A matter-wave Fabry–Pérot cavity in the ultrastrong driving regime, read through Fundamental Density Theory

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Abstract

A ^{7}Li condensate with its contact interactions tuned to zero, in the second excited band of a 1064-nm lattice and confined between two 532-nm light sheets, one of them translated near the round trip, is reported to collect on one trajectory within a few drive cycles, to coalesce from different initial conditions, to form two trajectories at twice the resonance and to return under a sudden π phase step [1]. Fundamental Density Theory (FDT) accepts every measurement and every image. In the manuscript's own reading, labelled as such wherever it is stated, the record is experimental proof of seven core concepts, each quoted where it is applied: a structure whose "mode geometry is set by the boundary conditions" (P-2), curvature read where "Two neighbouring patterns do" (I-3a), "horizon formation" with "No singularity anywhere" (P-4, 0.8), a step solved "from the state the system is in" (0.1a), one carrier and closed patterns (I-2, I-5), a pattern and its own support (0.1b), and c as the strand rate (0.1d); on the record's own inputs each is the identity map of the record's map and corroborates no invariant. The discrimination is carried by five predictions that general relativity and quantum mechanics do not make: two ^{7}Li–^{6}Li contrasts in which I-7's density channel is a constitutive input, the static-cavity frequency and the S–D band separation, and three contrasts in which P-5 is an additional source, the internal line of a sensor filling a quantized vortex, the line beside quartz enantiomers and the Bloch period beside a twisted rod. One exploratory observable is kept apart and uncounted.

1 Framework

1.1 Source, stance and verb discipline

The record [1] is experimental, with a model and simulations (source_status: experimental). Source results are written as measured, observed or reported; everything else is derived, estimated, reconstructed or illustrative-assumed, and every number the record does not print is an input of the accompanying claims ledger. A record locus is cited as L and the physical line of the record; a ledger row is cited by its identifier, SC for source claims, SL for lost superscripts, U for non-source inputs and NG for the notation guard, and a source-weakness row by its SA identifier. FDT is a true extension of general relativity and quantum mechanics: it agrees with their data without reservation, declines their interpretations where the invariants read the same record differently (core Use items 2 and 6), and diverges only where a core clause supplies an additional source, a constitutive input or a changed observable dictionary.

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1.2 One substance, the chain and the strand rate

FDT has one substance, the omnium, read by quantum mechanics, electromagnetism and general relativity as one identity (core 0.1, P-1). With E an energy, m a mass, ε_0 and μ_0 the response coefficients of the omnium, d a distance and t a time, the chain and its bridges, with Planck's constant $h = 2\pi\hbar$, a mode's energy E_q, mass m_q, frequency ω_q, kept time T_q and thread length ℓ_q, are

$$\begin{aligned} &\frac{E}{m} = c^2 = \frac{1}{\varepsilon_0\mu_0} = \left(\frac{d}{t}\right)^2, \qquad E_q = m_q c^2 = \hbar\omega_q, \qquad T_q = \frac{2\pi}{\omega_q} = \frac{h}{E_q}, \\ &\ell_q = cT_q = \frac{h}{m_q c}, \qquad \frac{d}{t} = c = 299\,792\,458 \text{ m s}^{-1} \text{ exactly.} \end{aligned} \tag{1}$$

The four terms adjust together, by one global optimisation, never one at a time (0.1a); the floor $d_{\min} = 2\ell_{\mathrm{P}}$, $t_{\min} = 2t_{\mathrm{P}}$, with ℓ_{P} and t_{P} the Planck length and time, bounds every physical stroke below and fixes no spacing above it (0.1a). In the manuscript's voice c is the strand rate: "c is the rate at which the one stroke runs, measured on the spot" (0.1d); it converts the time reading of the omnium into its space reading and, squared, its matter reading into its energy reading, and 299 792 458 counts metres of strand run per second of kept time. The record's "speed of light" (SC-045, L71) and "effective speed of light" (SC-055, L84; SC-129, L140) are its phrases; in the manuscript's labelled reading the run of the record's cloud is a closed pattern's run, v_{g}, never c (section 4).

1.3 I-1: the force law on its domain

The chart inventory below declares every α token once and names its application; the per-body exterior inputs of the pair domain are application A-1. With G Newton's constant, $F_{\max}$ the force ceiling and α_1, α_2 the two bodies' curvature ratios, α_i either of them, the force law holds always, at all scales, for two bodies:

$$F = \frac{c^4}{4G}\,\alpha_1\alpha_2, \qquad 0 < \alpha_i < 1 \;\Rightarrow\; F < F_{\max} = \frac{c^4}{4G} \approx 3.03 \times 10^{43} \text{ N}. \tag{2}$$

On the pair domain, with per-body exterior inputs $\alpha_i(d) = R_{\mathrm{s},i}/d$, nonoverlapping spherical supports of radii $R_{\mathrm{b},i}$ at monopole order, $R_{\mathrm{b},i} \geq R_{\mathrm{s},i}$ and $d \geq R_{\mathrm{b},1} + R_{\mathrm{b},2}$, with $\mathcal{M}_i$ each body's total gravitating energy and $R_{\mathrm{s},i} = 2G\mathcal{M}_i/c^2$ its Schwarzschild radius, the law reduces exactly to $F = G\mathcal{M}_1\mathcal{M}_2/d^2$. Two ^{7}Li patterns of the record's lattice, with $\lambda = 1064$ nm the lattice light's wavelength (SC-283, L504), one site apart at $d = \lambda/2 = 532$ nm (SC-092, L90), with the constants of CODATA 2018 (U-02) [7], have $R_{\mathrm{s}} = 1.730 \times 10^{-53}$ m and exterior inputs $\alpha_{\mathrm{ext}}(d) = 3.25 \times 10^{-47}$ each (U-56), with $\mathcal{M}_7$ one such pattern's total gravitating energy, so

$$F = \frac{c^4}{4G}\,\alpha_{\mathrm{ext}}(d)^2 = \frac{G\mathcal{M}_7^2}{d^2} = 3.20 \times 10^{-50} \text{ N} \tag{3}$$

(U-57): small, and a correct prediction (I-1). The interval ladder is kept apart: $0 < \alpha < 1$ is universal, $F < F_{\max}$ holds wherever the inputs occupy that interval, and $F \leq F_{\max}/4$ is the only pair-domain statement. Density is nowhere uniform, so I-1 has no force-free points (0.1). The record's tuning of "contact interactions to zero" (SC-091, L89) sets the contact channel, a response reached through a declared kernel (rate is not force); the sheets' push, driven by the sheets' own light, present with the modulation off (SC-296, SC-297, L516–L517) and zero without that light, and the band loss and the drive's term of the stroboscopic drift, driven by the modulation and zero without it, are driven observables that never recover the static force of I-1. No map from the contact channel to an I-1 input is written here.

1.4 I-2: one carrier, open strokes and closed patterns

The identity is

$$\text{photon} = \text{graviton} = \text{gluon} = \text{phonon} = \text{magnon}, \tag{4}$$

"the same spin-1 excitation of the density field, at different density / geometry regimes" (I-2). "There are no independent force carriers. 'Mediation' is a coordinate artifact; interactions are curvature plus geodesic motion. The identity is carrier-only: the braided closures of I-5 (matter modes) are never inside it." A closed pattern's phase rate exceeds its run, their product c^2, and "only the open stroke has them equal at every frequency" (I-2). The record's light sheets and lattice beams are open strokes; the ^{7}Li cloud is a closed pattern (I-5) whose run in the D band, where Ref. [5] realised a relativistic oscillator, is nearly uniform over a window of quasimomentum and turns over at the band's inflection, with $k_{\mathrm{L}} = 2\pi/\lambda$ the lattice wavenumber, $0.8104\,\hbar k_{\mathrm{L}}$ (SC-265, L374). The record's map rests on characteristics "defined only by initial position and direction of propagation" (SC-027, SC-028, L56–L57), the open stroke's non-dispersive run; section 3 reads where the cloud departs from it.

1.5 I-3: three faces, containment and the observation region

The field equation is unchanged, with $G_{\mu\nu}$ the Einstein tensor, $T_{\mu\nu}$ the stress tensor and κ the Einstein coupling, and α is downstream of its solution:

$$G_{\mu\nu} = \kappa T_{\mu\nu}, \qquad \kappa = \frac{8\pi G}{c^4}, \qquad \kappa F_{\max} = 2\pi \text{ (exact)}. \tag{5}$$

The density coordinate is the branch-tagged ratio of two curvatures, built from the Schwarzschild radius $R_{\mathrm{s}} = 2G\mathcal{M}/c^2 = \mathcal{M}c^2/(2F_{\max})$ of the total gravitating energy and the field radius r_f, with $\sigma = \pm 1$ the branch tag, r_c the finite-core cutoff and X the odds (0.4) on each branch:

$$\begin{aligned} &\alpha_\sigma = \Big(\frac{R_{\mathrm{s}}}{r_f}\Big)^{\sigma}, \qquad \alpha_{\mathrm{ext}} = \frac{R_{\mathrm{s}}}{r_f} \;\; (R_{\mathrm{s}} < r_f < \infty), \qquad \alpha_{\mathrm{int}} = \frac{r_f}{R_{\mathrm{s}}} \;\; (r_c \le r_f < R_{\mathrm{s}}), \\ &X_{\mathrm{ext}} = \frac{R_{\mathrm{s}}}{r_f - R_{\mathrm{s}}}, \qquad X_{\mathrm{int}} = \frac{r_f}{R_{\mathrm{s}} - r_f}, \qquad \alpha_\sigma = \frac{X_\sigma}{1 + X_\sigma}, \qquad \frac{\mathrm{d}\alpha_\sigma}{\mathrm{d}r_f} = -\frac{\sigma\alpha_\sigma}{r_f}. \end{aligned} \tag{6}$$

No value of r_c is written here (O-1). With E quantised and c constant the discreteness lands in the rest masses of confined patterns (confinement eigenvalues, the massive leg only; no form of the confinement operator is written here, O-9) and in the null periods and paths at the locked ratio $\ell_q/T_q = c$, bounded below by $2\ell_{\mathrm{P}}$ and $2t_{\mathrm{P}}$ (a one-sided infimum); $\alpha_\sigma(r_f)$ is a continuous chart over that discrete content. The third face is the exact optical metric of the exterior, with $\mathrm{d}\Omega^2$ the round-sphere element (written with an italic capital, kept apart from the domain Ω of I-5), and generalised Snell's law is the Fermat jump law of that metric with the exact index n_{opt}, $\theta_{1,2}$ the angles to the normal:

$$\mathrm{d}\ell^2_{\mathrm{opt}} = \frac{\mathrm{d}r_f^2}{(1 - \alpha_{\mathrm{ext}})^2} + \frac{r_f^2\,\mathrm{d}\Omega^2}{1 - \alpha_{\mathrm{ext}}}, \qquad n_{\mathrm{opt},1}\sin\theta_1 = n_{\mathrm{opt},2}\sin\theta_2. \tag{7}$$

Containment holds: given the same stress tensor, cosmological terms, initial and boundary data and gauge, FDT and general relativity solve the same equation and return the same curvature, and α alone produces no divergence (I-3). The observation-region rule governs every image of the record: an absorption image is a column density integrated along the imaging axis, a profile-weighted mean $\langle f\rangle_w = \int w f\,\mathrm{d}V / \int w\,\mathrm{d}V$ with the probe weight w uniform along the line of sight and f the imaged quantity, so no point value is read off a mean; the record's "Normalized atomic density" (SC-178, L247) names no normalisation, and every density statement below is a statement about such a column.

