions for questions; their specific dynamics remain to be found.

Conductivity is not a universal relativistic scalar independent of material and environment. This guides work towards matter's description, rest frame and response memory. Tube topology raises how boundaries alter allowed current paths and energy transfer. Established electrodynamics provides a computational baseline, within which a deeper model may reveal a new relationship.

06 The field linking magnets and light

What Maxwell's equations describe



Fig. 2 Two field structures: an ideal magnetic dipole section (left) and Newtonian acceleration directions (right). Author's model diagram; line density is not measured, and illustrative colours are not a shared measurement scale.

Classical electromagnetism uses electric field $\mathbf{E}$ and magnetic flux density $\mathbf{B}$. Charges and currents produce fields; changing fields can induce the other component, and disturbances propagate through vacuum at light speed. Maxwell theory calculates coils, antennas, circuits and light waves, extending beyond magnetic attraction to conservation of energy and momentum between bodies. [1]

A point charge experiences the Lorentz force. The electric part can change speed, while the magnetic part is perpendicular to instantaneous velocity in a given inertial frame and alone does no work on the charge. Magnetic devices can still transfer mechanical energy: a supply, changing field or stored system energy provides it. Attracting iron does not create cost-free energy.

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

Observers in relative motion can measure different proportions of electric and magnetic components. An arrangement purely electric in one frame can show magnetic flux density in another. This does not let every field become purely electric or magnetic through a velocity change. Invariants unchanged by Lorentz transformations determine the possibilities. This restriction will be crucial when formulating the hypothesis. [2]

Field lines are drawings, not material fibres; their pictured density depends on visualisation. Iron filings also become magnetised and interact, rather than passively photographing a field. In classical vacuum without magnetic charges, divergence of $\mathbf{B}$ vanishes. Breaking a bar magnet yields further dipoles, not isolated north and south poles.

Spatial force depends on source type. A point charge's electrostatic field falls as inverse distance squared; a distant magnetic dipole's field typically as inverse distance cubed. Dipole forces can scale differently and depend on orientation. A graph resembling Newton's law does not establish identical magnetism and gravity. Compare identical quantities and source geometries first.

07 Why iron retains magnetisation

Spin and exchange interaction



Material properties connect microscopic and macroscopic descriptions. Generative illustration.

A copper-coil current produces a magnetic field by an understandable macroscopic mechanism. A permanent magnet needs quantum description. Electrons carry intrinsic angular momentum, spin, and an associated magnetic moment; orbital motion also contributes. Spin is not a rotating charged ball but an intrinsic quantum property, measurable spectroscopically, for example.

Weak dipolar interactions between miniature magnets alone would not readily explain iron's strong, thermally stable order. Exchange matters: electrostatic energy and quantum conditions on many-electron states jointly favour particular spin arrangements. The Heisenberg model captures part of this through spin couplings. Their sign and magnitude depend on material; no rule requires every neighbouring spin always to point the same way. [3]

$$H = - \sum_{\langle i,j \rangle} J_{ij} \mathbf{S}_i \cdot \mathbf{S}_j$$

J is the exchange parameter; the sum covers selected site pairs. Positive J favours parallel alignment in this convention. Real metals may need band theory and itinerant electrons; localised spins are not a universal microscopic photograph. The model's usefulness lies in energy, correlation and temperature predictions.

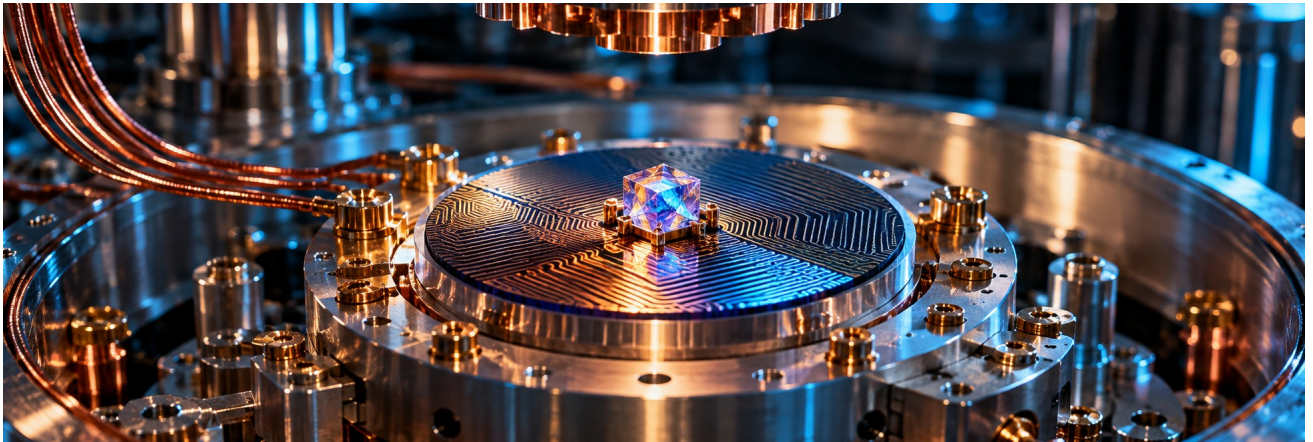
Macroscopic magnetisation also results from domains. Moments may be ordered within one region while its neighbour points elsewhere. Zero total magnetic moment need not mean no microscopic magnetic order. Heating, mechanical stress and external-field history can change domains. Some energy concerns orientation, some deformation and some radiated or dissipated heat. All of this enters the later interpretation of a precision gravitational experiment.

Single-electron magnetic moment measurements illustrate present precision. Fan and colleagues reported $g/2 = 1.00115965218059(13)$ in 2023, relative uncertainty about 0.13 parts per trillion. This exceptionally precise QED test also depends on independent determination of the fine-structure constant for theoretical comparison. [4]

This precision does not settle every collective magnetic material. It anchors deeper inquiry. Basic magnetic mechanisms are well understood, while complex many-body states, unusual symmetries and possible common foundations with gravity open new research directions.

08 New magnetic worlds

Altermagnetism and two meanings of monopole



New magnetic materials open further research regimes. Generative illustration.

Dividing materials into strongly magnetising ones and everything else is too crude. Ferromagnets

can have parallel moments; antiferromagnets' sublattices can compensate. Ferrimagnets have unequal opposing contributions; frustrated magnets and quantum phases without ordinary long-range order exist too. A new arrangement of matter is not by itself a new fundamental force.

Altermagnetism illustrates contemporary developments. Krempaský and colleagues combined photoemission spectroscopy with electronic-structure calculations, finding unusual band splitting in MnTe associated with magnetic ordering despite compensated total magnetisation. Crystal symmetries and electron spin–motion relationships matter. For EveryThink, this urges caution: a small external dipole moment need not mean two samples have identical internal electromagnetic and spin properties. [5]

Another open question concerns fundamental magnetic monopoles: particles carrying isolated magnetic charge. Their existence would change Maxwell's source structure and relate to deep questions of electric-charge quantisation. Mitsou's review, updated in October 2026, summarises extensive searches without reporting a confirmed discovery of such a particle. [7]

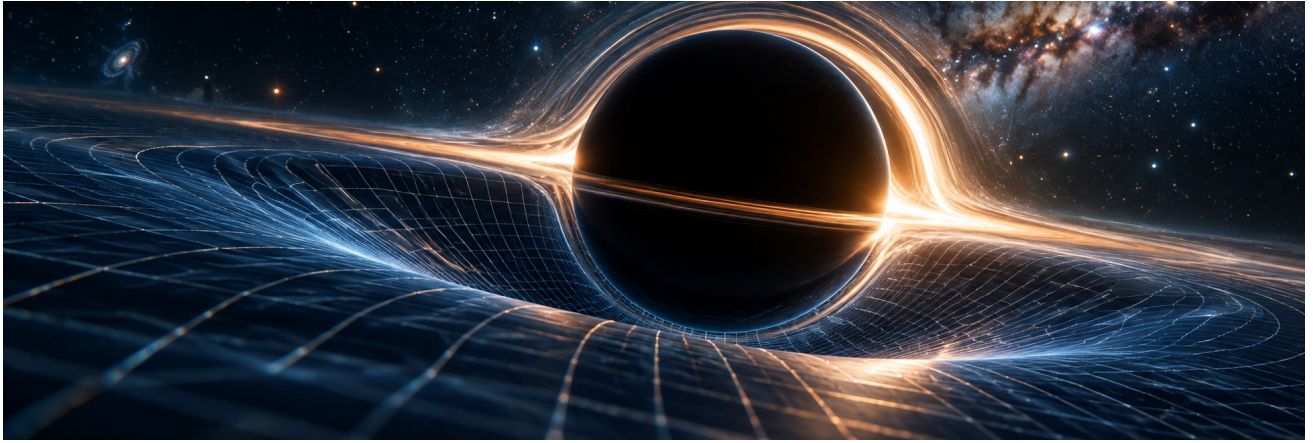
ATLAS searched ultraperipheral lead-ion collisions for monopoles. No statistically significant excess constrained production for a specified model and mass range; it does not rule out every mass or coupling. Converting event counts into mass bounds, especially for strongly magnetically coupled objects, requires theoretical assumptions. [8]

“Monopole” also describes emergent excitations in spin ice. Castelnovo, Moessner and Sondhi showed how defects in collective order can behave as effective magnetic charges at suitable scales. This is a material-system property, not an isolated elementary particle in vacuum. Confusing the meanings creates the false impression that fundamental-monopole searches have already ended. [6]

New magnetic phases can broaden our search space. When investigating possible magnetic-order/gravity coupling, we can compare microscopic organisation, stored energy and external-field response. Such characterisation may reveal differences invisible in ordinary magnetic-attraction experiments.

09 Gravity as geometry of measurable relationships

What spacetime curvature means



Curvature as a geometric description of gravity. Generative illustration.

Newton's law works very well for weak fields and slow motion in practical situations. General

relativity explains gravity through spacetime geometry. Geometry determines clocks' proper time, light cones and freely falling bodies' natural paths. An orbiting body can be locally in free fall although its distance from Earth's centre remains nearly constant. The ground beneath our feet, conversely, deflects us from free fall.

A ball on a rubber sheet captures only part of this, using gravity to explain gravity and omitting time. Curvature's more precise observable is relative acceleration of neighbouring free trajectories: tides. An appropriate local frame removes apparent local gravitational force, but generally not finite-region tidal differences. [9]

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

The equation's left side is geometry, the right energy, momentum, pressures and stresses. G cannot be replaced by magnetic field strength. c determines not only light propagation but causal structure. Light gravitates despite zero rest mass because radiation carries energy and momentum; binding and internal-motion energy also gravitate.

Gravity's special status relates to the equivalence principle. In a sufficiently small freely falling experiment, non-gravitational laws take their familiar special-relativistic form. The same frame choice cannot simultaneously remove electromagnetic force for particles with different charge-to-mass ratios. Gravitational and electromagnetic interactions therefore differ structurally even when particular trajectories happen to resemble each other.

'What is gravity really?' can ask whether the metric is fundamental, emergent from quantum degrees of freedom or an effective macroscopic description. Each needs mathematics and tests. Geometric success does not establish final ontology; unanswered philosophy does not justify rejecting successful predictions either. A new proposal must reproduce known results at least as accurately.

Ordinary matter's mass origin also matters for a common foundation. Much of proton and neutron mass relates to quantum chromodynamics: quark and gluon dynamics. Lattice hadron-mass calculations are a specific quantitative success of this explanation. Beyond external electromagnetism, MAGNITACE's broader inquiry can therefore examine internal particle energy, binding mechanisms and their relationship to gravitational interaction. [18]

10 What has actually been measured

Firm reference points for every new hypothesis

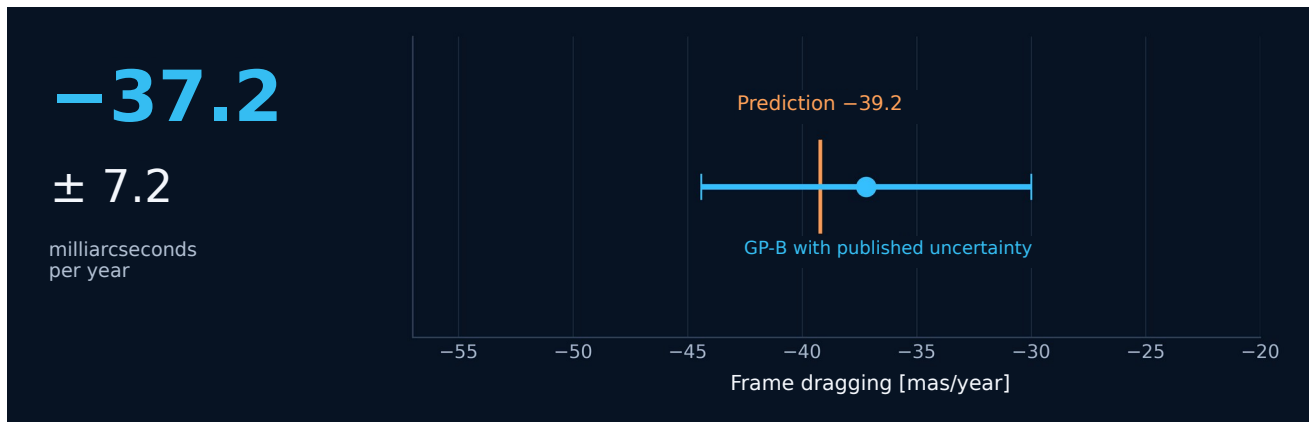


Fig. 3 Gravity Probe B: -37.2 ± 7.2 versus -39.2 milliarcseconds/year predicted. Redrawn published values, not new time-series analysis. Source [13].