1.6 Chart inventory

The chart inventory is declared once, here (I-3 chart discipline 1). The cloud's own gravitational window is the A-1 compactness of 0.1c, $\alpha_{\text{ext}} = \mathcal{M}c^2/(2F_{\max}r_f)$, which "needs no numerical G", and for a laboratory pattern "the small number is a correct reading (I-1)". Every bounded-map use names its application and is written in the odds form (0.4), $X \mapsto X/(1+X)$ (I-6). The table below lists every token.

token	application	warrant	evaluation and use here
α_{ext}	A-1 compactness	yes	the atlas's exterior branch; field-point evaluation of one ^{7}Li pattern at $r_f = d = 532$ nm, the I-1 input 3.25×10^{-47} (U-56); the cloud's own window at its own support, no value written; one atom's window at the atom's own support, moved at fixed r_f by isotope substitution (T-1, T-2)
α_{int}	A-1 compactness	yes	the atlas's interior branch on $r_c \le r_f < R_{\text{s}}$; configuration and source evaluations carry no value here; no value of r_c is written here (O-1)
β_σ	A-2 compactification	yes	computational chart only, $\beta_\sigma = \alpha_\sigma/(1+\alpha_\sigma)$; never a force, optical or density slot; no value here
α_{ovl}	A-3 overlap	no; PROVISIONAL	token and range $(0, 1)$ only: no value, threshold, ordering, sign or trajectory; no odds is constructed for it here (O-2)
α_{conf}	A-4 confinement	no; PROVISIONAL	token and range only on I-5's second axis, no value; no canonical odds is written here (O-3)
α_{mode}	A-5 mode manifestation	no; PROVISIONAL	a naming token for I-2 regimes, range only; ranks nothing, spaces nothing
$\alpha_{\text{core}} \to 1^-$	saturation diagnostic	schematic	P-3's skin value of a nucleus's interior chart, schematic only, never used for the cavity

The cavity's Floquet map, its fixed points, its stroboscopic "velocity", the record's "flow" (SC-213, L288) and its conformal factor carry no α, no odds, no chart, no branch and no clock factor; the flow of the record's map is continued across its fixed points, which the core's fold never is. The cloud's own α_{ext}, at its own support, carries no value; the one α with a value is the field-point $\alpha_{\text{ext}}(d)$ of one ^{7}Li pattern.

1.7 I-4: the quantum face

The forms $F = Gm_1m_2/d^2$, $F = F_{\max}\alpha_1\alpha_2$ and $F = (2\pi/\kappa)\alpha_1\alpha_2$ are one statement read in different limits (I-4), the pair algebra exact on its declared domain (L1 layer), general relativity reducing to it in the weak-field slow-motion limit at leading order (L2 layer), and every divergence in the FDT programme (L3 layer). The quantum face: with A an amplitude and φ a helical phase, $\psi = A\,e^{i\varphi}$ "is the projection of a helix onto the plane normal to the cone axis; 'superposition' is ignorance of the helical phase φ_0 at observation"; the dynamics is deterministic. The record's time-dependent Schrödinger equation (TDSE; SC-396, L865) is accepted with its numbers as the identity map.

1.8 I-5: the confinement eigenproblem and the band change

Mass is a confinement eigenvalue. For a pattern confined to a domain Ω with boundary data B, braid configuration n, orientation χ and, in this argument list as the core prints it, position t on the inside/outside chart, with D the confinement operator, u_q its mode q and ω_q the mode's frequency,

$$D(\Omega, B; n, \chi, t)\, u_q = \omega_q\, u_q, \qquad m_q c^2 = \hbar\omega_q. \tag{8}$$

No form of D, its domains, boundary data or spectrum is written here (O-9). The two held-out targets a derived operator must reproduce, $m_p/m_e = 1836.15267343$ and $(m_\mu/m_e)^2 = 42\,753$, are

carried as tests and never quoted as outputs. The cavity length $\bar{\mathcal{L}} = 680.7$ µm (SC-118, L129) is a measured size, never a support identified with a Compton length; no mass formula, anchor radius, absolute address or generation identity is written for any named pattern. The record's band transfer, "from the S band to the D band" (SC-275, L493), and the loss "from the D band via Bragg scattering" (SC-189, L259) to the "higher (F) band" (SC-412, L893) are the same closure taking another mode of the lattice: no strand count changes, no re-braiding occurs, and the response is the system-wide settlement of the state it starts from, never a reaction particle by particle (0.1a). In the manuscript's labelled reading the cavity and the sheets are the cloud's own support region and its boundary data B (0.1b).

1.9 I-6: the bounded map

Every bounded-map use is a named application written in the odds form, $0 < X/(1+X) < 1$ for $X > 0$, with $\alpha \to 0^+$ and $\alpha \to 1^-$ one-sided limits only; linearity lives in the odds, $X = X_0(1+y)$ with y an odds-enhancing drive, so the bounded variable is never linearised. Only A-1 carries a value here. A signed, dimensionful response coefficient — a sensitivity of section 5, a line shift, a contrast — is never a density and is never run through a density map (I-6 item 4).

1.10 I-7: the cloud's mass ledger, every channel once

With M the rest mass, E the non-rest energy, P the pressure, V the volume, T the temperature, σ_{SB} the flux constant and a the radiation energy-density constant, the total gravitating energy is

$$\mathcal{M} = M + \frac{E}{c^2} + \frac{PV}{c^2} + \frac{aT^4V}{c^2} + \dots, \qquad a = \frac{4\sigma_{\mathrm{SB}}}{c} = 7.566 \times 10^{-16}\ \mathrm{J\,m^{-3}\,K^{-4}}, \tag{9}$$

with $\sigma_{\mathrm{SB}} = 5.67 \times 10^{-8}\ \mathrm{W\,m^{-2}\,K^{-4}}$, which never enters $\mathcal{M}$ (0.2, 0.5). For the record's cloud of 2×10^5 atoms (SC-279, L500) each channel enters once. The wall's work on the cloud, the blue shift of the record's "repeated encounters with an approaching mirror" (SC-186, L256) by which "its momentum should increase with each drive cycle" (SC-414, L895), enters as E/c^2. The Zeeman energy of $|1,1\rangle$ at 543.6 G (SC-282, L502) enters once, lowering each atom's rest energy by 3.94×10^{-16} of Mc^2 (U-37), and the lattice and sheet light shifts enter once each, in the atom's rest energy as the Zeeman energy does, with no number written. The contact channel, which the record tunes to zero (SC-091, L89), enters E/c^2 once, at that zero. The radiation term is written with the cloud's own temperature, which the record does not print ("negligible thermal fraction", SC-089, L87; SC-281, L502), and enters no number. The pressure term PV/c^2 is written once, in Eq. (9), with the cloud's own pressure and support volume, which the record does not print, and enters no number; the wall's work is the E/c^2 entry above and is not counted again through this term. The enclosure's radiation and the beams' field are open strokes of their own and enter neither the cloud's $\mathcal{M}$ nor any of its channels; gravitational binding is read from the solved geometry and never added (0.5). Isotope substitution at fixed geometry moves compactness only (I-3 chart discipline 5): with Δ the ^{7}Li value less the ^{6}Li value for one atom at fixed r_f, $\Delta \ln \alpha_{\mathrm{ext}} = \Delta \ln \mathcal{M} = \Delta \ln M$. The Discriminator is quoted whole: "For purely density-coupled equilibrium observables, a heavier isotope → larger R_s → higher α → **larger** response — opposite in sign to conventional reduced-mass scaling." Discipline 2 is quoted whole: "A sign prediction competing with geometric, electronic or inertial channels is written as a sensitivity-weighted sum $\delta \ln O = \sum_i S_i\, \delta \ln x_i$ with every S_i defined (held-fixed variables stated). The density-channel **input** sign is the FDT discriminator; the **observable** sign is $\mathrm{sgn}(\prod S_i)$ and stays conditional until the sensitivities are established." Here O is an observable and x_i a channel's input.

1.11 P-5 and the helical window

P-5 is quoted whole: "A magnetic field is a macroscopic helical density gradient of the omnium: the bivector grade of the density field coherently aligned along an axis; vortex lines are bivector topological defects. Imposing a physical twist (torsion, helical geometry) on a material *is* establishing a magnetic field; mechanical vorticity and magnetic moments are different grade projections of one density-gradient topography, with no carrier exchange (I-2). Quantitative twist → moment forms are derived in-manuscript through I-1/I-2 with a declared kernel." I-3a's deviation map has "an antisymmetric part (vorticity: the bivector grade, the mechanical circulation whose magnetic projection is that of P-5)". No twist-to-moment form is written here, and no map from a circulating charge or a twist to an I-1 input is written here (O-6): the three predictions of section 5 that rest on P-5 are existence predictions.

A pattern whose rest energy depends on where it sits in a twist takes that energy as its clock factor (0.1c, the helical window). With E_0 its rest energy outside every twist, E_{ind} the energy of the moments the twist induces in it, the work of inducing them included, m its held moments, $\mathscr{B}$ the twist's magnetic field where they sit, E its rest energy there, $\mathfrak{m}$ the clock factor and z the coordinate along the twist's gradient,

$$E = E_0 + E_{\mathrm{ind}} - \sum \mathsf{m}\cdot\mathscr{B}, \qquad \mathcal{M} = \frac{E}{c^2}, \qquad \mathfrak{m} = \frac{E}{E_0}, \qquad \mathcal{M}\,\frac{\mathrm{d}^2 z}{\mathrm{d}t^2} = -\partial_z E = -\partial_z E_{\mathrm{ind}} + \sum \mathsf{m}\cdot\partial_z\mathscr{B}, \tag{10}$$

the last the slow limit with each m held at its settled value. A uniform twist turns a held moment and pushes nothing; the twist is read between neighbours, between patterns whose E/E_0, fall or torque differ at one point, or against a reference path (0.1c, Use item 7). The universality of free fall is the gravitational window's, and it stands.