GW150914 revealed a varying gravitational signal consistent with two merging black holes. The evidence

combined detector agreement, background statistics and relativistic predictions, rather than one instrument's trace. This opened gravitational astronomy. A classical wave record is not direct observation of a graviton or completed proof of quantisation. [10]

For GW170817, the gamma-ray burst arrived about 1.74 seconds after the gravitational signal. Under the original analysis's assumptions, this constrained the speed difference divided by c to roughly -3×10^{-15} to $+7 \times 10^{-16}$. These bounds include assumptions about emission times at the source. Equal propagation speed does not make electromagnetic and gravitational waves identical in nature. [11]

MICROSCOPE compared accelerations of bodies made from different alloys. For titanium and platinum test masses, $\eta = [-1.5 \pm 2.3 \text{ statistical} \pm 1.5 \text{ systematic}] \times 10^{-15}$. No weak-equivalence-principle violation was established. This does not forbid every conceivable new field: each needs a specific prediction for this measurement's composition, range and environment. [12]

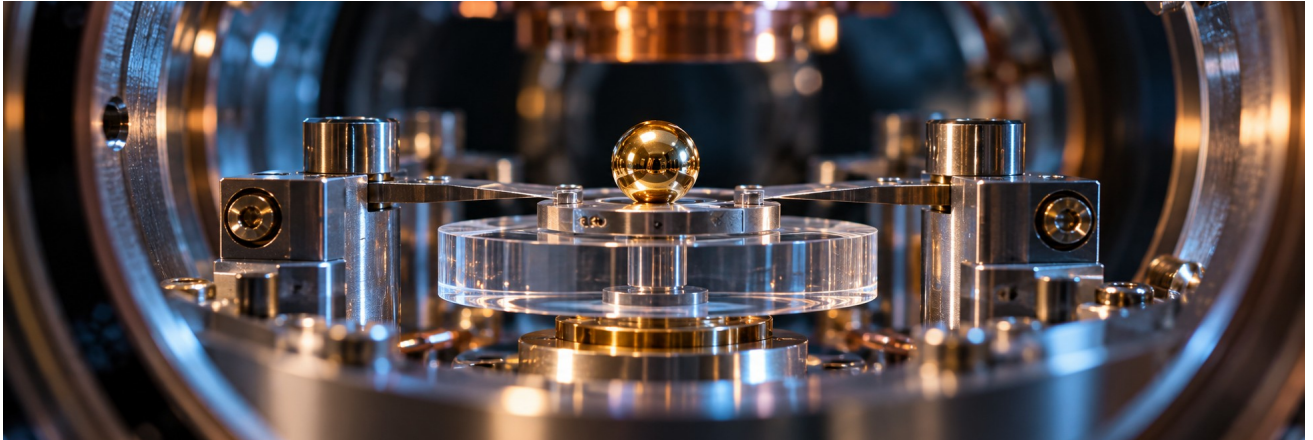
Gravity Probe B also measured local inertial-frame dragging by Earth's rotation: -37.2 ± 7.2 milliarcseconds per year, versus the relativistic prediction -39.2 . "Gravitomagnetism" denotes an analogy in describing moving matter's weak gravitational field. It is not evidence that Earth drags spacetime through its ordinary magnetic field. [13]

These results constrain different theoretical properties: disturbance propagation, universal free fall and rotation. A hypothesis cannot replace them with one intuitive model. It must specify its limit recovering verified equations and where deviations should appear. Quality increases with the independent situations survived using identical parameters. Retuning couplings for every failed test would reduce explanatory value.

Will's expert review summarises metric-theory tests and their parametrisation. We use it as a methodological foundation; current numerical results here are always tied to specific later measurements. [43]

11 Small masses and quantum free fall

Laboratory proximity does not automatically mean quantum gravity



Miniaturising gravity experiments demands new measurement capabilities. Generative illustration.

Gravity is tested between small bodies as well as cosmically. Lee and colleagues studied distances from 52 micrometres to 3 millimetres and found good agreement with Newton's law. For a chosen gravitational-strength Yukawa deviation, they constrained range below 38.6 micrometres at 95% confidence. This number cannot transfer to every new interaction without its coupling and the test bodies' composition. [14]

Westphal and colleagues measured attraction of roughly 90-milligram gold spheres. Source-position modulation isolated periodic gravity from background. This extended small-source measurements, but the spheres were not in spatial quantum superposition. It is important small-scale gravity, not direct evidence for a quantum gravitational field. [15]

In 2024, Fuchs and colleagues used a magnetically levitated mechanical system. Magnetism supplies suspension and readout; separately modulated matter supplies the gravitational effect sought. Magnets' presence alone does not demonstrate magnetism-to-gravity conversion. It shows why measurement technology must be distinguished from the interaction under investigation. [16]

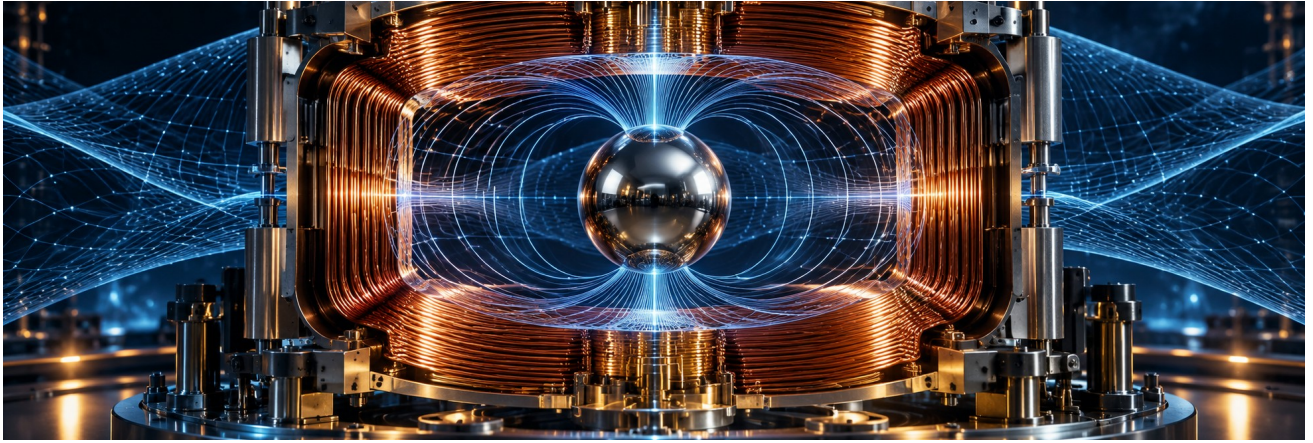
In 2026, Dobkowski and Folman's team compared the phase of a freely falling atomic-wave branch with one held on a laboratory trajectory. Agreement with quantum mechanics in a gravitational potential and the relevant equivalence principle does not establish that the source field itself was superposed. [40]

Antimatter has also become a direct gravitational test body. In 2023, ALPHA-g observed antihydrogen behaving consistently with attraction towards Earth. This precision differs from ordinary equivalence-principle tests. It cannot be described as testing matter–antimatter gravitational equality at MICROSCOPE's level. [17]

Read precisely what each experiment tests. Quantum matter in classical gravity, a small classical source and a superposed quantum source are distinct situations answering distinct questions. Greater sensitivity may connect their study, but changing a headline cannot merge them.

12 A joint description already exists

Einstein and Maxwell equations as the starting point



Electromagnetic energy enters the gravitational description. Generative illustration.

The most direct established connection is simple: electromagnetism contributes to the stress-energy tensor.

No new matter is needed for light or magnetism to gravitate. The metric also enters electromagnetism, so light paths, clock-compared frequencies and field evolution depend on geometry. This is Einstein–Maxwell theory. [9]

$$T_{\mu\nu}^{\text{EM}} = F_{\mu\alpha}F_{\nu}^{\alpha} - \frac{1}{4}g_{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}$$

The expression uses rationalised natural units and metric signature $-+++$. F is the electromagnetic tensor and g the metric; Greek indices span time and three spatial directions. SI introduces the corresponding permittivity and permeability factors. This is more than energy density: components include energy flux, momentum and directional stress transmitted by the field.

The classical electromagnetic tensor is traceless in four dimensions. This does not make the field's gravity zero. Einstein's equations are tensorial; zero trace does not mean every component vanishes. In electromagnetic vacuum at zero cosmological constant, the Ricci scalar can vanish while the Ricci tensor and full curvature remain non-zero. This will prevent wrongly deriving a scalar source from R alone.

Known exact models include Melvin-type ideal magnetic configurations. They show fields and geometry solved jointly beyond weak approximations. An infinite or otherwise idealised configuration is not laboratory apparatus. Its boundary conditions and global geometry cannot transfer unchanged to a finite coil in a room. [19]

Completeness of energy balance is more important still. Magnetic-field sources must sustain mechanical forces. Counting only field energy while omitting supports, winding stresses or the electrical supply can create an apparent gravitational-mass contradiction. An isolated stationary system requires the full conserved tensor, including material and binding. Pressure's local role must not be mistaken for arbitrary multiplication of total mass.

H0 therefore states that known physics of the complete system explains observed motion and frequencies. Before going beyond it we must calculate it accurately, lest neglected thermal, elastic or electromagnetic effects be mislabelled new gravity.

13 How much gravity a magnetic field produces

A numerical estimate of experimental difficulty

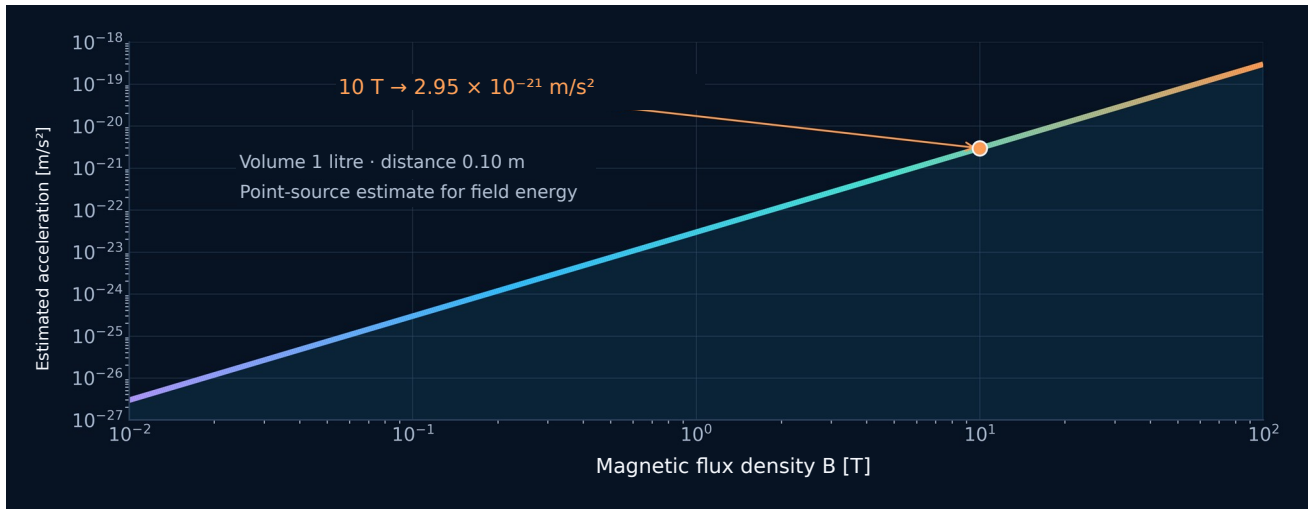


Fig. 4 Author's $a \approx GUB/(c^2r^2)$, volume 1 litre, $r = 0.10$ m. A point-source order estimate of field energy, excluding finite geometry and apparatus. Constants [44].

Imagine an ideal one-litre vacuum region with approximately uniform magnetic flux density 10 tesla.

Field energy is the volume integral of $B^2/(2\mu_0)$. In this simplified example it is about 39.8 kilojoules. The mass equivalent U/c^2 is approximately 4.43×10^{-13} kilograms. This is neither coil mass nor an amount of metal: it is only stored electromagnetic energy's equivalent. [44; author's calculation]

$$U_B = \int \frac{B^2}{2\mu_0} dV, \quad m_{\text{eq}} = \frac{U_B}{c^2}, \quad a \sim \frac{GU_B}{c^2r^2}$$

A point-source estimate at 0.10 metres gives about 2.95×10^{-21} m/s². Actual dimensions, stresses and surrounding matter require spatial calculation, so this is not a calibrated signal. It nevertheless illustrates laboratory field energy's extraordinarily small gravity. Reducing B a hundredfold at fixed volume reduces this estimate ten thousandfold.

For comparison, 1 kilogram at 0.10 metres gives about 6.67×10^{-9} m/s² in a point-source estimate. An unintended displacement of apparatus can therefore overwhelm the field-energy effect by many orders of magnitude. Calling an instrument a sensitive gravimeter says nothing about whether it can separate these particular causes.

At equal energy density, a purely electric field requires $E = cB$. The equivalent of 10 tesla is about 3×10^9 V/m. Across a litre, this is no realistic counterpart to an ordinary laboratory coil. Electric/magnetic comparison is therefore initially conceptual; feasibility does not follow merely from equal formulas. Surface emission, breakdown and mechanical stress severely constrain implementation.

14 Converting light and gravitational waves

The Gertsenshtein mechanism as a physical bridge

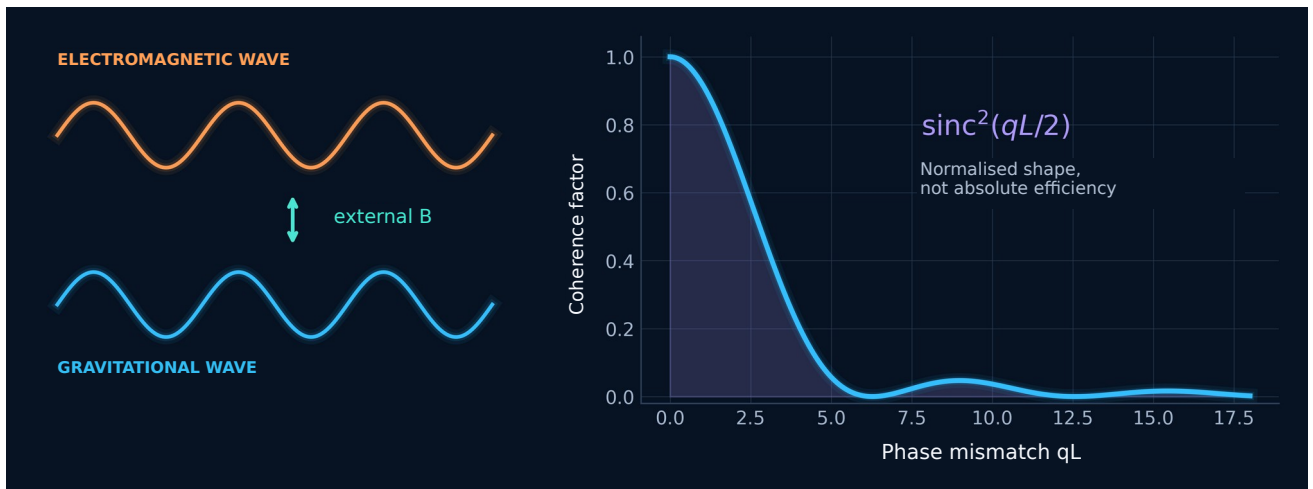


Fig. 5 Conceptual external-field conversion and $\text{sinc}^2(qL/2)$ for a homogeneous weakly coupled region. The normalised curve is neither absolute efficiency nor measurements. Context [20–22].

One particularly intriguing established coupling is the Gertsenshtein effect.

Within general relativity, an electromagnetic wave crossing an external magnetic field can generate a gravitational wave, and vice versa. Known equations predict this. There is no need to equate photon and graviton or claim a new fundamental force. Modern derivations also examine boundaries and coherent wave propagation. [20]

Efficiency depends on more than magnet strength: interaction length, transverse field, frequency, polarisation and wave phase difference all matter. In an ideal coherent weak-coupling regime, conversion probability grows approximately as $(B \text{ times region length})^2$, multiplied by a very small gravitational coupling. Plasma or quantum refractive-index corrections can disrupt coherence. Ignoring them overestimates gains from lengthening a magnet.

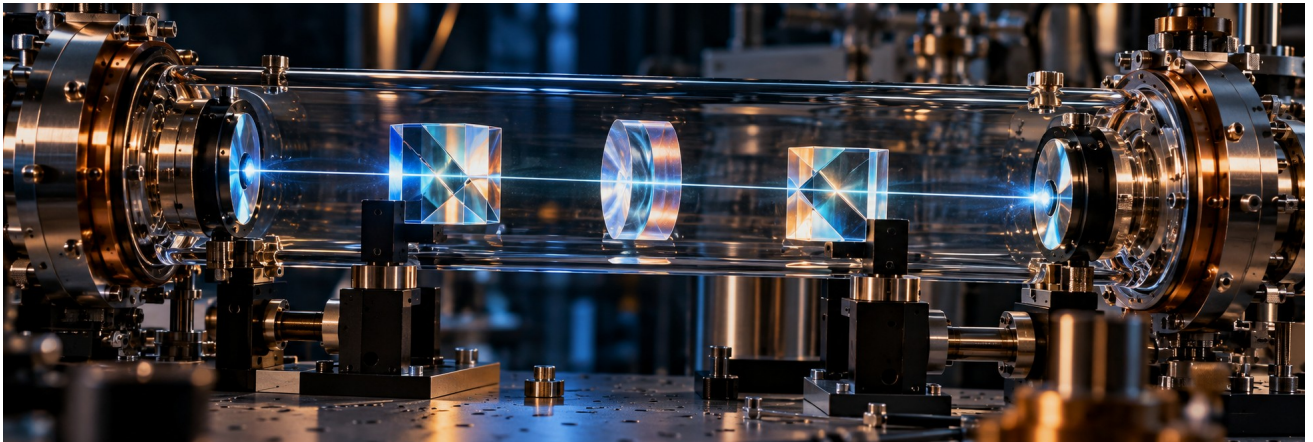
Domcke and Garcia-Cely showed how conversion can constrain high-frequency gravitational waves through radio observations. Results depend on cosmic magnetic-field and environmental models. Additional radio emission alone would not detect a graviton: conventional radiation sources must first be excluded and the corresponding relationships established. [21]

Hwang and Noh stress consistent conversion between potentials, physically measured electric and magnetic fields, and metric perturbations in curved space. An equation correct for a plane wave in a homogeneous medium need not apply unchanged to a real detector. Popular shorthand about turning light into gravity often omits precisely this technical limitation. [22]

For MAGNITACE, this mechanism matters twice: it shows a conversion physics already predicts and defines part of H0. Detecting exactly this effect would be a significant experimental achievement. It would not by itself demonstrate the additional field in EveryThink's hypothesis.

15 The vacuum has a quantum structure

Nonlinear electrodynamics and additional-field searches



Precision optics probes nonlinear vacuum properties. Generative illustration.

Maxwell's classical vacuum is linear: fields superpose and light waves do not directly

scatter from each other in this approximation. QED adds virtual charged-particle effects, giving small nonlinear corrections at suitable energies or strong backgrounds. Virtual denotes calculation elements, not a freely accessible reservoir of real particles or energy.

Drummond and Hathrell derived quantum corrections to photon propagation in curved backgrounds. Their effective account combines electromagnetism and curvature, including products of R with quadratic expressions in F . These are theoretical QED consequences under specific conditions. They do not make arbitrary curvature produce a large laboratory effect, nor let low-energy phase velocity alone establish a causality violation. [23]

Vacuum magnetic birefringence is another precise test. PVLAS's 2020 summary reported sensitivity below that needed for QED's predicted signal. At 2.5 tesla, $\Delta n = (12 \pm 17) \times 10^{-23}$, versus approximately 2.5×10^{-23} predicted. This concerns one experiment, not a claim that all nonlinear-QED effects were unobserved or the theory refuted. [24]

Alongside known corrections, searches seek hypothetical light fields. Pseudoscalar axion coupling involves F times its dual, classically $\mathbf{E} \cdot \mathbf{B}$. The later scalar coupling involves F^2 , the difference between magnetic and electric contributions. Their parity and polarisation behaviour differ. Constraints on one coupling cannot be copied to the other without calculation.

ALPS II's first campaign found no new light particles. The May 2026 version gives a 95% two-photon coupling bound of $1.5 \times 10^{-9} \text{ GeV}^{-1}$ for pseudoscalars below roughly 0.1 meV, also considering other bosons. It seeks light passing an opaque barrier through a hypothetical mediator. [25]

The conclusion for our hypothesis is measured. Additional field-geometry coupling is mathematically conceivable, but known quantum physics already contains some such structures. A new proposal must distinguish its contribution from these corrections and respect bounds from other measurements.

16 The universe as a strong-field laboratory

Magnetars and cosmic magnetic fields



Artist's impression of a magnetar; colours and structures are illustrative. Generative illustration.

In laboratories, the gravity of magnetic-field energy is usually very weak. A neutron star's environment brings together high density, relativistic gravity, strong magnetisation and plasma. Magnetars therefore offer a natural environment for studying the interplay between electromagnetism and geometry. Typical estimates of their strong fields are around 10^{10} to 10^{11} tesla. These are inferred from various observations and models, rather than measured by inserting a terrestrial probe. [46]

Magnetar radiation depends on the magnetosphere, field geometry, stellar surface and processes in the crust. Kaspi and Beloborodov's review explains why the evolution and release of magnetic energy can drive intense X-ray activity. This does not imply that the strong gravitational field arises solely from magnetism. The star also contains immense rest energy and internal energy in matter, and would gravitate without that same magnetic configuration. [46]

Cosmic magnetic fields require similar care. They can originate or be amplified in plasma, through the motion of conducting matter and dynamo processes. The origin of primordial seed fields in the early universe remains open, with several candidate mechanisms. Knowledge of a late-time field alone does not determine its earliest origin.

Planck's analysis of primordial magnetic fields showed that such fields can alter the cosmic microwave background through several distinct channels. Numerical bounds depend on the spectrum, smoothing scale and model assumptions. A single field-strength number cannot therefore be stripped of its cosmological meaning and presented as a universal bound on all magnets. The historical Planck 2015 result serves here as a specific methodological example, not a guarantee of the latest constraint on every model. [45]

Strong fields alone do not guarantee a better test. The more complex the environment, the more parameters may mimic the sought deviation. Laboratories offer weaker signals, but sometimes better-known geometry and controlled changes. Astrophysics offers extreme conditions at the cost of harder separation of mechanisms. The strongest conclusion would require one model, with the same couplings, to explain both domains while remaining consistent with precision Solar System tests.

17 Attempts at unification

An extra dimension and the mathematical double copy



Seeking a common mathematical structure of interactions. Generative illustration.

Kaluza-Klein theory shows that higher-dimensional geometry can decompose into a four-dimensional metric, electromagnetic potential and extra scalar degree of freedom. This is more than

a verbal resemblance between fields. A shared higher-dimensional geometry can generate specific couplings in fewer dimensions. Crucial assumptions concern the fields' dependence on the extra coordinate, the shape of space and what would be observable. [29]

This historical approach does not by itself provide a confirmed complete theory of the actual universe. It must address matter particles, the other known interactions, the stability of any hidden dimension and its experimental consequences. A review from 1997 cannot have its assessment of experimental possibilities presented as the state of constraints in 2026. We use it for the structure of the idea, not as current evidence for an extra dimension.

Another surprising connection is the double copy of scattering amplitudes. Bern, Carrasco and Johansson showed that, with a suitable organisation of gauge-theory contributions, gravitational amplitudes can be obtained from a pair of corresponding mathematical structures. Their work contains specific non-trivial checks, alongside a precisely stated conjecture of broader validity. [30]

Double copy offers an unexpected way to seek a shared structure of interactions. These relationships concern particular theories and scattering amplitudes, and may also involve additional fields. Their physical interpretation must distinguish electric gauge symmetry, non-Abelian structure and gravity's geometric symmetry. The research question is which parts of this mathematical connection extend to other situations, and what deeper principle might explain their similarity.

Both routes are valuable to EveryThink because they show a mathematically concrete connection. Each specifies what maps to what, which assumptions are necessary and where extra degrees of freedom appear. An elegant relationship nevertheless differs from empirically confirmed unification of natural interactions. An experiment need not reward mathematical beauty: agreement between predictions and measurements decides.

EveryThink benefits from keeping several research scales alongside one another. Deeper unification may require new geometric or quantum language. At the same time, limited low-energy prototypes can be tried and their observable consequences explored. Such a prototype provides a first computational step while leaving the broader question open.

18 Where quanta and geometry meet

Effective theory, loops and informational connections



Quantum geometry as an open research direction. Generative illustration.