1.12 The two readings of this record

A pattern's kept time and thread length rescale together, $d \mapsto \mathfrak{m}d$, $t \mapsto \mathfrak{m}t$ and $g_{\mu\nu} \mapsto \mathfrak{m}^2 g_{\mu\nu}$ with $g_{\mu\nu}$ the metric, keeping $d/t = c$ on the spot, while the distant bookkeeper reads the acceleration $\nabla_{\mathcal{U}}\mathcal{U}^\mu = -\mathfrak{P}^{\mu\nu}\partial_\nu \ln\mathfrak{m}$ with $\mathcal{U}$ the four-velocity and $\mathfrak{P}^{\mu\nu} = c^2 g^{\mu\nu} + \mathcal{U}^\mu\mathcal{U}^\nu$: moving at constant speed, on the pattern's own clocks and rulers, through a density gradient is gravity (the extended equivalence principle, 0.1c). The value of $\ln\mathfrak{m}$ is invisible, its gradient is the free fall of one pattern, and its second derivatives are the deviation of neighbouring patterns (I-3a). Two readings follow for this record. First, the record measures no gravity: its lattice is horizontal (SC-283, L504), and its "curved spacetime" (SC-033, L65; SC-158, L206) and stroboscopic drift are read between neighbours (section 3). Second, the Bloch-oscillation force on the $|1,1\rangle$ cloud in the record's field gradient "along the same axis" (SC-285, L506) is the helical window's slow limit, $\mathcal{M}\,\mathrm{d}^2z/\mathrm{d}t^2 = -\partial_z E$, with z along the horizontal lattice axis: the push alone sets the Bloch period, and the weight, across that axis, has no component along z. With the record's $\mathfrak{T}_{\mathrm{B}} = 10.70$ ms (SC-286, L507) the push is $F = h/(\mathfrak{T}_{\mathrm{B}}\lambda/2) = 1.164 \times 10^{-25}$ N, 1.019 times the ^{7}Li weight, a gradient of 1.33 G cm^{-1} on the $|1,1\rangle$ moment of 0.943 Bohr magnetons at 543.6 G (U-43, U-37).

1.13 Notation guard

One symbol carries one meaning across the file; E carries the three this file's displays give it, and t is also the chart position of Eq. (8), each as the core prints it. The record's tokens are renamed as the table below lists, on every surface; the core keeps its own symbols: α the curvature ratio (branch-tagged), n the strand count, σ the branch tag (and σ_{SB}), κ the Einstein coupling, X the odds, D the confinement operator, Ω the confinement domain, a the radiation constant, T the

temperature, t time, E an energy in Eq. (1), the non-rest energy in Eq. (9) and the helical window's rest energy in Eq. (10), B I-5's boundary data, c the strand rate and $\lambda = 1064$ nm the lattice light's wavelength (I-2).

record token	meaning in the record	name here
α (L870)	Eq. (S25)'s amplitude-modulation fraction	$\mathfrak{a}_{\mathrm{AM}}$
σ_M (L114, L878); "4σ" (L504, L515)	the sheets' Gaussian root-mean-square (rms) half-width; a diameter of four rms widths	b_{M}; "four rms widths" in words
ϕ, $\phi(t)$ (L103 … L896)	the modulation phase	Φ, $\Phi(t)$
n (L127, L654, L716)	the cycle count, the map's iteration	$\mathfrak{n}$
R (L570, L584, L612, L640)	the inverse conformal map	$\mathcal{R}$
B (L543); the field of L502, L506	a magnetic field	$\mathscr{B}$
T (L68, L164, L197); T_B (L507)	the drive period, the round-trip time; the Bloch period	$\mathfrak{T}$; $\mathfrak{T}_{\mathrm{B}}$
$L(t)$, L_0, L; ΔL (L332)	the cavity length: instantaneous; the average (the main text's L_0, the Supplementary Information's L); the Supplementary Information's resonant L_0 (L659); the modulation	$\mathcal{L}(t)$; $\bar{\mathcal{L}}$; $\mathcal{L}_0$ (equal to $\bar{\mathcal{L}}$ at resonance); $\mathcal{L}(t) - \bar{\mathcal{L}}$

record token	meaning in the record	name here
Ω, Ω_0 (L103 … L885)	the drive's and the static cavity's angular frequencies, printed in Hz as $\Omega/2\pi$	ω_{d}, ω_0; printed $\omega_0/2\pi = 95.1(5)$ Hz
ω (L99)	the lattice modulation's angular frequency	ω_{AM}
D, S, F bands (L94, L505, L893)	the second excited, lowest and third excited bands	upright text: D band, S band, F band
F (L554–L567); F, m_F (L500)	the conformal map; hyperfine quantum numbers	$\mathcal{C}$; kets with no letter
A (L103, L118, L215); A (L538–L612)	the fractional modulation amplitude; the vector potential	A; $\mathcal{A}$
c (L68, L70, L652, L846)	light's speed in a cited estimate; the model's wave speed, set to one (L590)	the record's phrase, attributed; v_{w}, in the matter-wave cavity v_{g}
d (L90, L92)	the lattice spacing	$\lambda/2$
V_L, V_M, V_{mirrors}, V_{lattice} (L91, L110, L114, L870)	potential energies	$\mathcal{V}_{\mathrm{L}}$, $\mathcal{V}_{\mathrm{M}}$, $\mathcal{V}_{\mathrm{sh}}(x,t)$, $\mathcal{V}_{\mathrm{lat}}(x,t)$
q, q_0 (L102, L374, L884)	quasimomentum	$\mathfrak{q}$, $\mathfrak{q}_0$
p (L111, L639)	the resonance order, the cycle length	$\mathfrak{p}$
$z(t)$ (L534)	the moving mirror's position in the model	$\mathsf{z}(t)$
s, w (L554–L563)	the conformal coordinates	s, w
f, g (L54, L637, L639)	the one-cycle map and its inverse	$\mathcal{F}$, $\mathcal{F}^{-1}$
θ (L746)	the arcsine of the detuning over the amplitude	η
Δ (L723)	the fractional detuning	written out, $(\bar{\mathcal{L}} - \mathcal{L}_0)/\bar{\mathcal{L}}$
Q (L70)	the cavity quality factor	$\mathcal{Q}$
δ (L643)	a small deviation	δx
x	position	x; I-6 in the odds form only
E (L124–L128)	the Bloch band energy of the record's Eq. (3)	$\mathcal{E}(\mathfrak{q})$
E_R (L91)	the recoil energy $\hbar^2 k_{\mathrm{L}}^2/(2M)$ of a lattice photon	E_{R}
M, Ψ, k_L, $\hbar$, λ, t, v_g	atomic mass, wavefunction, lattice wavenumber, Planck, wavelength, time, run	M, Ψ, k_{L}, $\hbar$, λ, t, v_{g}
(added)	design symbols, each defined in its block	$\mathfrak{d}$, t_k, $\mathfrak{w}$, $\mathfrak{q}$, S_{dens}, S_V, $S_{\mathfrak{q}}$, S_{M}, $\mathfrak{g}_{\mathrm{SD}}$

2 System chart

The table below places every element of the record on its FDT object and chart; only one row carries an α with a value.

element	FDT object	chart, token	value written
^{7}Li cloud in the D band	a closed pattern (I-5) in its own support (0.1b), run v_{g}	A-1, α_{ext} at its support	none; the atom's window is moved by isotope substitution (T-1, T-2)
two ^{7}Li patterns one site apart	an I-1 pair on the pair domain	A-1, $\alpha_{\mathrm{ext}}(d)$	3.25×10^{-47} each; 3.20×10^{-50} N
532-nm light sheets	open strokes; the boundary data B of the cloud's support, labelled	none	none
1064-nm lattice beams	open strokes in a standing wave whose modes the cloud takes (I-5)	none	none
bias at 543.6 G and its gradient	the twist's field $\mathscr{B}$ (P-5); the helical window's push	none	push 1.164×10^{-25} N
the cavity's Floquet map	the record's map: no odds, chart, branch or clock factor	none	none
enclosure radiation	open strokes outside the cloud's $\mathcal{M}$	none	none

3 Observation map

3.1 The positioning, in the manuscript's labelled reading

In the manuscript's own reading, labelled so here and wherever it recurs, the record is experimental proof of seven core concepts. Each clause is quoted verbatim where the record is positioned, on the record's own nouns; each reading, on the record's own inputs, is the identity map of the record's map (Use item 2) and corroborates no invariant. The discriminating claims are the predictions of section 5.

Structure set by a driven boundary (P-2). P-2 reads: "Energy injection (acoustic, electromagnetic, thermal, parametric) excites standing density waves", and "mode geometry is set by the boundary conditions (the clamps, P-3), not by the medium". The record drives one sheet's position (SC-109, L116; SC-278, L495–L496); its diffuse cloud collects on the trajectory that "encounters the moving boundary when it is at the average length and moving inward" (SC-131, SC-132, L142–L143); "the emergent blue areas indicate depletion of density around the unstable fixed point" (SC-149, SC-150, L188–L189), the line that meets the wall at the same position moving outward (SC-339, L654); a drive at twice the resonance gives "two stable fixed point trajectories" (SC-206, SC-207, L276–L277); and the waveform "can vary the number of fixed points and exchange their stability character" (SC-016, L24–L25). The manuscript reads this as the structure a parametric energy injection excites, its geometry set by the boundary conditions, not by the medium. No trajectory is placed on P-2's nodal loci and no sheet on P-3's clamps; the record's "nodes of wall velocity" (SC-247, L292) are the extrema of the position modulation, its own phrase; no α, gradient of α or chart is evaluated for the structure, which the record's map (Eq. (1), Eq. (S20)) returns.

Curvature read between neighbours (I-3a, Use item 7). Use item 7 reads: "A reading of curvature, a tide or a density gradient is a comparison of neighbouring patterns, or of a pattern with a reference path — an extended pattern's skin against its own centre path among them (I-3a); a pattern carries none at a point, because its clocks and rulers adjust with the density it crosses." I-3a reads: "A pattern follows its geodesic and carries no reading of the curvature it

crosses (0.1c). Two neighbouring patterns do, and so do a pattern and a reference path". The record's offset trajectories, "after several cycles of boundary modulation, ... rephase" (SC-171, SC-172, L203–L204), and its atomic trajectories "coalesce around a single trajectory" (SC-143, L167); its stability criterion runs "depending on whether small deviations δx compound or decay" (SC-334, L643); and the slope of the record's Eq. (1) at its fixed points is $e^{-2\pi \mathsf{An}}$ at the stable point and $e^{+2\pi \mathsf{An}}$ at the unstable one (derived in section 3.2). The manuscript reads these as the between-neighbours structure the core gives curvature. One trajectory's stroboscopic drift alone reads no curvature (I-3a); the record's "flow" (SC-213, L288) stays its word for the map's drift, never 0.1c's flow, which is the bookkeeper's reading of a clock factor the cavity's map does not carry. No Jacobi operator of a gravitational field is written for the cavity.

Horizon formation with no singularity (P-4, 0.8). P-4 reads: "the flat special-relativistic cone is the uniform-density idealisation, and refraction, lensing and horizon formation are one phenomenon"; 0.8 reads: "No singularity anywhere." Beside them stands the record's "The perturbative solution Eq. (S19) to a simple sinusoidal drive does not match any canonical general relativistic model, even disregarding the lack of a singularity" (SC-392, SC-393, L852–L853). Between the record's fixed points "the stroboscopic velocity assumes only one sign" (SC-157, L205), and "in between the two fixed points, stroboscopic velocity has only one sign" (SC-384, L839). The manuscript reads the one-way region as horizon formation at the cloud's own run, with no singularity. No aperture index or α is computed for the cavity: the band's run is a closed pattern's run (section 4).

A step settled from the state it starts from (0.1a). 0.1a reads: "The global optimisation is solved at every step, from the state the system is in; the expected behaviour is not necessarily the evolving system's optimum. Events do not commute, and a process run backward is never the mirror of the forward event. Responses are system-wide and many-to-many (I-5b's reclosure is one), never one-to-one, particle by particle; I-1's pair expression stays exact on its declared domain (I-1, I-4). The core names no objective for the optimisation (author ruling 2026-10-17): an analysis that names one — a total shear, an action, an energy — writes it as its own reading." After the record's "sudden π phase shift" the wavepacket "returns to its original trajectory" (SC-194 to SC-196, L258–L260; SC-228, L338). The manuscript reads the return as a new forward settlement under the flipped drive, whose leading-order map is the inverse of the first: Eq. (S23) with $\Phi \to \Phi + \pi$ exchanges the two fixed points (section 3.2). The exact return that the record's map expects "is not necessarily the evolving system's optimum", and the record prints no return fidelity.

One carrier and a closed pattern (I-2, I-5). The identity and its carrier-only sentences are quoted in section 1.4. The record's Eqs. (S3)–(S6) map "the problem of a cavity with a dynamically evolving boundary" (SC-307, L551–L552) conformally to the static cavity, under which "The wave equation is conveniently automorphic" (SC-310, L558), every null line kept (Eq. (11)), so its photonic map holds for open strokes; the matter wave departs where "reflection from a moving barrier changes the group velocity" (SC-241, SC-242, L358–L359). The manuscript reads the departure at I-2: only the open stroke has its phase rate equal to its run at every frequency, and reflection from the moving sheet changes the closed pattern's run. The faint trajectories and the smearing, among the "signatures of nontrivial dynamics beyond those predicted for photons" that the record attributes "to residual curvature in the dispersion relation" (SC-017, SC-018, L25–L27), are that closed pattern's.

Patterns and their support (0.1b). 0.1b reads: "A room, box, cell, domain or grain is that pattern's own support region, with the pattern's own boundary data for a wall — never a vessel holding a separate occupant." The manuscript reads the record's cavity, $\bar{\mathcal{L}} = 680.7$ µm between the sheet centres (SC-118, L129), as the cloud's own support region and the sheets as its boundary data, I-5's B.

The strand rate (0.1d). The strand rate is quoted in section 1.2. The manuscript reads the record's "effective speed of light" (SC-055, L84) as the cloud's band run, a closed pattern's run in the frame of the lattice at rest in the laboratory (section 4). The boost group of 0.1d is "a linear map keeping the stroke lines $x = \pm ct$", and "closed patterns share every symmetry of the stroke equation"; the record's "Lorentz boost" (SC-319, L589) is the boost of its model wave equation, with the wave speed v_{w} set to one (SC-320, L590).

3.2 The record's map, derived in the manuscript's names

In units with the model wave speed $v_{\mathrm{w}} = 1$, the record's conformal map [3, 2] is $t \pm x = \mathcal{C}(\mathsf{s} \pm \mathsf{w})$ (SC-308, SC-309, L554–L556); differentiating each line and multiplying,

$$\mathrm{d}t^2 - \mathrm{d}x^2 = \mathrm{d}(t+x)\,\mathrm{d}(t-x) = \mathcal{C}'(\mathsf{s}+\mathsf{w})\,\mathcal{C}'(\mathsf{s}-\mathsf{w})\,\big(\mathrm{d}\mathsf{s}^2 - \mathrm{d}\mathsf{w}^2\big), \tag{11}$$

two coordinate descriptions of one flat interval with every null line kept; no clock factor is assigned to the product $\mathcal{C}'\mathcal{C}'$ (0.1c), and no 0.1c clause is applied to it. With $\mathcal{F}^{\mathfrak{n}}$ the $\mathfrak{n}$-cycle map, A the fractional amplitude, Φ the modulation phase and $\bar{\mathcal{L}}$ the mean length, the record's resonant map, Eq. (1) and Eq. (S23) (SC-081, L131; SC-375, L789), is

$$\mathcal{F}^{\mathfrak{n}}(x) = \frac{\bar{\mathcal{L}}\Phi}{\pi} + \frac{2\bar{\mathcal{L}}}{\pi}\arctan\Big[e^{2\pi\mathsf{A}\mathfrak{n}}\,\tan\Big(\frac{\pi x}{2\bar{\mathcal{L}}} - \frac{\Phi}{2}\Big)\Big], \tag{12}$$

the exponent's sign read from the record's own limit, $x_{\mathfrak{n}} \to \mathcal{L}_0(1+\Phi/\pi)$ for all other starting points (SC-376, L801; SL-06). With $\xi = \pi x/(2\bar{\mathcal{L}}) - \Phi/2$, the slope is $\partial_x \mathcal{F}^{\mathfrak{n}} = e^{2\pi\mathsf{A}\mathfrak{n}}\sec^2\xi/(1+e^{4\pi\mathsf{A}\mathfrak{n}}\tan^2\xi)$: it equals $e^{2\pi\mathsf{A}\mathfrak{n}}$ at the unstable point $x = \bar{\mathcal{L}}\Phi/\pi$, where $\xi = 0$, and tends to $e^{-2\pi\mathsf{A}\mathfrak{n}}$ at the stable point $x = \bar{\mathcal{L}}(1+\Phi/\pi)$, where $\tan\xi$ diverges. Replacing Φ by $\Phi + \pi$ moves the unstable point to $\bar{\mathcal{L}}(1+\Phi/\pi)$ and the stable point to $\bar{\mathcal{L}}\Phi/\pi$ modulo $2\bar{\mathcal{L}}$, and returns Eq. (12) with $e^{2\pi\mathsf{A}\mathfrak{n}}$ replaced by $e^{-2\pi\mathsf{A}\mathfrak{n}}$: at leading order the shifted map is the inverse of the first, map algebra and no event read backward (0.1a). Near resonance, Eq. (S19) (SC-364, L734) reads, with $\mathcal{L}_0$ the resonant length,

$$\frac{\mathrm{d}x}{\mathrm{d}\mathfrak{n}} = 2\bar{\mathcal{L}}\Big[\mathsf{A}\sin\Big(\frac{\pi x}{\bar{\mathcal{L}}} - \Phi\Big) - \frac{\bar{\mathcal{L}} - \mathcal{L}_0}{\bar{\mathcal{L}}}\Big], \tag{13}$$

whose A-term is the drive's, a driven observable zero at zero drive, and whose other term is the sampling's detuning (I-1); its fixed points, Eq. (S20) with $\eta = \arcsin[(\bar{\mathcal{L}} - \mathcal{L}_0)/(\bar{\mathcal{L}}\mathsf{A})]$, exist while A exceeds the detuning's magnitude (SC-379, L806).

3.3 The anchored map

The table below anchors each cluster of the record to its equation or figure, with the record's verb class; the corroboration statements follow it.

anchor	the record	class	FDT reading
Eq. (2), Methods	sheets $\mathcal{V}_{\mathrm{M}} = 6.36\,E_{\mathrm{R}}$, $\mathsf{b}_{\mathrm{M}} = 10$ µm (SC-107); four rms widths, 40 µm (SC-294)	setting	the support's boundary data, labelled; $40/4 = 10$ agrees
Eq. (3)	$\omega_0 = \pi v_{\mathrm{g}}/\bar{\mathcal{L}}$ at $\mathfrak{q}_0$ (SC-116)	model	hard-wall idealisation, 89.7 Hz
fit, L133	$\omega_0/2\pi = 95.1(5)$ Hz (SC-121)	measured	identity map
L102, L884	$\mathfrak{q}_0 = 0.74\,\hbar k_{\mathrm{L}}$; $0.736\,\hbar k_{\mathrm{L}}$ (SC-102, SC-403)	fitted	in-sample, never calibrated by the record's Eq. (3)
Eq. (1), S23	the resonant map (SC-081, SC-375)	model	Eq. (12); identity map
Fig. 1(d)	one trajectory within "a few drive cycles" (SC-130)	observed	P-2 structure, labelled
Fig. 2	twelve phases, 3 repeats, coalescence (SC-140, SC-143, SC-167)	observed	I-3a between neighbours, labelled
Fig. 3(a)	the one-sign region (SC-157)	observed	P-4 horizon formation, labelled
Fig. 3(b), (c)	TDSE and D-band fraction (SC-161, SC-183)	in-sample; simulated	identity map; I-5 band change
Fig. 4	two trajectories at 191 Hz (SC-203, SC-206)	observed	P-2 structure, labelled; π fitted (SC-217)
Fig. 5	the return after the π step (SC-228)	observed	0.1a settlement, labelled
S2–S9	wave equation, conformal map, chiral ring (SC-306–SC-322)	model	Eq. (11); S9's sign noted
S24–S26	the TDSE (SC-396–SC-398)	model	I-4 face; identity map
Fig. S3, L845	curvature from the stroboscopic velocity (SC-386)	reading	declined once (convergence)

The static cavity. The depth $\mathcal{V}_{\mathrm{L}} = 12.32\,E_{\mathrm{R}}$ (SC-093, L91), $E_{\mathrm{R}}/h = 25.12$ kHz for ^{7}Li (U-13), is the peak-to-peak depth of $\mathcal{V}_{\mathrm{L}} \sin^2(k_{\mathrm{L}} x)$, the convention that returns the record's inflection $0.8104\,\hbar k_{\mathrm{L}}$ (SC-265, L374); Eq. (S25) as printed has period λ and peak-to-peak $2\mathcal{V}_{\mathrm{L}}$, and its amplitude reading returns $0.612\,\hbar k_{\mathrm{L}}$ (SC-398, L870; U-15). At $\mathfrak{q}_0 = 0.74\,\hbar k_{\mathrm{L}}$ the run is $v_{\mathrm{g}} = 0.1221\ \mathrm{m\,s^{-1}}$ (U-14): the record's Eq. (3) gives $\omega_0/2\pi = 89.7$ Hz and no $\mathfrak{q}$ gives more than 91.3 Hz (U-16); the Gaussian walls shorten the round trip to 92.4 Hz in a semiclassical count, the cloud turning 14.9 µm from a sheet centre where $\mathcal{V}_{\mathrm{sh}} = 2.10\,E_{\mathrm{R}}$ (U-17), against the fitted 95.1(5) Hz (SC-121, L133). The record's Eq. (3) is the hard-wall idealisation and never calibrates $\mathfrak{q}_0$; the remaining gap is the record's own. Invariant: I-2, a closed pattern's run nearly uniform over the window; precision 0.5 %; falsifier: a round trip holding the hard-wall value at every $\mathfrak{q}$, an open stroke's uniform run. The cluster is the identity map on the record's inputs and corroborates no invariant.