It is often said that gravity cannot be quantised. More precisely, we must distinguish a low-energy effective description from a complete theory valid at arbitrarily high energies. Donoghue showed how general relativity can be used as a quantum effective theory, separating certain long-range quantum contributions from unknown physics at very high energies. This does not settle every question about black holes and the universe's origin, but it counters the impression that no consistent quantum-gravity calculation exists in a limited domain. [27, 28]

An effective theory contains all relevant terms allowed by the chosen symmetries, ordered by their importance at a given energy. Some coefficients are predicted by known low-energy physics; others must be measured or determined by a deeper theory. Adding a new operator is therefore not automatically a discovery. Its scientific value lies in establishing its physical origin, consistency and an independent measurable consequence.

Loop quantum gravity emphasises the quantum nature of geometric quantities and independence from a predetermined background. Ashtekar and Bianchi's review explains its main ingredients and the motivation for studying extreme regimes. For MAGNITACE, the inspiring question is how electromagnetic fields would be described within quantum geometry, and whether that joint description could yield new observable relationships. Testing this possibility remains a separate research task. [31]

Thermodynamic and holographic relationships provide another route. Jacobson derived Einstein's equation from particular assumptions about horizon entropy and local heat balance. This offers a profound interpretation of gravitational equations; it does not experimentally identify a unique microscopic material of spacetime. [32]

Maldacena's correspondence connects specific gravitational and non-gravitational quantum descriptions. Its strength lies in precisely defining both sides. It asks under what conditions geometric properties can correspond to properties of a quantum system, and what role entanglement plays in that relationship. Extending these ideas to our cosmological environment is another open research area. [33]

Following EveryThink's first volume, we can take these approaches as inspiration for asking whether geometry and physical information are different descriptions of a deeper system. We will not use that claim as a computational shortcut here. The low-energy hypothesis will have its own equations and separate tests. Any future microscopic interpretation would have to derive them and explain why their coefficients take the values found.

19 What would demonstrate gravitational entanglement

A scientific dispute whose full significance must be preserved

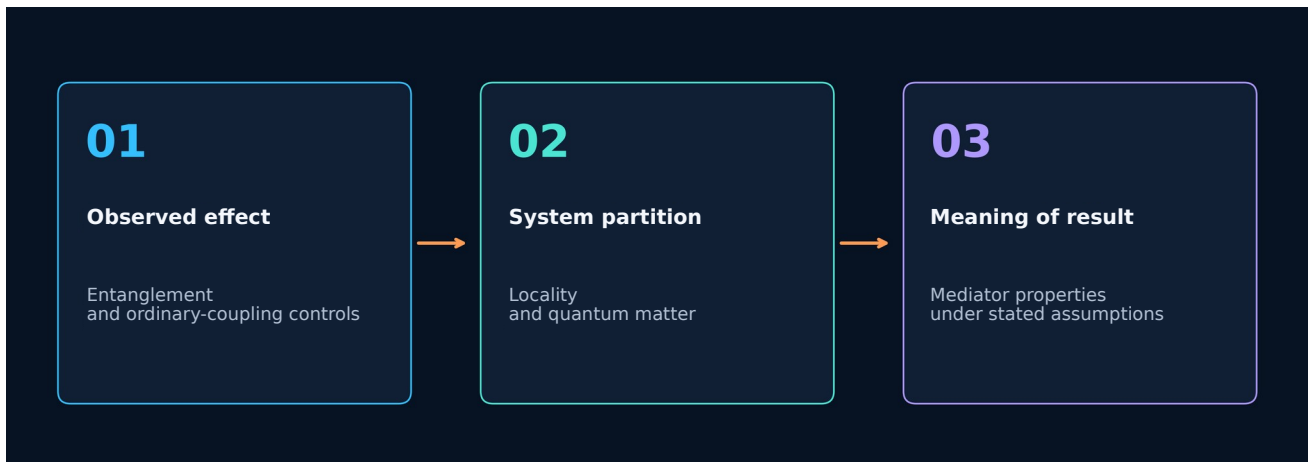


Fig. 6 Evidential structure of gravity-mediated entanglement: data, system partition and mediator assumptions. No completed detection of a quantum gravitational field is depicted. Sources [34–39].

In 2017, Bose and colleagues, and independently Marletto and Vedral, proposed tests in which two massive quantum objects would become entangled through gravitational interaction. The aim is to investigate the mediator's properties without

directly capturing an individual graviton. The evidential argument nevertheless includes assumptions about the separation of subsystems and the information a classical mediator can transmit between them. [34, 35]

In 2025, Aziz and Howl presented a calculation in which certain descriptions with a classical gravitational field permit entanglement within the quantum theory of matter. This was not an announcement of a laboratory measurement. In their 2026 paper, Gundhi, Infantino and Bassi object that the effect under discussion concerns quantum-particle spreading and the choice of system partition, and need not constitute entanglement mediated by classical gravity in the required sense. [37, 38]

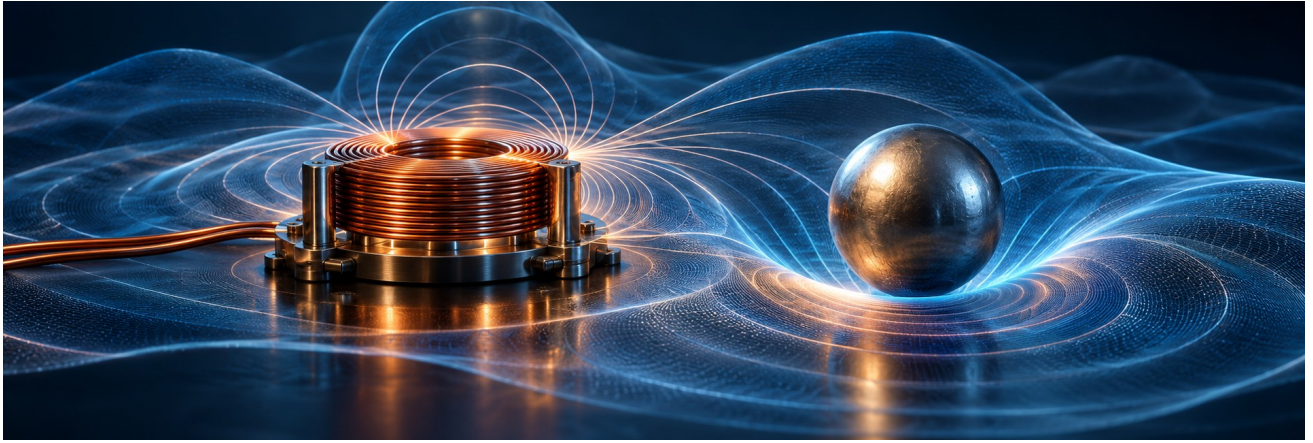
In a paper published on 19 October 2026, Di Biagio discusses the distinction between informational and spacetime locality, and re-examines the assumptions under which the evidential argument holds. For this publication, the crucial point is that one cannot remove those conditions while retaining the original strength of the conclusion. Any data must be interpreted within a precisely specified model of measurement and subsystems. [39]

Graviton detection requires similar care. Carney, Domcke and Rodd show that sensitivity to energy corresponding to individual gravitons is not the same as demonstrating a non-classical gravitational field. A quantum detector can produce discrete records even for some classical inputs. Suitable statistical and correlation properties of the signal would be decisive. [36]

EveryThink draws a general principle from this: before an experiment, write down both what should happen and what that result would justify claiming. An additional force from magnetic apparatus would not yet demonstrate gravity's quantum origin. Even if it proved to be a genuinely new interaction, its quantum character and any unification would require separate tests.

20 One mathematical branch of EveryThink

A scalar prototype for another channel between fields



A hypothetical additional field-matter-geometry channel. Generative illustration.

Let us formulate H1 as one computational prototype: in addition to the known Einstein-Maxwell interaction, a light scalar degree of freedom is weakly coupled to an electromagnetic invariant and to the

gravitational sector. Changing the electromagnetic configuration may then produce an additional signal that cannot be explained solely by changes in the complete energy, momentum and stress of known fields and materials. This variant lets us seek a further connection between fields and formulate its specific possible manifestations.

H0 is known physics: general relativity, electromagnetism, the necessary quantum corrections, and the apparatus's thermal and mechanical response. H1 contains H0 as the limit of zero new couplings or inaccessible range. Further development should identify parameter regions compatible with existing measurements and compare them with new instruments' capabilities. The outcome may suggest apparatus changes, a more sensitive configuration or another research branch.

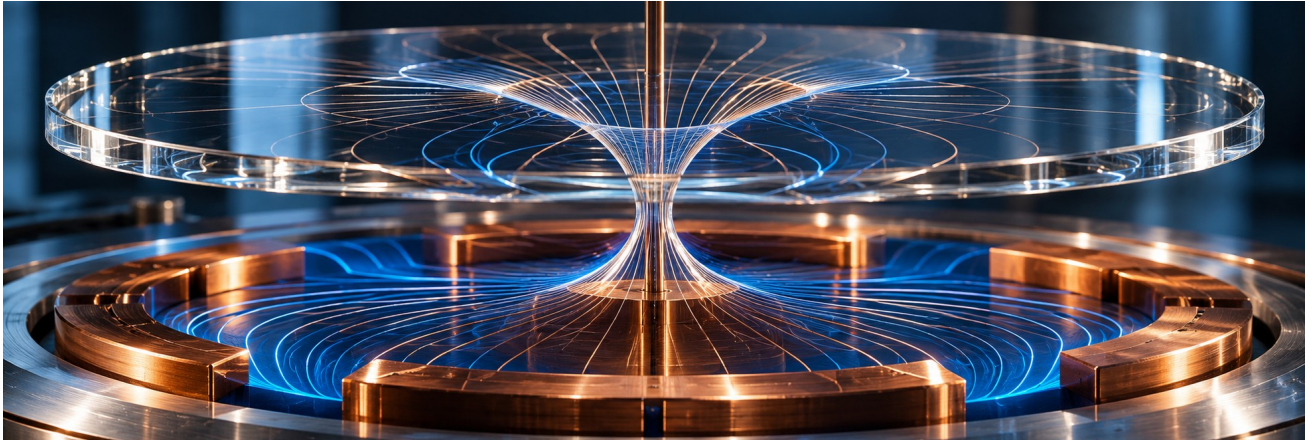
Scalar fields do not lie outside established scientific traditions. Dilaton-type models and scalar-tensor theories have long been studied. Damour and Donoghue show in detail how light-field couplings affect atomic composition and violations of the equivalence principle. Our contribution combines these principles with a specific strategy for comparing electromagnetic configurations. We claim neither novelty for the operators themselves nor priority for an as-yet unverified mechanism. [26]

We choose a scalar as a simple first prototype because its value at an event carries no direction. It also offers a physically distinct possibility alongside the photon and spin-two gravitational perturbations. Other hypotheses might use a pseudoscalar, a new vector or higher metric derivatives. Each branch has its own symmetries, stability and experimental signature. Formulating them separately permits later comparison of concrete possibilities and development guided by results.

H1 focuses on a specific question: are we missing a weak, independently testable channel between electromagnetism, matter and geometry? This defined prototype allows a first calculation and a search for its consequences. It leaves open the broader question of gravity and magnetism's common origin. A positive answer would offer a further research direction and motivate the search for a deeper structure from which that coupling might arise.

21 The hypothesis in mathematical form

An effective action and its limits



From intuition to a concrete mathematical prototype. Generative illustration.

Use $\hbar = c = 1$, signature $-+++$ and reduced Planck mass M_P . A simple

illustrative action is the sum of Einstein and Maxwell terms, the dynamics of a real scalar ϕ and two added couplings. Ordinary matter enters $\mathcal{L}_m$. For the local laboratory account we neglect the cosmological constant, not its cosmological existence.

$$S = \int d^4x \sqrt{-g} \left[\frac{M_P^2}{2} R - \frac{1}{4} F_{\mu\nu} F^{\mu\nu} - \frac{1}{2} \partial_\mu \phi \partial^\mu \phi - \frac{1}{2} m_\phi^2 \phi^2 + \beta M_P \phi R - \frac{d_\gamma}{4M_P} \phi F_{\mu\nu} F^{\mu\nu} + \mathcal{L}_m \right]$$

m_ϕ determines the scalar quantum's rest mass and associated range. β and d_γ are dimensionless in this normalisation. ϕ has mass dimension one, R dimension two and F^2 dimension four; every term in square brackets therefore has dimension four. ϕF^2 modifies the effective electromagnetic coefficient, while ϕR mixes the scalar with geometry. This is an example of an effective model, not a complete action containing every symmetry-allowed operator. [26–28; author's choice of parametrisation]

This choice preserves electromagnetic gauge invariance and general covariance. That alone does not guarantee physical acceptability. In the working neighbourhood, the effective Einstein coefficient must be positive, $M_P^2 + 2\beta M_P \phi > 0$, as must the photon kinetic coefficient $1 + d_\gamma \phi / M_P$. The model also needs stable scalar kinetics and a consistent energy domain. Violating these conditions would mean failure of the chosen approximation, rather than predict a working device.

On transformation to the Einstein frame, ϕR mixing produces, among other effects, scalar coupling to mass parameters and a change in kinetic normalisation. For small perturbations around $\phi = 0$, the relevant local kinetic factor is $1 + 6\beta^2$. β therefore cannot simply be read as a directly measured force between two bodies. We must first canonically normalise the field and determine the scalar charges of the specific materials.