The driven cavity. The drive $\omega_{\mathrm{d}}/2\pi = 95.5$ Hz (SC-126, L214) sits $1 - 95.1/95.5 = 0.004(5)$ above the fitted resonance, 0.8 standard errors; with $\mathsf{A} = 1.45 \times 10^{-2}$ (SC-127, L215) the fixed points move by $\eta/\pi = 0.1(1)$ of $\bar{\mathcal{L}}$, $\eta = 0.3(4)$ rad (U-51), a shift the drawn lines are not said to include. The map's rate $2\pi\mathsf{A} = 0.091$ per cycle doubles the stable point's density in 7.6 cycles; the record's 80 ms at 95.5 Hz are 7.64 cycles (SC-166, L195; U-50), and "a few drive cycles" (SC-130, L141) stays its phrase. Fig. 2 samples phases in steps of $\pi/6$ (SC-140, L161), 3 repeats each (SC-167, L196). Three prints of the faint trajectories' phases stay at their lines: $\pi/6$ and $5\pi/3$ (SC-148, L183), $\pi/2$ and $3\pi/2$ (SC-249, L294), $3\pi/2$ and $5\pi/3$ (SC-415, L896); so do the "black dotted" and "(black) dashed" lines (SC-155, L200; SC-180, L249) and the colours, red for the stable line in Figs. 2 and 3 and for the unstable one in Fig. S2 (SC-175, L207; SC-351, L698). The smearing near phase 0 is observed (SC-163, L212); the D-band fraction is calculated (SC-183, L251), and the band loss is the same closure in another mode (I-5). Invariant: I-3a; precision 3 repeats per phase; falsifier: neighbouring trajectories whose separation held under the drive. The cluster is the identity map and corroborates no invariant.

Higher order and the phase step. At $\omega_{\mathrm{d}}/2\pi = 191$ Hz (SC-203, L273) the record prints $\mathsf{A} = 7.27 \times 10^{-3}$ (SC-204, L274) as half the previous amplitude, while half of 1.45×10^{-2} is 7.25×10^{-3} and $\mathsf{A}\omega_{\mathrm{d}}/2\pi$ is 1.385 Hz at the first drive against 1.389 Hz at the second, 0.3(4) % (U-52); the wall velocity it preserves, written as the amplitude times the drive frequency, omits $\bar{\mathcal{L}}$ (SC-205, L275). Fig. 5's $\mathsf{A} = 2.9 \times 10^{-2}$ (SC-225, L334) gives $\mathsf{A}\bar{\mathcal{L}} = 19.7$ µm and $2\pi\mathsf{A} = 0.18$ per cycle (U-50), where Eq. (S17)'s continuum step asks a small per-cycle rate $2\pi\mathsf{A}$ (SC-358, L716); its ticks step 10.4 ms, an inferred 96.2 Hz (SC-221, L328; U-54). Invariant: 0.1a; precision: one wavepacket, one step, no return fidelity; falsifier: a return that retraced the forward path cycle by cycle at every step time. The cluster is the identity map and corroborates no invariant.

The model and the simulation. Eq. (S9) as printed, $\partial_t \mathcal{A} - \partial_x \mathcal{A} = 0$ (SC-322, L602–L604), has solutions $\mathcal{A}(x+t)$ moving in $-x$, while the stated motion in $+x$ and the null lines of constant $t - x$ (SC-325, L609) need $\partial_t \mathcal{A} + \partial_x \mathcal{A} = 0$; the line after Eq. (S12) prints the second crossing as the magnitude of $\dot{\mathsf{z}}$ below zero (SC-338, L653), where $\dot{\mathsf{z}} > 0$ and $\dot{\mathsf{z}} < 0$ are meant; Eq. (S13)'s "z(tmc)" reads $(\mathsf{z}(t_m) \mp x_{0,1})/v_{\mathrm{w}}$ (SC-345, SC-346); each is transcribed with its note. Fig. S2's off-resonant case gives $\eta = \arcsin(1/2) = \pi/6$ and the fixed points $\bar{\mathcal{L}}/6$ and $5\bar{\mathcal{L}}/6$, as printed (SC-352, L700). The simulation's spread $0.1\,\hbar k_{\mathrm{L}}$ (SC-400, L881) is an input with no printed measurement; at the uncertainty limit it makes a packet of 5 µm, 20 times smaller than the 106 µm it is matched to (SC-401, L882; U-55); its $\mathfrak{q}_0 = 0.736\,\hbar k_{\mathrm{L}}$ matches "the experimental value of 95.5 Hz" (SC-403, SC-404, L884–L885), a third print kept apart; its grids are 0.1 µs and 5.7 nm, 93 points per site (SC-407, L888; U-54). Invariant: I-4, whose quantum face the TDSE's numbers carry; precision: in-sample in $\mathfrak{q}_0$ and size; falsifier: an observed approach to the stable fixed point that the TDSE fails to reproduce for most initial conditions (SC-161, SC-162, L210–L211). The cluster is the identity map and corroborates no invariant.

4 Cone-position translation

The density cone is the local light cone, and the flat special-relativistic cone is its uniform-density idealisation (P-4). In the record the lattice light and the sheets run at c; the cloud runs at its band's $v_{\mathrm{g}} = 0.1221\ \mathrm{m\,s^{-1}}$ at $\mathfrak{q}_0 = 0.74\,\hbar k_{\mathrm{L}}$ (U-14), at most $0.1243\ \mathrm{m\,s^{-1}}$ at the inflection (U-15): in the manuscript's labelled reading a closed pattern's run in the frame of the lattice at rest in the laboratory, never c and never an effective c. No aperture index and no aperture speed is computed for the cavity: their constitutive form enters no number here (O-8). The wall's peak speed $\mathsf{A}\bar{\mathcal{L}}\omega_{\mathrm{d}} = 5.92\ \mathrm{mm\,s^{-1}}$ at $\omega_{\mathrm{d}}/2\pi = 95.5$ Hz, with $\mathsf{A}\bar{\mathcal{L}} = 9.87$ µm, is 0.0485 of that run (U-49); $\pi\mathsf{A} = 0.0456$ is its ratio to the round-trip run $2\bar{\mathcal{L}}\omega_{\mathrm{d}}/2\pi = 0.130\ \mathrm{m\,s^{-1}}$ (U-49), and the static cavity's $2\bar{\mathcal{L}}\omega_0/2\pi = 0.1295\ \mathrm{m\,s^{-1}}$ (U-53) exceeds v_{g}; the soft walls shorten the round trip to 92.4 Hz in the semiclassical count, and the remaining gap is the record's own. The record's "more than a percent" (SC-128, L139) keeps its own figure. The one-way region of the stroboscopic map is, in the manuscript's labelled reading, horizon formation at the cloud's own run (P-4), with no singularity (0.8); the band's dispersion curve in the $(\mathfrak{q}, \mathcal{E})$ plane is no density cone, and no tip, rim or α is assigned to it. The record's optical-cavity estimate (SC-044 to SC-050, L68–L72) instantiates at a 1-ns round trip, a cavity of 0.15 m, and $\mathcal{Q} = 10^{10}$ as $6 \times 10^7\ \mathrm{m\,s^{-2}}$, 6×10^6 standard gravities (U-48), its "on the order of a million times the earth's gravity" keeping its own figure.

5 Predictions

Five predictions that general relativity and quantum mechanics do not make follow, T-1 to T-5. Each names its candidate and the source-weakness row it discriminates first, then its referent,

observable, FDT input, comparator, design, precision criterion, channel table or single-channel scope, decision rules and ablation; each is prospective, T-1 and T-2 predicting a sign under a declared positive sensitivity and T-3 to T-5 an existence, and every candidate becomes a block, so none is retired. In T-1, T-2, T-3 and T-5 $\mathfrak{d}_i$ is the contrast of pair i (T-4's contrast and its statistic are defined in its block), $\bar{\mathfrak{d}}$ the mean of the contrasts, $\mathcal{S}_\mathfrak{d}$ their sample standard deviation and $\mathfrak{t}_k$ block k's Student statistic; $\mathcal{N}$ is a noise component and $\mathcal{Z}_k$ block k's design threshold; a fair coin, drawn before each pair, sets the order of every pair and so gives a slow drift between the two members a random sign. Every number that the record does not print is an input of the claims ledger, and every apparatus it does not name is external.

5.1 T-1: the static-cavity frequency of ^{6}Li against ^{7}Li

Candidate DC-1; it discriminates SA-25, the static-cavity frequency that the record determines "By fitting a triangle wave to the trajectory of the localized wavepacket in an undriven cavity", $\omega_0/2\pi = 95.1(5)$ Hz (SC-119, SC-120, SC-121, L130–L133). The warrant is I-7, a constitutive input: the Discriminator and Discipline 2, both quoted whole in section 1.10.

Referent. The record's apparatus with ^{7}Li in $|1,1\rangle$ at 543.6 G (SC-280, SC-282, L501–L502) and ^{6}Li, a different-n closure from ^{7}Li (I-5), spin-polarized in its lowest hyperfine state at the same field — identical fermions, with no s-wave collisions — in the same 1064-nm lattice beams and 532-nm sheets at the same deflector settings ($\bar{\mathcal{L}} = 680.7$ µm, $\mathfrak{b}_\mathrm{M} = 10$ µm); the lattice and sheet intensities scaled by M_7/M_6, with M_7 and M_6 the two atomic masses, so that $\mathcal{V}_\mathrm{L}/E_\mathrm{R} = 12.32$ and $\mathcal{V}_\mathrm{M}/E_\mathrm{R} = 6.36$ on the beams' axis for each isotope, set from measured beam powers and computed polarizabilities, never from a cavity or band frequency (I-7 Discipline 3); 10^2 ^{6}Li atoms at $T/T_\mathrm{F} \le 0.24$, with T_F the Fermi temperature (U-24, U-36); the force sequence set per isotope from its own magnetic moment so that $\mathfrak{q}_0 = 0.74\,\hbar k_\mathrm{L}$, and the ^{6}Li quasimomentum spread matched to the condensate's (external).

Design. Eight pairs, each a ^{7}Li and a ^{6}Li static-cavity measurement of ω_0 by the record's triangle-wave fit, back to back in the order the coin draws before each pair, which randomises the sign of a drift between the two; before each pair both isotopes' intensities are re-set from fresh power measurements. With $\Delta\ln\omega_0|_\mathrm{cons}$ the comparator below and S_dens the response of $\ln\omega_0$ to the density channel's input, the observable and the FDT input are

$$\begin{aligned} \mathfrak{d}_i &= \ln\omega_0(^7\mathrm{Li}) - \ln\omega_0(^6\mathrm{Li}), \qquad i = 1,\dots,8, \\ \Delta\ln\omega_0 &= \Delta\ln\omega_0\big|_\mathrm{cons} + \int_{^6\mathrm{Li}}^{^7\mathrm{Li}} S_\mathrm{dens}\,\mathrm{d}\ln\alpha_\mathrm{ext}, \qquad \Delta\ln\alpha_\mathrm{ext} = \Delta\ln\mathcal{M} = \Delta\ln M = 0.153917, \end{aligned} \tag{14}$$

where the response $S_\mathrm{dens} = \partial\ln\omega_0/\partial\ln\alpha_\mathrm{ext}$ is taken with the inertial mass in E_R and with $\mathcal{V}_\mathrm{L}/E_\mathrm{R}$, $\mathcal{V}_\mathrm{M}/E_\mathrm{R}$, $\mathfrak{q}_0/\hbar k_\mathrm{L}$, $\mathfrak{b}_\mathrm{M}$ and $\bar{\mathcal{L}}$ held, the inertial channel being the comparator's $-\Delta\ln M$; α_ext is the atom's A-1 window, moved at fixed r_f, the atom's own support (I-3 chart discipline 5), by $\Delta\ln M$ from the isotope masses only (U-07 to U-09). A positive S_dens is the manuscript's reading of "larger response" as a higher frequency; no clause fixes its magnitude, and the prediction rests on that declared positive sensitivity. *Comparator*, the consensus calculation, attributed: at matched dimensionless parameters the band and the soft-wall round trip scale as $1/M$, so $\Delta\ln\omega_0 = -\Delta\ln M = -0.153917$ for the masses 7.016003437 u and 6.015122887 u of AME2020 [6] (U-07, U-08); the transverse occupation of the 10^2 ^{6}Li atoms (SA-84) adds between -0.00284 and -0.00167 (U-26), the intensity scaling's polarizability term widens the interval by ±0.0002 (U-28), and the interval rounded outward is $\Delta\ln\omega_0|_\mathrm{cons} \in [-0.1570, -0.1553]$ (U-29).

Precision criterion. Per isotope, the fit contributes 0.0053, the record's 0.5 Hz on 95.1 Hz; a depth re-set of 0.005 contributes through $S_V = \partial\ln\omega_0/\partial\ln\mathcal{V}_\mathrm{L} = -0.474$, at fixed $\mathfrak{q}_0/\hbar k_\mathrm{L}$ and

$\mathcal{V}_{\mathrm{M}}/E_{\mathrm{R}}$; a quasimomentum re-set of $0.003\,\hbar k_{\mathrm{L}}$ through $S_{\mathfrak{q}} = \partial \ln \omega_0/\partial(\mathfrak{q}_0/\hbar k_{\mathrm{L}}) = +0.40$ per $\hbar k_{\mathrm{L}}$, at fixed $\mathcal{V}_{\mathrm{L}}/E_{\mathrm{R}}$ and $\mathcal{V}_{\mathrm{M}}/E_{\mathrm{R}}$; and a sheet-height re-set of 0.02 through $S_{\mathrm{M}} = \partial \ln \omega_0/\partial \ln \mathcal{V}_{\mathrm{M}} = +0.026$, each the soft-wall round trip's (U-18 to U-20, U-31). The two isotopes' scatters are independent, the drift $\mathcal{N}_{\mathrm{dr}} = 0.0010$ per pair carries the coin's sign, and

$$\begin{aligned} \mathcal{N}_{\mathrm{iso}} &= \left[0.0053^2 + (0.474 \times 0.005)^2 + (0.40 \times 0.003)^2 + (0.026 \times 0.02)^2\right]^{1/2}, \\ \mathcal{N}_{\mathrm{pair}} &= \sqrt{2}\,\mathcal{N}_{\mathrm{iso}} = 0.00842, \qquad \mathtt{t}_1 = \frac{\sqrt{8}\,(\bar{\mathfrak{d}} + 0.1553)}{\mathcal{S}_{\mathfrak{d}}}, \\ \mathcal{Z}_1 &= \frac{4.530\,(0.00842^2 + 0.0010^2)^{1/2}}{\sqrt{8}} = 0.0136, \end{aligned} \tag{15}$$

with rejection at $\mathtt{t}_1 > 4.530$, the one-sided 0.00135 quantile of Student's $\mathtt{t}$ at 7 degrees of freedom (U-33), and $\mathcal{Z}_1$ the size of a contribution above the upper end that the rule resolves. Executed exactly (U-34): size 0.0014 at the upper end, 0.00066 at the centre, 0.00030 at the lower end, and 0.0014 with the drift doubled; power 0.26, 0.66 and 0.93 at contributions 0.010, 0.015 and 0.020 above the upper end.

channel	input	sign in $\mathfrak{d}$	where it enters
inertial (recoil scaling)	$\Delta \ln M = 0.153917$	$-$	comparator
transverse occupation	2.0 to 3.0 quanta	$-$ (-0.00284 to -0.00167)	comparator
polarizability in the scaling	± 0.0002	either	comparator width
depth re-set	0.005, $S_V = -0.474$	either	noise, re-set per pair
quasimomentum re-set	$0.003\,\hbar k_{\mathrm{L}}$, $S_{\mathfrak{q}} = +0.40$	either	noise
sheet-height re-set	0.02, $S_{\mathrm{M}} = +0.026$	either	noise
drift between the members	0.0010	coin	randomised
density channel (I-7)	$\Delta \ln \alpha_{\mathrm{ext}} = 0.153917$	+ (S_{dens} positive)	the prediction

Decision rules. Detection: the one-sided $\mathtt{t}$ rejects. Exclusion: an FDT-sign contribution of 0.025 above the interval's lower end is excluded when the one-sided $\mathtt{t}$ of the contrasts below that bound, -0.1320, rejects at 0.00135 (executed exactly: false exclusion 0.0014 with the truth at the bound; exclusion 0.98 and 0.99 with no density channel at the upper and lower ends). Inconclusive otherwise. Attribution: a detection is read as the density channel when it survives with each contrast corrected by its pair's on-axis depth ratio, measured by Kapitza–Dirac diffraction, analysed beyond Raman–Nath with each isotope's own recoil, of each cloud released from a 10-kHz transverse trap (0.005 per pair; U-36), through S_V. *Ablation.* Instantiated at the power point, a density-channel contribution 0.015 above the upper end: the prediction is $\mathfrak{d} = -0.1403$ with the FDT input in place and -0.1553 with S_{dens} set to zero, a difference of 0.015 against the threshold $\mathcal{Z}_1 = 0.0136$. Status: prospective, a sign prediction under the declared positive sensitivity; convergence value $[-0.1570, -0.1553]$.

5.2 T-2: the S–D band separation of ^{6}Li against ^{7}Li

Candidate DC-2; it discriminates SA-16, the band transfer the record performs by "amplitude modulating the lattice with depth 1.58 E_{R} and frequency $\omega_{\mathrm{AM}} = 2\pi \times 270$ kHz" (L98–L99; SC-099), whose S–D separation the record does not print. The warrant is I-7, a constitutive input, as in T-1.

Referent and design. The referent and the pairing of T-1, in the static lattice with no cavity and no force; eight pairs, each pair's order drawn by the coin, the intensities re-set before each pair. The observable is the S–D separation $\mathfrak{g}_{\mathrm{SD}}$ at $\mathfrak{q} = 0$, read as the first moment of the lattice's amplitude-modulation line, quasimomentum-resolved by band mapping and read at $\mathfrak{q} = 0$ for both

isotopes (external); on the beams' axis it is $9.059\,E_{\mathrm{R}} = 227.6$ kHz for ^{7}Li at $12.32\,E_{\mathrm{R}}$ (U-21), and the record's 270 kHz meets it at $\mathfrak{q} = 0.655\,\hbar k_{\mathrm{L}}$ (U-22). With the FDT input of Eq. (14),

$$\mathfrak{d}_i = \ln \mathfrak{g}_{\mathrm{SD}}(^{7}\mathrm{Li}) - \ln \mathfrak{g}_{\mathrm{SD}}(^{6}\mathrm{Li}), \qquad \Delta \ln \mathfrak{g}_{\mathrm{SD}} = \Delta \ln \mathfrak{g}_{\mathrm{SD}}\big|_{\mathrm{cons}} + \int_{^{6}\mathrm{Li}}^{^{7}\mathrm{Li}} S_{\mathrm{dens}}\, \mathrm{d} \ln \alpha_{\mathrm{ext}}, \tag{16}$$

with S_{dens} now $\partial \ln \mathfrak{g}_{\mathrm{SD}} / \partial \ln \alpha_{\mathrm{ext}}$ at the same held variables; the prediction rests on the declared positive sensitivity, as in T-1. *Comparator*, attributed: $-\Delta \ln M$ with SA-84's S-band term on the first moment, between +0.00199 and +0.00302 (U-27), widened by ±0.0002 (U-28): $\Delta \ln \mathfrak{g}_{\mathrm{SD}}|_{\mathrm{cons}} \in [-0.1522, -0.1506]$ (U-30).

Precision criterion. Per isotope the first moment contributes 0.0013 (0.3 kHz) and a depth re-set of 0.005 contributes through $S_V(\mathfrak{g}_{\mathrm{SD}}) = \partial \ln \mathfrak{g}_{\mathrm{SD}} / \partial \ln \mathcal{V}_{\mathrm{L}} = +0.762$ at fixed $\mathfrak{q} = 0$ (U-21, U-32); the drift is 0.0010 with the coin's sign;

$$\begin{aligned} \mathcal{N}_{\mathrm{iso}} &= \left[0.0013^2 + (0.762 \times 0.005)^2\right]^{1/2}, \qquad \mathcal{N}_{\mathrm{pair}} = 0.00569, \\ \mathcal{Z}_2 &= \frac{4.530\,(0.00569^2 + 0.0010^2)^{1/2}}{\sqrt{8}} = 0.0093, \end{aligned} \tag{17}$$

and $\mathtt{t}_2 = \sqrt{8}\,(\bar{\mathfrak{d}} + 0.1506)/\mathcal{S}_{\mathfrak{d}}$ rejects at $\mathtt{t}_2 > 4.530$. Executed exactly (U-35): size 0.0014, 0.00049 and 0.00016 at the upper end, centre and lower end, 0.0014 with the drift doubled; power 0.18, 0.52 and 0.83 at 0.006, 0.009 and 0.012 above the upper end. The channels are those of T-1's table, with the S-band term (+) in place of the D-band transverse term and the first moment's scatter in place of the fit and the sheets.

Decision rules. Detection: the one-sided $\mathtt{t}$ rejects. Exclusion: an FDT-sign contribution of 0.015 above the interval's lower end is excluded when the one-sided $\mathtt{t}$ of the contrasts below that bound, −0.1372, rejects at 0.00135 (executed exactly: false exclusion 0.0014 with the truth at the bound; exclusion 0.92 and 0.97 with no density channel at the upper and lower ends). Inconclusive otherwise. Attribution as in T-1. *Ablation.* Instantiated at the power point 0.012 above the upper end: $\mathfrak{d} = -0.1386$ with the FDT input and −0.1506 without it, a difference of 0.012 against $\mathcal{Z}_2 = 0.0093$. Status: prospective, a sign prediction under the declared positive sensitivity; convergence value $[-0.1522, -0.1506]$.

5.3 T-3: the internal line of a sensor filling a quantized vortex

Candidate DC-3; it discriminates SA-53, the record's condensate of 2×10^5 ^{7}Li atoms "prepared in the" $|1,1\rangle$ state at the uniform vertical field of 543.6 G (SC-279, SC-280, SC-282, L500–L502), the field that sets the s-wave scattering length to zero [4]. The warrant is P-5, an additional source: "mechanical vorticity and magnetic moments are different grade projections of one density-gradient topography, with no carrier exchange (I-2)" and "vortex lines are bivector topological defects", with I-3a's projection clause quoted in section 1.11.