Quantum corrections may generate further terms. If needed at the planned experiment's precision, they must enter the uncertainty budget or be added explicitly. Writing two new coefficients does not guarantee closure under renormalisation. The scientifically careful meaning of this action is limited: it provides a consistent starting language for a first calculation and for asking which coupling combinations experiments can constrain.

22 A difference beyond energy alone

Electromagnetic invariants as a discriminating tool

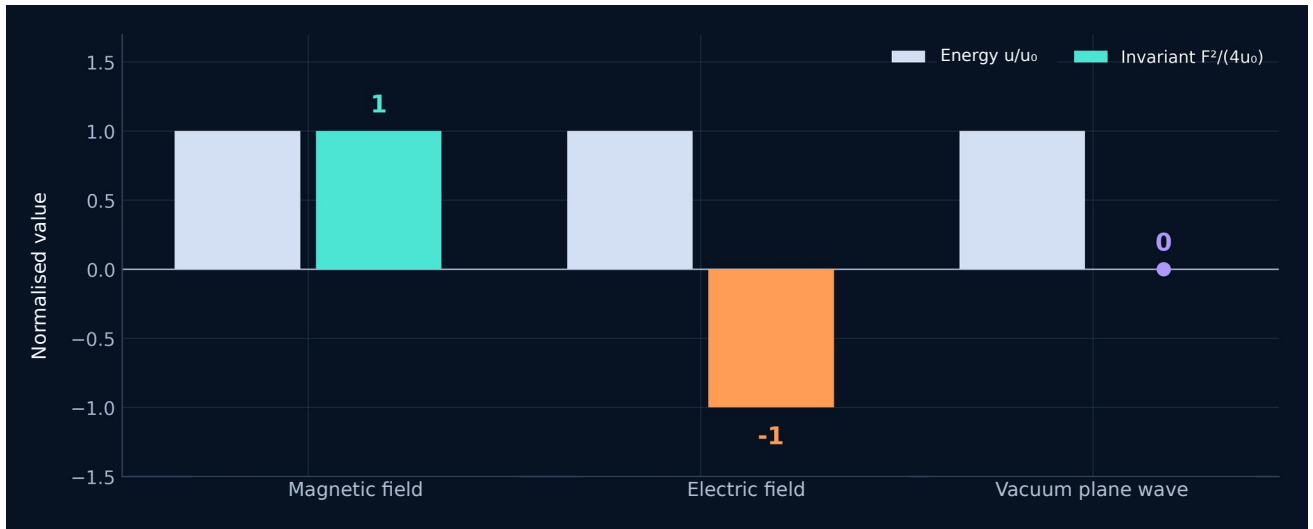


Fig. 7 Equal local u_0 , different invariants. Rationalised $c = 1$, $F^2 = 2(B^2 - E^2)$. An ideal plane wave has zero invariant yet carries energy. Author's analytical model, no experimental data.

Varying the action with respect to ϕ gives its field equation. The right side contains

the electromagnetic invariant and a curvature contribution. The equation describes how known fields can excite the scalar. It does not yet determine the measured signal's magnitude, which also depends on boundary conditions, field propagation and the particular detector's response.

$$(\square - m_\phi^2)\phi = \frac{d_\gamma}{4M_P} F_{\mu\nu} F^{\mu\nu} - \beta M_P R$$

$$F_{\mu\nu} F^{\mu\nu} = 2(B^2 - E^2), \quad u = \frac{1}{2}(E^2 + B^2)$$

The first equation uses natural units; E and B in the second pair likewise use a consistent rationalised system with $c = 1$. In SI, the sign distinction corresponds to $B^2 - E^2/c^2$. Electromagnetic energy density instead contains the sum of electric and magnetic contributions. These two kinds of information about the field are therefore different.

Purely magnetic and purely electric configurations can have equal energy but opposite signs of F^2 . An ideal plane electromagnetic wave in vacuum has $F^2 = 0$ and $E \cdot B = 0$, yet carries energy and gravitates. In H1, this ideal wave alone would not provide the same direct ϕF^2 scalar source as a static field. Other backgrounds, boundaries or interfering waves change the situation, however.

This is a concrete reason to compare configurations rather than magnet strength alone. Two configurations with the same complete H0 gravitational prediction may have different direct scalar sources. "Complete" is crucial: equal field energy alone does not guarantee equal stresses, multipoles or total apparatus energy. Only after calculating and measuring these can a residual be interpreted as a candidate new signal.

The earlier point about the tensor's trace is equally important. In a classical electrovacuum region with zero cosmological constant, R vanishes even though the field gravitates. ϕR alone would therefore not provide the intended direct scalar source of a free magnetic field. The explicit ϕF^2 term introduces that possibility. Saying that field energy somehow curves space cannot replace the need for this term.

23 From an equation to a measurable signal

Range, scalar charge and deviation magnitude

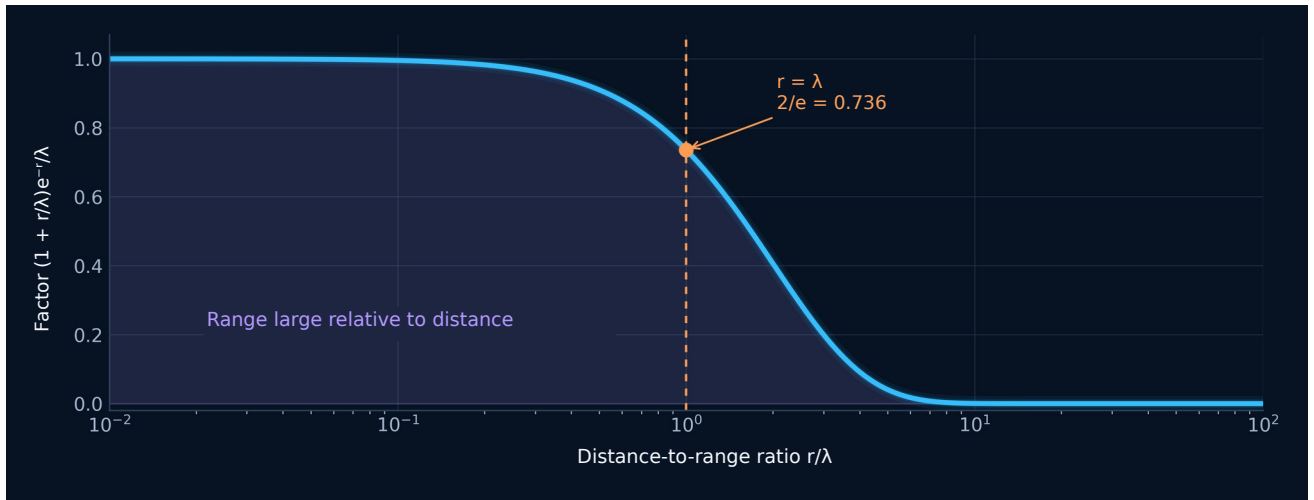


Fig. 8 Yukawa radial-force attenuation relative to its short-distance limit. A static point-source model, not an experimental exclusion bound.

Weak static fields can be expressed as a screened Poisson problem. With canonically

normalised field χ and a chosen source density J_χ , the solution contains the Yukawa kernel $\exp(-mr)/(4\pi r)$. The sign before the integral depends on J_χ 's definition; physical attraction or repulsion is determined by the product of source and detector couplings. The following potential sets this convention explicitly.

$$V(r) = -\frac{Gm_A m_B}{r} \left[1 + 2q_A q_B e^{-r/\lambda} \right]$$

Here $q_A = MP \partial \ln(m_A)/\partial \chi$, and similarly q_B , evaluated in the working background. G is Einstein's gravitational constant in this normalisation, and r the distance between stationary point sources. Fits to a laboratory-measured constant must include any scalar contribution. Finite apparatus requires volume integration. In SI, $\lambda = \hbar/(m_\chi c)$. m_χ is the canonically normalised perturbation's mass, not automatically the unchanged m_ϕ parameter of the original action.

At a fixed λ , one experiment may measure only the product of source and detector charges. A null result will therefore generally not determine β and d_χ separately. Separating them requires several materials, different source configurations or complementary clock measurements. A very short range can hide stronger coupling from a distant detector. Long-range coupling, conversely, faces precision composition and Solar System tests.

For illustration, define the phenomenological ratio κ between additional acceleration and Chapter 13's order-of-magnitude gravitational estimate for field energy, with r much smaller than λ . At a hypothetical threshold of 10^{-15} m/s^2 , this particular source would require about $|\kappa| \geq 3.4 \times 10^5$. This is only a ratio of two chosen numbers. It establishes neither compatibility with other experiments nor the achievability of that threshold near a magnet.

The next step in this mathematical branch is a joint calculation of parameters and realistic sensitivity. We do not yet perform a global numerical fit. We have a defined prototype that can be extended, compared with other mechanisms and connected to instrument design.

24 A decisive laboratory test

Source states that can be characterised independently

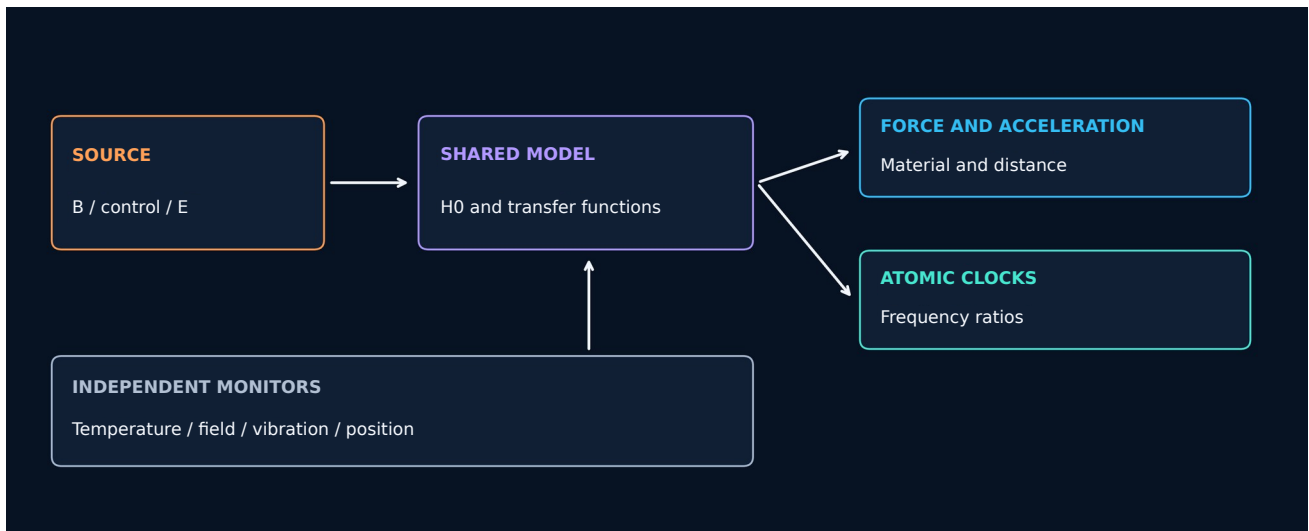


Fig. 9 EveryThink measurement concept. Electric state E depends on feasibility; matched field energy is no substitute for a complete apparatus model. Not a completed tested device.

The proposed programme measures differences between predefined source

states. State A contains stored magnetic energy. State B contains comparable additional energy in a control system, such as a thermal or another electromagnetic reservoir. State C is an electric counterpart where feasible. No pair is automatically perfectly equivalent: its known gravitational difference must be calculated from the complete construction and checked by measuring positions, temperatures and energies.

The source should be spatially separated from the detector. Wires, cooling lines and mechanical supports must not transmit uncharacterised modulation. A toroidal or otherwise compensated magnet may help limit ordinary field leakage into the detector region. Even an ideal toroid does not remove every material coupling, gradient, vibration or change in mass multipoles. Measure and model the resulting field rather than infer it from the coil's name.

One detector can monitor force or acceleration of a neutral test mass, while another compares atomic-frequency ratios. The force channel tests different distances and at least two materials. Clocks require ordinary gravitational, Zeeman, Stark and thermal shifts to be separated. Two different transitions may respond differently to a change in electromagnetic coupling, while a reference resonator can sometimes detect common interference. [41; proposed extension of the test]

Before collecting the main data, verify each detector's linear response and transfer function. Strong field modulation at the sensor's most sensitive frequency may be suboptimal if it also excites a structural resonance. Slow switching reduces some dynamic effects but increases sensitivity to drift. The specific compromise must follow from the measured noise spectrum.

The proposed scheme is a concept for further specialist development. Detailed apparatus design will determine achievable sensitivity, suitable sources and their operation. Here we formulate the main measurement tasks: independent source characterisation, sufficient control states and detectors with different responses to individual physical contributions. An initial partial implementation can verify one of these steps and refine the next design. A later signal can then be compared with a specific prediction.