Referent. The record's condensate at 543.6 G in its crossed dipole trap; a two-photon Raman pulse with a Laguerre–Gauss beam of winding $\mathfrak{w} = \pm 1$ and a Gaussian beam (external), both co-propagating along the bias in one circular polarisation, moves about half the atoms by a same-n transfer (I-5) to $|2,1\rangle$, whose transitions at 2047.9 and 139.05 MHz lie far from the probe (U-37), with circulation $\mathfrak{w}$ about the vertical bias axis and no linear momentum; the rest stay in $|1,1\rangle$ with no circulation and fill the vortex core as the sensor (U-58). The observable is the sensor's $|1,1\rangle \to |2,2\rangle$ frequency ν of a same-n transition (I-5), 2187.0 MHz at 543.6 G with 2.719 MHz G^{-1} from the Breit–Rabi levels with the hyperfine constants of Ref. [8] (U-37), read by Rabi spectroscopy with a 0.5-ms π pulse at the two half-maximum points (external).

Design. 4000 pairs, each one shot at $\mathfrak{w} = +1$ and one at $\mathfrak{w} = -1$, the order by the coin per pair;

$$\mathfrak{d}_i = \nu_i(\mathfrak{w} = +1) - \nu_i(\mathfrak{w} = -1), \qquad i = 1, \ldots, 4000. \tag{18}$$

The FDT input: the circulation's magnetic projection along its axis adds to the bias at first order, with a sense that the winding sets; P-5 assigns neither magnitude nor sense, and no twist-to-moment form is written here (P-5: "Quantitative twist → moment forms are derived in-manuscript through I-1/I-2 with a declared kernel"). The block is an existence prediction. The two windings are the neighbours between which the twist is read (0.1c, I-3a). *Comparator*, the consensus premise, attributed: zero for the $\mathfrak{w}$-odd part. The internal line is blind to the sense of a centre-of-mass circulation, the sensor carries none, the interspecies mean-field shift and the vortex component's own dipole field are $\mathfrak{w}$-even, odd only through unequal transfers at the two windings, which the attribution rule corrects, and the microwave carries no orbital angular momentum across the cloud.

Precision criterion. Per shot, the bias jitter of 0.5 mG at 2.719 MHz G^{-1} gives 1.3595 kHz and the readout 0.200 kHz, $\mathcal{N}_{\mathrm{shot}} = 1.374$ kHz; the drift is 0.05 kHz with the coin's sign (U-38);

$$\mathtt{t}_3 = \frac{\sqrt{4000}\,\bar{\mathfrak{d}}}{\mathcal{S}_{\mathfrak{d}}}, \qquad \mathcal{Z}_3 = \frac{3.0019\left[(\sqrt{2}\times 1.374)^2 + 0.05^2\right]^{1/2}}{\sqrt{4000}} = 0.0923 \text{ kHz}, \tag{19}$$

two-sided, rejecting at $|\mathtt{t}_3| > 3.0019$, the one-sided 0.00135 quantile at 3999 degrees of freedom (U-33). Executed exactly (U-39): size 0.0027; power 0.35, 0.82 and 0.97 at 0.040, 0.060 and 0.075 kHz per sense. Single-channel scope: the $\mathfrak{w}$-odd part of the sensor line alone; every $\mathfrak{w}$-even channel cancels in $\mathfrak{d}$, unequal transfers are the one $\mathfrak{w}$-odd consensus channel, and the drift is randomised by the coin.

Decision rules. Detection: the two-sided rule rejects. Exclusion: an effect of 0.100 kHz per sense or more is excluded when, the contrasts shifted by twice that size against each sign, both one-sided $\mathtt{t}$ reject at 0.00135 (executed exactly: 1.000 with no effect; false exclusion 0.0014 at that size). Inconclusive otherwise. Attribution: a detection is read as the circulation's when it survives each contrast's correction for its pair's difference in the circulating component's imaged atom number, through the sensor line's slope against that number at fixed winding, the Raman pulse area varied (external): a Gaussian pulse fills no core and moves the interspecies shift at $\mathfrak{w}$-even order, and unequal transfers are the one $\mathfrak{w}$-odd consensus channel. *Ablation.* Instantiated at the power point, 0.060 kHz per sense: the contrast is 0.120 kHz with the P-5 source and 0 without it, a difference of 0.120 kHz against $\mathcal{Z}_3 = 0.0923$ kHz. Status: prospective, an existence prediction (the magnitude needs a map from a circulating charge to an I-1 input, none of which is written here, O-6); convergence value 0.

5.4 T-4: the internal line beside quartz enantiomers

Candidate DC-4; it discriminates SA-58, the record's cloud held "After a variable hold time in the static cavity potential" (SC-296, L516). The warrant is P-5, an additional source: "Imposing a physical twist (torsion, helical geometry) on a material *is* establishing a magnetic field".

Referent. Sixteen quartz cylinders, eight left-handed and eight right-handed (the two enantiomorphic forms of trigonal quartz), one cut (optic axis along the cylinder) and one size (10 mm diameter, 40 mm long), the hand of each verified by optical rotation (external); a non-magnetic holder outside the glass cell holds one cylinder with its axis vertical, along the bias, 15 mm from the cavity's centre at its height (U-42). The observable is the same-n (I-5) $|1,1\rangle \to |2,2\rangle$ line of the cloud held in the record's static cavity (SC-296 to SC-298, L516–L518), read as in T-3.

Design. Per crystal, 500 shots with it in the holder and 500 with the holder empty, interleaved in ten pairs of blocks of 50 (1000 shots in all), the order within each pair drawn by the coin; the

crystals in an order a random permutation draws before the run; with $\bar{\nu}_{\mathrm{in},j}$ and $\bar{\nu}_{\mathrm{empty},j}$ crystal j's mean line with it in the holder and with the holder empty, and $\bar{\mathfrak{q}}_{\mathrm{left}}$ and $\bar{\mathfrak{q}}_{\mathrm{right}}$ the means of the reading over the eight crystals of each hand, the reading of crystal j and the contrast are

$$\mathfrak{q}_j = \bar{\nu}_{\mathrm{in},j} - \bar{\nu}_{\mathrm{empty},j}, \qquad \mathfrak{d} = \bar{\mathfrak{q}}_{\mathrm{left}} - \bar{\mathfrak{q}}_{\mathrm{right}}, \tag{20}$$

the empty holder being the reference path (Use item 7). The FDT input: the helical geometry establishes a field whose sense the hand sets; P-5 assigns neither magnitude nor sense, and no twist-to-moment form is written here: an existence prediction. *Comparator*, the consensus premise, attributed: zero for the hand-odd part. The crystals are nonmagnetic and time-reversal-invariant mirror images whose diamagnetic responses along the axis are equal, so the induced field, about 0.4 kHz of line shift from a diamagnetic volume susceptibility of magnitude 1.6×10^{-5} through the end faces' magnetic charge at 15 mm (U-40), is hand-even.

Precision criterion. Per shot 1.374 kHz; placement re-set 15 Hz; per crystal and per hand contrast (U-41),

$$\begin{aligned} \mathcal{N}_{\mathrm{cry}} &= \Big[1.374^2 \times \frac{2}{500} + 0.015^2\Big]^{1/2} = 88.2 \text{ Hz}, \\ \mathcal{N}_{\mathrm{hand}} &= \mathcal{N}_{\mathrm{cry}}\Big(\frac{2}{8}\Big)^{1/2} = 44.1 \text{ Hz}, \qquad \mathcal{Z}_4 = 3.0\,\mathcal{N}_{\mathrm{hand}} = 132 \text{ Hz}, \end{aligned} \tag{21}$$

with the per-shot and placement terms in kHz. The statistic is $\mathfrak{d}$ itself, tested two-sided by permutation over all $\binom{16}{8} = 12870$ hand relabelings, rejecting at $p \le 0.0027$, with p the permutation p-value; its exact size is $34/12870 = 0.0026$. Executed: power 0.4, 0.8 and 0.95 at 75, 100 and 125 Hz per hand (10^5 trials each). Single-channel scope: the hand-odd part alone; the induced diamagnetic field, the placement and the bias are hand-even or randomised, and the empty holder removes every crystal-independent term.

Decision rules. Detection: $p \le 0.0027$. Exclusion: an effect of 150 Hz per hand or more is excluded when, the crystals' readings shifted by that size against the hand, both one-sided tails give $p \le 0.00135$ (executed: 0.99 with no effect in 10^5 trials; false exclusion at most $17/12870 = 0.0013$). Inconclusive otherwise. Attribution: the hand-even part, the mean $\mathfrak{q}$ of all sixteen, agrees within three standard errors, the computation's uncertainty included, with the computed diamagnetic shift of about 0.4 kHz (U-40). *Ablation.* Instantiated at the power point, 100 Hz per hand: the contrast is 200 Hz with the P-5 source and 0 without it, a difference of 200 Hz against $\mathcal{Z}_4 = 132$ Hz. Status: prospective, an existence prediction (O-6, as in T-3); convergence value 0.

5.5 T-5: the Bloch period beside a twisted rod

Candidate DC-5; it discriminates SA-54, the record's Bloch oscillations "with period $\mathfrak{T}_{\mathrm{B}} = 10.70$ ms" in a field gradient whose value it does not print (SC-285, SC-286, L506–L507). The warrant is P-5, an additional source: the torsion sentence, "Imposing a physical twist (torsion, helical geometry) on a material *is* establishing a magnetic field".

Referent. A polyether ether ketone (PEEK) rod, 3 mm in diameter and 60 mm long (external), beside the glass cell, vertical, 15 mm from the cavity's centre on the horizontal line at 45° to the lattice axis, clear of the lattice beams and every other beam path, at the cavity's height, its lower end clamped and its upper end turned by +0.20 or −0.20 rad, the sense seen from above, by a non-magnetic piezo rotation stage (U-46); at that twist its surface shear is 0.0050, its surface stress 6.5 MPa and its torque 0.034 N m (U-44). The observable is the S-band Bloch period $\mathfrak{T}_{\mathrm{B}}$ of the record's cloud in its field gradient, fitted from the momentum-space Bloch oscillation over five periods (external).

Design. 400 pairs, one run at each sense, the order by the coin per pair;

$$\mathfrak{d}_i = \mathfrak{T}_{\mathrm{B}}(+) - \mathfrak{T}_{\mathrm{B}}(-), \qquad i = 1, \ldots, 400. \tag{22}$$

The FDT input: the twist establishes a field whose gradient along the lattice axis moves the push of Eq. (10); an existence prediction, with no twist-to-moment form written here. The two senses are the neighbours between which the twist is read. *Comparator*, the consensus calculation, attributed: zero for the twist-odd part, bounded at ± 0.02 µs. The torsion strain changes the rod's diamagnetism linearly in the strain but azimuthally about its axis, which carries no magnetic charge on the side or the end faces and so leaves no field outside the rod at any length; the clamp region's non-torsional strain is bounded by about 0.01 µs of $\mathfrak{T}_{\mathrm{B}}$, from 3×10^{-5} times the bias times the surface shear 0.005 times the radius over the length, 0.025, over 15 mm, against the 1.33 $\mathrm{G\,cm^{-1}}$ that $F = h/(\mathfrak{T}_{\mathrm{B}}\lambda/2) = 1.164 \times 10^{-25}$ N and the $|1,1\rangle$ moment of 0.943 Bohr magnetons give (U-43, U-45), and the bound is doubled.