25 Separating physical contributions

Interference obeys physical laws of its own



Conceptual precision laboratory arrangement. Generative illustration.

The main practical task in precision measurement is to distinguish electromagnetic and mechanical contributions. A test body may retain charge, a magnetic moment or non-zero susceptibility. Even electrically neutral material can respond to field gradients through induced polarisation. For many weakly magnetic samples, force includes a term proportional to the gradient of B^2 . Such a signal is even under polarity reversal and can mimic precisely a scalar effect that also depends on a quadratic invariant.

Current reversal alone is therefore not decisive. It separates some odd couplings, but not every even contribution. We need geometry changes, residual-field measurements at the detector, suitable material controls and independent calibrations. Shielding is not magical either: it can itself magnetise, heat or deform, with a frequency-dependent response. Changing shielding type should be a control measurement, not a reason to ignore its own gravitational mass.

Heating adds further channels. Thermal expansion changes matter’s position and hence the actual known gravitational signal. Radiation creates pressure, while temperature gradients in imperfect vacuum can generate gas-mediated forces. Magnetostriction can change a ferromagnet’s dimensions synchronously with magnetisation. A connected wire can transmit Lorentz force into the support structure. These mechanisms are not statistical accidents, and longer averaging need not remove them.

Possible origin	What it can mimic	Required control
Residual charge	Stray-E force	Neutralisation; independent probe
Susceptibility	Signal even in B	B^2 gradient; exchange materials
Magnetostriction	Mass-position change	Optical deformation measurement
Heating and gas	Drift or periodic force	Temperature, pressure, control heating
Support vibration	Source-frequency component	Accelerometers; mechanical substitution

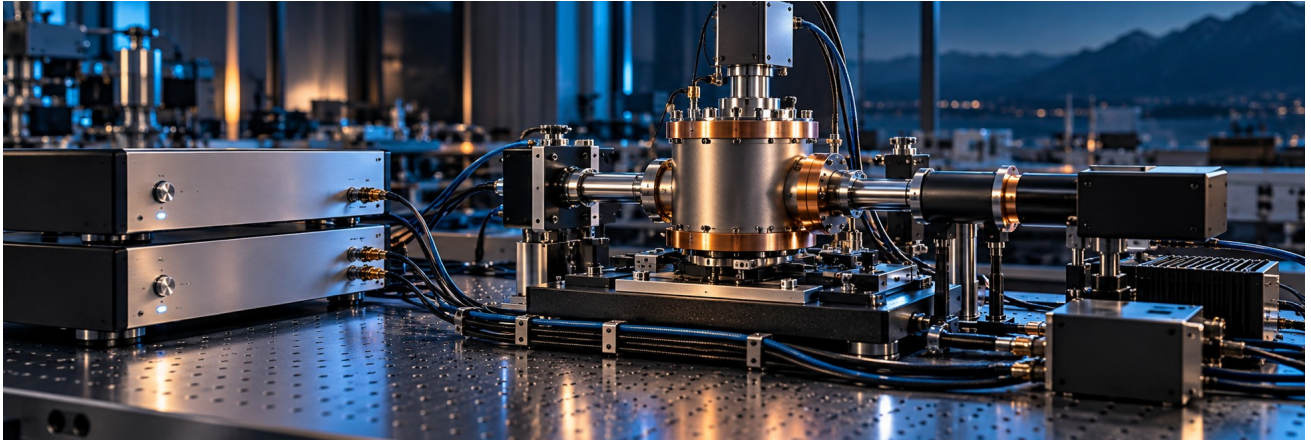
Table 1 Physical contributions and independent controls. Author’s comparison matrix.

Precision gravity experiments therefore use modulation, reference channels and systematic-uncertainty analysis. Westphal’s experiment had to establish that non-gravitational contributions did not dominate the measured signal. MICROSCOPE explicitly analysed thermal instabilities and short events capable of mimicking the differential acceleration sought. We adopt their methodological principle, not automatically their achieved sensitivity. [12, 15]

A discovery candidate should survive source substitution, a change of detector, blinded changes in state order and calibrated injections of known interference. If amplitude tracks temperature or residual fields better than H1’s source functional, known physics provides the explanation. That would not make the measurement a disappointment: eliminating incorrect interpretations is essential to every credible experiment.

26 Preparing future experimental analysis

A statistical plan before unblinding data



Measurement planning determines permissible inference. Generative illustration.

Initial exploration helps identify useful relationships and questions. For later confirmatory measurements, prespecify the main observable, sign convention, expected signal shape and calibration procedure in advance. For force, this could mean response amplitude and phase against a known source sequence; for clocks, a difference of frequency ratios with specified transition sensitivities. Auxiliary channels have predefined roles in monitoring interference.

A simple working model is $y(t) = A s(t; \lambda) + \text{a sum of control contributions} + \text{noise}$. Template s includes source geometry, time evolution, range and detector transfer function; A represents a chosen coupling combination. Control terms must not be added retrospectively simply to manufacture the desired residual. Strong correlation between the template and a temperature channel must be reflected in the uncertainty of A .

Blinding can hide state order or a small calibration component until the analysis is closed. One data subset sets filters and exclusion rules; a confirmatory subset is analysed by the fixed procedure. Failed runs must also be retained, with reasons for exclusion. Retrospectively selecting a few favourable intervals can create the appearance of a periodic signal even from ordinary noise.

For white uncorrelated noise, some uncertainties improve approximately with the square root of measurement time. Long-term drift, coloured noise and periodic interference disrupt this rule. We therefore measure the power spectrum, stability over time and cross-channel correlations. Combining statistical and systematic uncertainties must respect their dependencies: mechanically adding arbitrary percentages is not an uncertainty budget.

Searching many ranges, frequencies, orientations or model versions increases the chance of a random extreme. Significance must account for the actual search scope. Even the often-cited five-standard-deviation threshold does not replace systematic-error controls and independent repetition. Publish the result alongside calibration data, code, time series and the precise prediction model, so another team can repeat the calculation.

An experiment designed this way can be useful even without a discovery. It supplies a reproducible upper bound on a specified parameter combination, helping select another configuration, a more sensitive measurement or a different model branch. Recording the original assumptions preserves exactly which possibility was tested and which questions remain open.

27 Distinguishing research possibilities later

Specific versions and parameters matter



Comparing configurations and materials distinguishes mechanisms. Generative illustration.

One finite-precision test cannot exclude H1 with arbitrarily small couplings throughout its mathematical space. A region below sensitivity can always remain. What is scientifically testable is a specific version with defined range, couplings, environment and predicted amplitude. If that prediction exceeds verified sensitivity and no signal appears, that version is excluded in the relevant parameter region. Searches for new particles are routinely evaluated this way.

A candidate detection must meet several conditions simultaneously. Its distance dependence must match the calculated geometry and range. Material dependence must agree with scalar charges rather than magnetic susceptibility alone. Source-configuration changes must follow the predicted invariant or complete source integral. Time phase cannot be adjusted arbitrarily for every run: it must agree with model dynamics in the chosen operating regime.

Test	H1 requirement	What challenges it
Distance	One common range λ	Incompatible spatial dependence
Material	Calculated scalar charges	Susceptibility-only dependence
Source state	Full-action prediction	Signal tracks heating alone
Replication	Identical model parameters	Verified bound below prediction

Table 2 Testing a specific H1 version. Author’s comparison matrix.

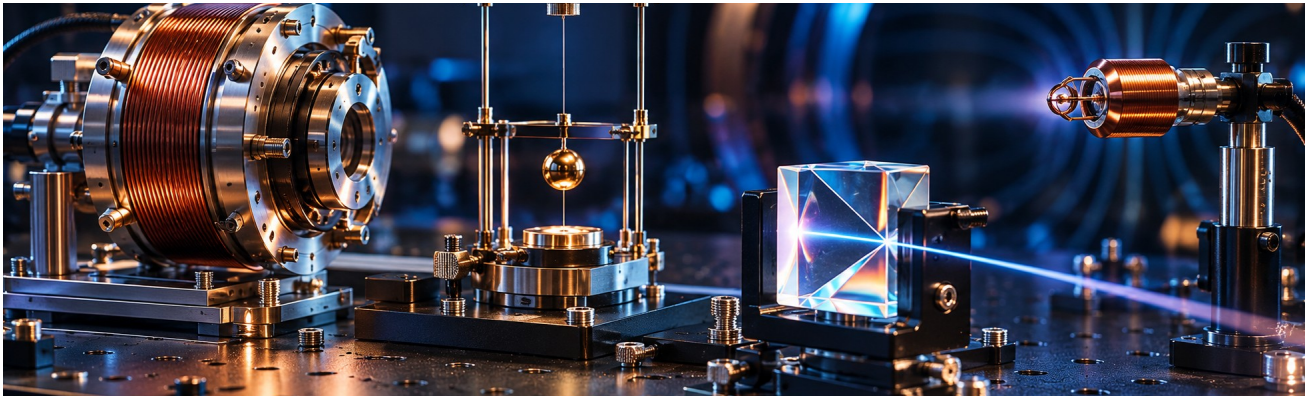
An inconsistency within H1 itself would be particularly valuable. A force signal might, for example, require such strong electromagnetic coupling that it simultaneously predicts an already excluded clock-ratio change or equivalence-principle violation. Dismissing the less convenient experiment would not suffice. Either the conversion contains an error, or the chosen model does not explain the signals jointly.

Conversely, a positive deviation need not confirm the entire hypothesis. A first laboratory anomaly may be an unknown artefact, an error in the apparatus model or another new interaction. Repetition and comparison of several signatures distinguish these possibilities. “A new force was detected” is stronger than “the measurement disagrees with our current instrument model”. “Gravity and electromagnetism were unified” is substantially stronger still.

EveryThink can also proceed by comparing different branches. If one simple variant fails a result, that may point towards a different coupling structure, another measurement regime or a new view of the original question. Record every change in assumptions so that the possibility actually tested remains clear. The purpose of this phase is to orient further inquiry.

28 Combining bounds without false comparisons

Each experiment constrains a different model projection



Different instruments measure different manifestations. Generative illustration.

MICROSCOPE is not directly a 10^{-15} bound on $d\gamma$. Its η compares the accelerations of two materials in Earth's source field. Translating this into H1 coefficients requires Earth's scalar charge, the charges of both alloys, the range and any environment-dependent effects. Similarly, ALPS II constrains mediator mass and photon coupling in a particular polarisation and geometry. A numerically smaller bound is not necessarily a stronger test of another model. [12, 25, 26]

Channel	Tested observable	Conversion to H1
MICROSCOPE	Differential acceleration	Earth/alloy charges; range
Torsion balances	Force and range	Source geometry and material
ALPS II	Regenerated photons	Boson, mass, polarisation
Atomic clocks	Frequency ratios	Transition sensitivities; time model
Spin tests	Directional spin forces	An operator beyond φF^2

Table 3 Converting experiments to one model. Author's comparison matrix.

Clock experiments can probe dimensionless-constant changes or hypothetical fields varying in space and time. Filzinger and colleagues used spatially separated clocks and optical resonators to access couplings that may partly cancel in local comparisons. Their interpretation includes an ultralight-dark-matter model. For a static artificially generated field, we must therefore rederive the source, frequency response and transfer between sites. The published number cannot be adopted without these steps. [41]

Spin-polarised torsion measurements provide another distinct channel. Heckel and colleagues searched for electron-spin-dependent interactions and directional effects. This methodology matters for claims that new gravity follows spin orientation itself. It is nevertheless different from the scalar φF^2 term. Even in one material, spin charge, total magnetic moment and electromagnetic energy may vary differently. [42]

A global evaluation must therefore start with a common definition and normalisation of the action. Next derive each experiment's observables, rather than visually overlay curves with different axes. Then construct a likelihood or another clearly defined statistical procedure, propagating composition, geometry and environmental uncertainties. Any correlations between inputs must be preserved.

This publication maps these couplings and the required calculations; it does not present a completed joint fit. The precise scientific statement is that H1 is a concretely formulable family of models subject to many existing constraints. A joint recalculation and measurements of the particular design's properties will allow assessment of new laboratory sensitivity.

29 What a discovery would mean for physics

An added field need not be the final explanation



Consequences of deeper coupling remain research questions. Generative illustration.

Imagine two independent teams repeatedly detecting an extra signal matching H1's distance and material predictions, with known interference excluded and the same parameters passing

the other tests. This would demonstrate the inadequacy of the existing null model in that regime and could offer strong support for a new scalar field. It would be a major discovery of new physics.

We would still need to determine what the new mediator explains. It may be another weak force alongside gravity and electromagnetism, or a low-energy manifestation of a broader theory. It might relate to cosmology, but that would require separate data on cosmic evolution and field density. Laboratory detection alone does not establish its cosmological contribution.

Deeper unification would require deriving the known sectors, their symmetries, coupling relationships and interactions with matter. The theory should explain electromagnetism's two signs of charge, ordinary free fall's universality and the observed polarisations of gravitational and electromagnetic disturbances. A new bridge between two existing sectors does not by itself determine their common microscopic origin.

Nor would cost-free energy follow. A consistent model must include the new field's energy and the source that excites it. Mechanical work from a cycle must be accounted for in the complete energy balance. Predicting a force is not predicting an engine, and observing a new coupling does not automatically enable practical control of gravity.

A discovery could indirectly change our view of what gravity is. New experimental information would help distinguish classes of effective theories and might lead to new mathematical structures. Its strongest impact would come from specific measured relationships: dependence on energy, field configuration, material and distance. These data can take us from surprise to explanation.

EveryThink can thus combine bold questions with a rigorous acknowledgement of limits. The greatest intellectual advance need not be "everything is one". It may be discovering a precise rule explaining when distinct phenomena connect and when their differences remain physically decisive.

30 Five technical checks before conclusions

Units, symmetries, energy, sources and readout



Calibration, dimensions and transfers belong to the full experiment. Generative illustration.

The first check is units. Chapter 13 uses SI: B in tesla, E in V/m and energy in joules. The action uses $\hbar = c = 1$ and rationalised electromagnetic normalisation. Substituting tesla directly into natural-unit F^2 without conversion would be meaningless. The reduced Planck mass also differs from the ordinary Planck mass by $\sqrt{(8\pi)}$. Precise normalisation is part of the prediction, not a cosmetic choice. [44]

The second check is symmetry. A proposal using B^2 alone, without specifying an observer frame and including the electric component, need not be relativistically invariant. Adding an arbitrary potential depending directly on electromagnetic potential A without checking gauge symmetry may introduce unobservable or inconsistent dependence. F^2 and F times its dual are natural in this respect, but have different transformation properties.

The third check is conservation of energy and momentum. Coupled fields exchange energy, so each sector's tensor is not generally conserved separately. The correctly defined total, including scalar and source, must be conserved. A calculation that includes switching on a coil but omits power-supply work or support deformation cannot demonstrate a violation of this balance.

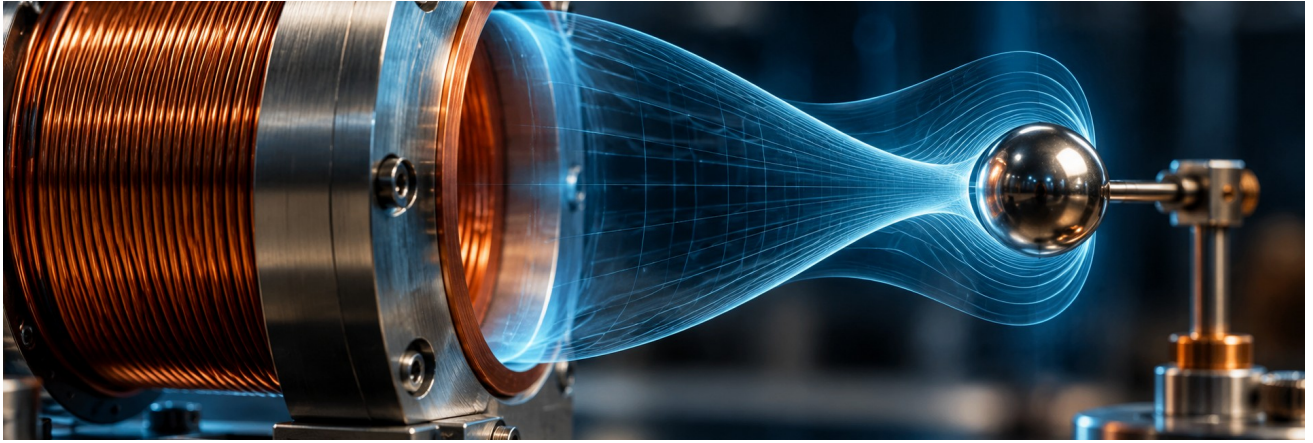
The fourth check is the complete source. A magnetic-phase change may simultaneously alter internal energy, temperature, dimensions and external fields. A distant apparatus's potential depends on its entire mass configuration and multipoles. Comparing a measured signal only with an idealised small-volume B^2 integral may omit material that dominates ordinary gravity. Strongly gravitationally bound bodies additionally require relativistic structure and self-gravity.

The fifth check is readout itself. Clock frequency depends on proper time and the transition's internal energy structure. Detector force depends on field coupling and the calibration model. Metric, scalar field and sensor reading are different quantities. Their entire conversion must be derived, including how the experiment defines distance, time and a reference unit.

These checks do not provide a final theory, but are powerful tools for eliminating incorrect proposals. A candidate that fails them needs correction before even visually impressive data are interpreted. A bold hypothesis and a careful technical calculation support one another.

31 An analytical bridge from invariant to force

Derivation within a precisely limited approximation



Force prediction needs source, detector and relative geometry. Generative illustration.

Consider weak perturbations near $\varphi = 0$ and negligible

spatial variation in kinetic normalisation and use the canonical field $\chi = \sqrt{K} \varphi$, where $K = 1 + 6\beta^2$. The direct electromagnetic coupling to χ then has coefficient $d_\gamma/\sqrt{K}$. In rationalised natural units, define $u_B = B^2/2$ and $u_E = E^2/2$. In this approximation, only the direct electromagnetic source contribution can be written as a density proportional to $u_B - u_E$.

$$\sigma_\chi^{\text{EM}} = \frac{d_\gamma}{M_P \sqrt{K}} (u_B - u_E), \quad K = 1 + 6\beta^2$$

For the static equation $(\nabla^2 - m\chi^2)\chi = \sigma_\chi$, the solution is the negative integral of the source with a Yukawa kernel. If the source is small compared with both detector distance and range, its direct electromagnetic scalar charge can approximately be replaced by a volume integral. We obtain $Q_{\text{EM}} = d_\gamma(u_B - u_E)/(M_P \sqrt{K})$. This more precisely states that equal purely electric and magnetic energies can have opposite effects in this term.

A test body of mass mt responds through $q_t = M_P \partial \ln(mt)/\partial \chi$. Substituting $M_P^{-2} = 8\pi G$ yields the following signed radial contribution; positive a_r points outwards from the source. Conversion to SI is given explicitly in the formula.

$$a_r^{\text{EM}} = -\frac{2Gq_t d_\gamma}{\sqrt{K}} \frac{U_B - U_E}{c^2 r^2} \left(1 + \frac{r}{\lambda}\right) e^{-r/\lambda}$$

The minus sign therefore denotes attraction for positive $q_t d_\gamma(u_B - u_E)$. In this limit, the ratio to the order-of-magnitude gravitational estimate for purely magnetic energy is $\kappa = 2q_t d_\gamma/\sqrt{K}$. These are not two arbitrary independent amplifiers: q_t follows from the full action and detector composition, and is subject to other experimental bounds.

The result has crucial limitations. It is the direct field-coupling contribution, not a real coil's total force. Source material carries its own scalar charge; a state change may alter temperature, stress and the composition of its energy. Finite volume requires retaining the integral and any dynamics. If the source is not small relative to λ , the simple point charge Q_{EM} is insufficient. We also assume the environment neither screens nor nonlinearly changes the scalar field.

Nevertheless, this calculation gives the hypothesis concrete content. It specifies dependence on energy, invariant sign, range and detector material, and links phenomenological κ to the illustrative model's parameters. Further specialist work can confirm or refine these rules, or find them inapplicable to a realistic construction. In each case, this is now a checkable mathematical problem.

32 The research path beyond this study

What remains to calculate and measure



Research continues through calculation, prototypes and measurement. Generative illustration.

One subsequent theoretical task is canonical normalisation of the illustrative action in a particular background, the complete set of couplings to atomic matter and correct source functionals for the chosen configurations. Next comes a numerical field solution for finite geometry, including detector, source, shielding and surroundings. Only this can turn the author's proposal into a prediction in measured units.

The second step is jointly evaluating existing bounds. Parameters must be constrained with the same model across free-fall, short-range-force, photon and clock tests. If the viable region lies below the noise of every realistic instrument, the conclusion for that experimental concept must be negative. The calculation will identify configurations worth developing and the new questions their comparison opens.

The third step is a metrological prototype intended to measure interference. Initially it can test ordinary mechanical, electromagnetic and thermal transfers without claiming detection of a new force. Its success will be a credible uncertainty budget and demonstrated sensitivity in a real configuration. Such a budget cannot be derived from an isolated sensor's best theoretical sensitivity.

A later evidential stage can follow with a preregistered experiment and independent replication. Source model, calibration, exclusion rules and analysis must be open to public scrutiny. If an anomaly appears, first seek its physical signature and test it with new configurations. Interpretation must remain proportionate to what the data actually distinguish.

Search terms included Einstein Maxwell stress energy, quantum exchange magnetism, Gertsenshtein photon graviton conversion, dilaton equivalence principle and gravity mediated entanglement, with experiment names. Related papers and original citations expanded the search. References document foundations and recent interpretive disputes. Full-text access varied; some details came from author abstracts and institutional records. No complete numerical reanalysis or independent experimental replication was performed.

What do we know so far? Magnetism has a well-developed relativistic and quantum description. Gravity has a highly successful geometric description and a usable low-energy quantum effective theory. Their known mutual coupling is real, but a definitive common microscopic origin is unproven. EveryThink opens several possibilities for deeper explanation and develops one into a mathematical prototype. At this stage, its contribution is a map of questions, connections and next steps. Discovery remains possible; any evidence belongs to a subsequent research stage.

33 Questions changing the direction of inquiry

From slow fall towards a common mechanism



New questions change the view of a familiar arrangement. Generative illustration.

Return to a magnet moving through copper with dramatically altered motion. This experience

can begin a question extending beyond the original experiment. MAGNITACE now broadens its search space. We ask whether the relationship between motion, environment and field can reveal something essential about gravitational coupling too. This section offers concrete intellectual paths for development. Their names organise our research; they do not themselves claim a historically new discovery.

The first unexpected question shifts attention from material to process. What if the important quantity is not copper's presence itself, but how the system responds over time? The same magnet and tube, at the same instantaneous position and speed, can have different motion histories and different persisting currents. Two situations looking identical in a photograph may therefore differ physically. Research can focus on the difference between instantaneous state and response history. This opens HCu-M, the environmental-memory branch.

The second question concerns a body's coupling to its surroundings. What if a gravitational property also depends on the joint state of magnet, conductor and electromagnetic field? This differs from simply claiming that all Earth's attraction weakens. It could involve altered passive gravitational coupling of a particular object in a particular environment. We call this open branch HCu-G. Its first aim is to identify a meaningful state property and how it would manifest across several configurations.

The third question concerns boundaries. Could the relation between local motion and the whole system's arrangement carry further information? Closing a current path, connecting an external circuit or changing a remote termination can affect allowed field modes and their time evolution. Known electrodynamics already includes such dependencies. HCu-B asks further: could a structure also have a precisely calculable gravitational consequence, perhaps beyond the present model? Useful configurations would separate local material changes from changes in the overall response.

The fourth question seeks a common origin. What if electromagnetic response and gravity's geometric description emerge as different manifestations of a deeper system? The copper tube could then provide an accessible starting point even if its ordinary motion agrees completely with induction. HCu-U will seek common microscopic variables and a way to derive both macroscopic descriptions from them. Possible outcomes include a new interpretation of known equations, another relationship between their coefficients or a new prediction.

These four directions can be explored together because they address different parts of the problem. Environmental memory concerns time; state coupling concerns object and environment; boundaries concern overall arrangement; common origin concerns a deeper descriptive level. At this stage, develop their simplest versions and record the assumptions they add. The following chapters give two questions an initial computational form and the fourth a specific theoretical task.

34 Environmental memory as a computational route

Equal instantaneous speed can conceal different situations

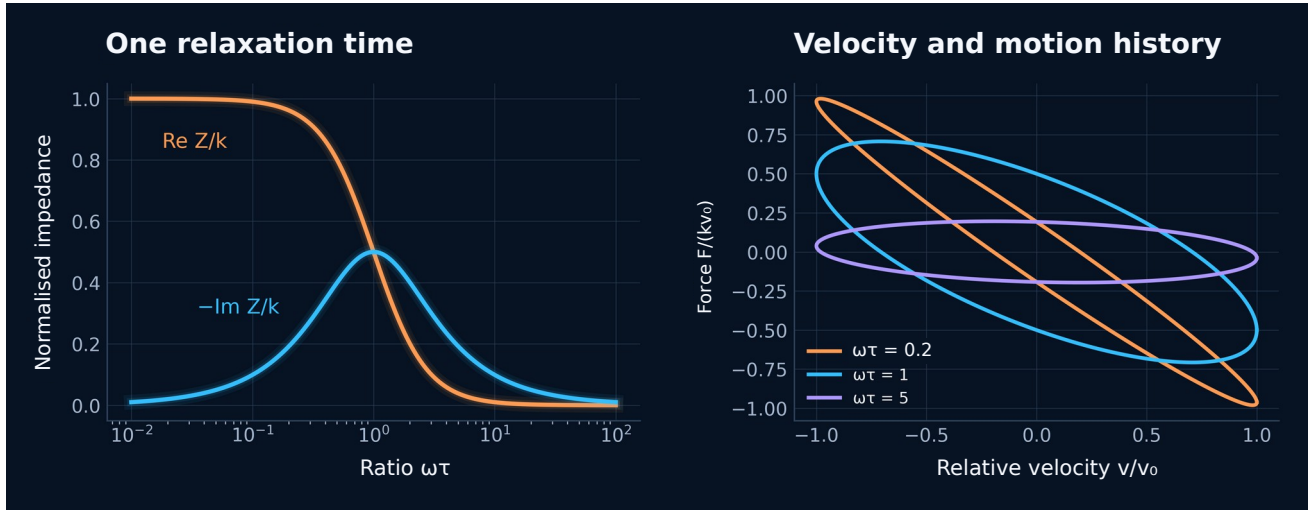


Fig. 10 Exponential-kernel memory model. Left: real and negative imaginary Z/k for $\exp(i\omega t)$. Right: harmonic-velocity force at three $\omega\tau$. Author's calculation; parameters were not measured in a copper tube.

$F = -kv$ uses instantaneous velocity alone. General linear response allows force

to depend on earlier motion of the magnet relative to the conductor. A causal memory kernel $\Gamma(s)$ assigns different weights to different time delays. For small motion around a chosen working arrangement, we can write the following one-dimensional equation. A complete description may involve tensors, spatial dependence and additional state variables.

$$F_{\text{prostř}}(t) = - \int_0^\infty \Gamma(s) v_{\text{rel}}(t - s) ds$$

Here s is positive time delay, v_{rel} relative velocity and $F_{\text{prostř}}$ the environment's force on the magnet. Γ has SI dimensions kg/s^2 . Dependence on history can also be derived by describing the object jointly with many environmental degrees of freedom, then mathematically eliminating the environment. Caldeira and Leggett developed this procedure for a chosen quantum Brownian-motion model. It is a methodological tool here; the copper tube's kernel needs its own electromagnetic and material calculation. [52]

The first solvable prototype uses an exponential kernel. τ denotes a single relaxation time, and k the positive magnitude of low-frequency response. The same model can be rewritten using auxiliary quantity w , with velocity dimensions. With the harmonic convention $\exp(i\omega t)$, the ratio of negative force to velocity is the complex impedance $Z(\omega)$.

$$\Gamma(s) = \frac{k}{\tau} e^{-s/\tau}, \quad s \geq 0, \quad \tau \dot{w} + w = v_{\text{rel}},$$

$$F_{\text{prostř}} = -kw, \quad Z(\omega) = \frac{k}{1 + i\omega\tau}$$

The real part of Z/k is $1/[1 + (\omega\tau)^2]$, and its imaginary part $-\omega\tau/[1 + (\omega\tau)^2]$. For very slow changes, w approaches v_{rel} and approximately instantaneous resistance is recovered. Faster changes create significant phase lag. Two passages at the same instantaneous speed can therefore have different force because w differs. The graph consequently plots a time-parametrised loop between velocity and response.

The model permits precise energy accounting. Assign the auxiliary degree of freedom $E_{\text{pam}} = k\tau w^2/2$. Its evolution equation gives $dE_{\text{pam}}/dt = kwv_{\text{rel}} - kw^2$. Mechanical power on the magnet is $-kwv_{\text{rel}}$; adding the change in E_{pam} leaves $-kw^2$. Energy can

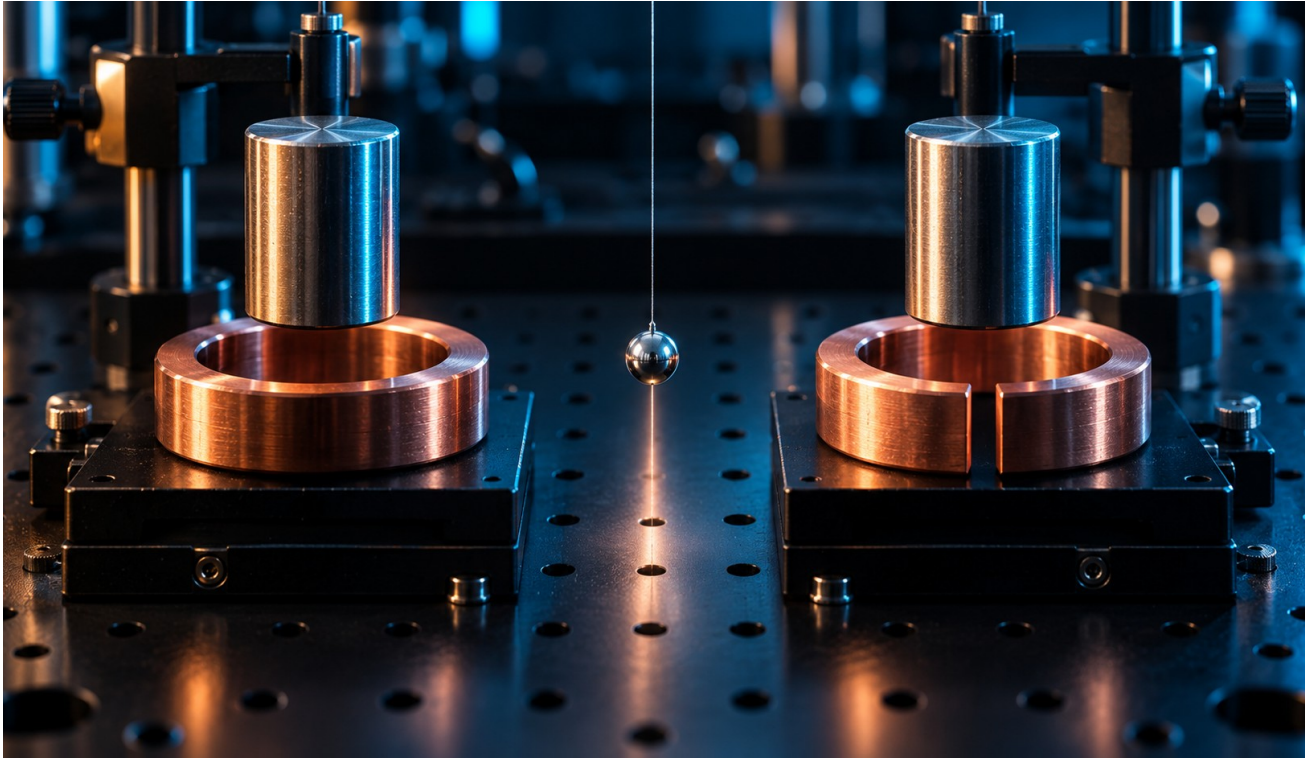
return from the auxiliary degree of freedom to the magnet during part of the motion, while this passive prototype's total dissipation remains non-negative. This balance is the author's derivation for the chosen model, not a new measurement.

What does the original question gain? We can ask whether a deeper gravitational coupling follows instantaneous velocity, stored energy, current history or another quantity. Phase lag already has an environmental-response explanation. A new branch might predict an additional relationship, such as matching relaxation structures in electromagnetic and independent gravitational channels. Precise amplitude and spatial dependence remain to be derived. This formulation leaves room for inquiry while showing which quantities are missing.

Under the relevant equilibrium conditions, Kubo's linear-response theory connects dissipation with time correlations of fluctuations. This raises another question: alongside mean force, could noise structure and its changes with material state be useful? An initial programme can measure both response and correlations, seeking a common description. Strongly driven non-equilibrium states require an appropriate generalisation of the equilibrium relationship. [51]

35 Gravitational coupling dependent on system state

A working parametrisation for HCu-G



Prepared states provide a starting comparison. Generative illustration.

Develop the intuition that magnet-conductor relationships change some gravitational

property of the magnet. First ask whether we mean a change in the source gravitational field or in the magnet's response to an external field. Let us choose the second. For a weak, approximately homogeneous external field and an unambiguously prepared state, define the phenomenological ratio of passive gravitational mass m_g to inertial mass m_i .

$$\frac{m_g(Q)}{m_i(Q)} = 1 + \varepsilon Q, \quad \delta \mathbf{a}_g = \varepsilon Q \mathbf{g}$$

Q is a dimensionless state parameter and ε an undetermined coefficient. $\delta \mathbf{a}_g$ denotes only the proposed additional gravitational contribution in this weak-field account; total magnet acceleration also includes electromagnetic and other forces. This gives HCu-G its first concrete content: a working parametrisation for further derivation. A complete dynamic version must specify Q 's evolution, effects on other system components and the energy balance.

One possible Q is the normalised change in induced-field energy: $Q = (U_{\text{ind}} - U_{\text{ind},0})/U^*$, with U^* a fixed reference energy. Other possibilities include a state variable describing current correlations or a relaxation mode. Each choice is a different hypothesis. Reference normalisation alone creates no new physics: changing U^* correspondingly rescales ε . We need a physical reason why the selected quantity would enter gravitational coupling.

This leads to an unexpected comparison. Can two configurations have similar mean magnetic energy and temperature but different current histories? Can external coils reproduce part of the field without the same copper wall? Can circuit relaxation change while preserving the geometry of the magnet's passage? These questions help determine whether the property sought relates mainly to energy, material, current

structure or preparation history. Each implementation will, of course, also change some known contributions; their joint characterisation is precisely what enables comparison.

Distinguishing inertial and gravitational response requires more than one falling trajectory. Small calibrated mechanical driving in a suitable direction and frequency range can probe inertia. In a system with memory, however, this measures a dynamic transfer function: its phase component cannot be called a rest-mass change without a model. A separate gravitational channel can monitor differential force in a known external field. The aim is two sufficiently independent descriptions of the same prepared state.

If the proposed coupling also affects nearby objects, the programme expands to their responses and the effect's spatial range. If it affects only the magnet coupled to the conductor, explaining this material selectivity becomes crucial. These possibilities can yield different models. The earlier scalar H1 offers one route to describing field-matter coupling, but general HCu-G need not be restricted to it at this stage.

This chapter's research outcome is a more precise question: by what rule could a body's joint state with its surroundings enter its gravitational response? We have an initial parametrisation, possible state variables and ways to vary them. Further work can seek a microscopic mechanism, compare its consequences with existing measurements and gradually select the most discriminating configuration. The initial idea's value lies in opening this path.

36 Common origin as a distinct research problem

From two descriptions to one system



A common origin remains a possibility to formulate and investigate. Generative illustration.

HCu-U asks whether magnetism and gravity are macroscopic manifestations of one deeper

system. The magnet need not directly produce gravity, nor gravity act as a kind of magnetic force. Both can arise from the same foundation while retaining distinct observable manifestations. The concrete aim is to identify fundamental variables, their dynamics and the transition to measurable electromagnetic and gravitational quantities.

Sakharov's induced gravity provides a historical example. It asks whether a curvature-proportional gravitational-action term can arise from changes in quantum fluctuations' effective action when space curves. The text also discusses an analogy with induced electromagnetism. This hypothesis about effective equations' origin can inspire further constructions. For MAGNITACE, the essential method is to try deriving a macroscopic geometric term from deeper degrees of freedom. [53]

A first HCu-U calculation could proceed as follows. Choose a microscopic system X and specify its coupling to electromagnetism and geometry. Mathematically eliminating X yields an effective description $\text{Seff}[g, A]$. In the relevant approximation, seek an R term, a Maxwell F^2 term, any mixed terms and relationships between their coefficients. It would be particularly interesting if the same mechanism predicted a relationship between measurable parameters of both sectors.

Further concrete questions follow. Which properties of X determine the gravitational constant, and which the electromagnetic coupling? Does the emergent description survive state or boundary changes? Is relativistic symmetry exact or limited to a particular regime? How does gravitational response to different forms of energy, including strong-interaction energy, emerge? These questions define the proposed common foundation and help select the simplest model for an initial calculation.

Correlations may be interesting alongside mean values. In stochastic gravity, Hu and Verdaguer develop an account adding stress-energy fluctuations to its average, using open-system tools and environmental influence methods. For our further work, this connects the statistical response of

matter with a geometric description. This framework has its own assumptions; the cited work does not derive a new gravitational effect of the copper tube. [54]

HCu-B can then ask how the shared effective description changes with boundaries. Circuits allow changes in resistance, inductance and current-path connections. Fields permit study of mode-spectrum changes. Gravity allows energy, stress and correlation contributions to be tracked. We seek a rule linking these changes, perhaps revealing another coupling. Each candidate can first become a partially solvable model clarifying exactly what follows from it.

Early research combines conceptual inquiry, mathematical prototypes and exploratory measurements. We seek variables, relationships and regimes worth further attention. Once a possibility is sufficiently developed, a separate confirmation stage can follow. MAGNITACE remains a living programme beginning concretely with magnet and copper. Its path leads through environmental memory, state response and field structure towards a deeper common principle. We now develop several possibilities: specifying assumptions, deriving consequences and seeking connections. A precisely posed question may take us somewhere different from our initial expectations.

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