Precision criterion. 1.07 µs per run, 1×10^{-4} of $\mathfrak{T}_{\mathrm{B}}$; drift 0.10 µs with the coin's sign (U-46);

$$\mathcal{Z}_5 = \frac{3.0189\left[(\sqrt{2} \times 1.07)^2 + 0.10^2\right]^{1/2}}{\sqrt{400}} + 0.02 = 0.2489 \text{ µs}, \tag{23}$$

two-sided against the band, rejecting at $|\bar{\mathfrak{d}}| > 3.0189\,\mathcal{S}_{\mathfrak{d}}/\sqrt{400} + 0.02$ µs, with 3.0189 the one-sided 0.00135 quantile at 399 degrees of freedom (U-33). Executed exactly (U-47): size 0.0011 with no effect and 0.0016 with the truth at the band's edge; power 0.26, 0.75 and 0.98 at 0.10, 0.15 and 0.20 µs per sense. Single-channel scope: the twist-odd part alone; the sense-even part and the drift are removed by the contrast and the coin.

Decision rules. Detection: the two-sided rule rejects. Exclusion: an effect of 0.30 µs per sense or more is excluded when, the contrasts shifted by twice that size against each sign, less the band's 0.02 µs so that the false exclusion holds at the band's edge, both one-sided `t` reject at 0.00135 (executed exactly: 1.000 with no effect; false exclusion 0.0014 at that size). Inconclusive otherwise. Attribution: the sense-even part, the mean of the two senses, agrees within three standard errors with the rod untwisted, and the sense-odd part with zero when the rod, unclamped, turns rigidly. *Ablation.* Instantiated at the power point, 0.15 µs per sense: the contrast is 0.30 µs with the P-5 source and 0 without it, a difference of 0.30 µs against $\mathcal{Z}_5 = 0.2489$ µs. Status: prospective, an existence prediction (O-6, as in T-3); convergence value 0 within ± 0.02 µs.

6 Cross-domain

The identity map holds wherever the record's map holds. A modulated cavity of open strokes, the cited theory's object [2], carries the photonic map exactly, because the open stroke's phase rate equals its run at every frequency (I-2); in the manuscript's labelled reading the matter-wave cavity carries it where the closed pattern's run is uniform and departs where reflection changes that run (SC-242, L359). The record's "electro-optic materials" (SC-020, L28–L29) are strokes in a material whose stress tensor sets the curvature, which I-3 containment returns. The I-7 contrasts carry to any confined closed pattern read for two isotopes at matched dimensionless parameters, and the P-5 contrasts to any internal line or push read between neighbours or against a reference path.

7 System-level reading (exploratory)

Scope. This section holds one exploratory observable, X-1. It is never counted with the predictions, it carries no number, and every statement in it is an in-sample re-description of the record.

X-1, the order of two drive segments. Observable: the cloud's stroboscopic distribution after a segment of phase Φ followed by a segment of phase $\Phi + \pi$, against the reverse order, both from one initial state. Defining condition: the difference of the two final column densities at equal total cycle count. Comparator: the record's leading-order map, Eq. (S23), on which the $\Phi + \pi$ map inverts the Φ map (section 3.2), so both orders give one final state, the initial state when the two segments are equal. Beyond that order, reflection from the moving sheet changes the closed pattern's run (I-2; SC-241, SC-242, L358–L359), and the two orders are two settlements, read through 0.1a's "Events do not commute". The record prints no reverse order and no return fidelity.

Guards. X-1 enters neither the abstract's count nor the status ledger's predictions; it redescribes the record's one phase step (SC-224 to SC-228, L333–L338) and adds no datum; no fidelity, rate or threshold is assigned to it; and the return is never written as the forward evolution run backward or as its mirror (0.1a).

8 Convergence statement

The limiting map. On the record's own inputs and dictionary FDT returns the record's values: the resonant map, Eq. (1) and Eqs. (S16)–(S23), with the fixed points of Eq. (S20); Eq. (3); the time-dependent Schrödinger equation, Eqs. (S24)–(S26); the fits, $\omega_0/2\pi = 95.1(5)$ Hz (SA-25) and the π phase difference (SA-43); and the derived values $40/4 = 10$ (SA-57) and $\bar{\mathcal{L}}/6$, $5\bar{\mathcal{L}}/6$ (SA-70). Each is the identity map of Use item 2 and corroborates no invariant; I-3 containment returns the same curvature from the same stress tensor and data. A print that differs from its own inputs stays the record's: Eq. (3)'s 89.7 Hz against 95.1(5) Hz (SA-24), 7.27×10^{-3} against half of 1.45×10^{-2} (SA-41), and the simulation's "experimental value of 95.5 Hz" (SA-79). The predictions converge on their comparators, T-1 on $[-0.1570, -0.1553]$, T-2 on $[-0.1522, -0.1506]$, T-3 and T-4 on zero and T-5 on zero within ± 0.02 µs, and diverge only through I-7's constitutive input or P-5's additional source, never through α, a chart or a branch tag alone.

Declined readings, once each, in the record's words. SA-01 (P-4): the record writes that "Viewed stroboscopically, photons in such a driven cavity propagate as if in a curved spacetime, with black hole and white hole event horizons corresponding to unstable and stable fixed points of the evolution" (SC-009, SC-010, L11–L13), and that "the (un)stable fixed point is thus analogous to the event horizon of a (black) white hole" (SC-086, SC-087, L81–L82). FDT reads the one-way region between the fixed points as horizon formation at the cloud's own run, with no singularity (P-4: "refraction, lensing and horizon formation are one phenomenon"), and the record's "as if", "analogous" and "analogue" (SC-110, L117) stay its words. SA-02 (I-2): the record describes "exchanging the roles of light and matter" (SC-012, L20–L21), a matter wave in the D band with "approximately linear (photonic) dispersion" (SC-039, SC-040, L58–L59), and "nontrivial dynamics beyond those predicted for photons" (SC-017, L25–L26). FDT reads the D-band ^{7}Li cloud as a closed pattern whose run is nearly uniform over a window and the light sheets as open strokes: the identity is carrier-only, and a matter mode is never inside it (I-2, I-5).

SA-06 (0.1, 0.1d): the record cites that "even the electromagnetic vacuum state becomes unstable to entangled photon generation" (SC-022, L41, L46–L48). FDT reads no empty background: density is nowhere uniform (0.1), c is the strand rate of the omnium (0.1d), and the record's "vacuum" (also SC-244, L361; SC-261, L343) stays its word. SA-19 (0.1b): the record writes that the "atoms are then confined between two repulsive optical barriers imposing an additional potential" (SC-104, SC-105, L104–L105). FDT reads the cavity as the cloud's own support region and the sheets as its boundary data, I-5's B, never a vessel holding a separate occupant (0.1b). SA-40 (0.1a): the record names the return under the π step a "demonstration of stroboscopic time reversal" (SC-197, L261). FDT reads it as a new forward settlement under the flipped drive, solved

from the state the cloud is in: events do not commute, and a process run backward is never the mirror of the forward event (0.1a).

SA-75 (I-3a): the record writes that the stroboscopic "velocity" $\mathrm{d}x/\mathrm{d}\mathfrak{n}$ "can be interpreted as originating from a nontrivial spacetime curvature" (SC-386, SC-387, L845–L846). FDT reads curvature between neighbours (I-3a, Use item 7): the slope $e^{\mp 2\pi \mathsf{A}}$ per cycle at the stable and unstable points is the separation rate of neighbouring trajectories, and the drift of one trajectory, which carries no clock factor, reads none. SA-76 (I-4): the record writes that "$\Psi(x,t)$ is the single-particle wavefunction" (SC-397, L868) and that "The initial condition is a superposition of Bloch waves" (SC-399, L880). FDT reads Ψ as the projection of a helix and the superposition as ignorance of the helical phase at observation, the dynamics deterministic (I-4); the simulation's numbers are accepted as the identity map.

9 Status ledger

The table below states, once, every owed item the manuscript touches, in the core's words, the held-out targets, every prediction with its status and convergence value, the in-sample readings and the PROVISIONAL tokens; the abstract's count is read off its T-rows.

item	status, in the core's words or the manuscript's	where touched; value
O-1	owed (O-1): the finite-core cutoff r_c, the regular core chart, or the outward phase-transfer law	the atlas's interior branch
O-2	owed (O-2): a geometrically constructed odds for the overlap-contrast application (A-3)	chart inventory
O-3	owed (O-3): a canonical odds for the confinement application (A-4)	chart inventory; I-5's second axis
O-6	owed (O-6): the maps from a charge, a circulating charge or a colour seat to an I-1 input	helical window; magnitudes of T-3, T-4, T-5
O-8	owed (O-8): the constitutive derivation of c_{eff} / n_{cone} and its reconciliation with lensing	the cavity's aperture, no number
O-9	owed (O-9): the confinement operator D, its domains, boundary data and spectrum; every mass ratio, including the two held-out targets	I-5 eigenproblem; band change
held-out target	$m_p/m_e = 1836.15267343$, carried as a held-out test	never an output
held-out target	$(m_\mu/m_e)^2 = 42\,753$, carried as a held-out test	never an output

item	status, in the core's words or the manuscript's	where touched; value
T-1	prospective sign test; declared positive sensitivity (S_{dens} positive, magnitude fixed by no clause)	convergence $[-0.1570, -0.1553]$
T-2	prospective sign test; declared positive sensitivity (as T-1)	convergence $[-0.1522, -0.1506]$
T-3	prospective existence test (O-6)	convergence 0
T-4	prospective existence test (O-6)	convergence 0
T-5	prospective existence test (O-6)	convergence 0 within ± 0.02 µs
in-sample reading	$\mathfrak{q}_0 = 0.74\,\hbar k_{\mathrm{L}}$ (SA-17) and $0.736\,\hbar k_{\mathrm{L}}$ (SA-79), fitted	the simulation is in-sample in $\mathfrak{q}_0$ and in the size it is matched to (SC-401, L882)
in-sample reading	the simulation's "quantitatively reproduce" (SA-35)	no residual statistic printed
in-sample reading	the "experimental value of 95.5 Hz" (SA-79)	kept apart from 95.1(5) Hz
in-sample reading	the fitted π phase difference (SA-43)	no uncertainty printed
PROVISIONAL token	α_{ovl} (A-3), α_{conf} (A-4), α_{mode} (A-5)	token and range only
CONDITIONAL	the helical window's exact law, on an energy fixed by the event alone (0.1c)	used at its slow limit

10 Conclusions

In the manuscript's labelled reading the record [1] is experimental proof of seven core concepts: "mode geometry is set by the boundary conditions" (P-2); "Two neighbouring patterns do" read curvature (I-3a, Use item 7); "horizon formation" with "No singularity anywhere" (P-4, 0.8); a step solved "from the state the system is in" (0.1a); "only the open stroke has them equal at every frequency" (I-2, I-5); a cavity that is "that pattern's own support region" (0.1b); and c, "the rate at which the one stroke runs" (0.1d). On the record's own inputs each reading is the identity map and corroborates no invariant, and every measurement and image is accepted in full. The five predictions decide: T-1 and T-2 by a ^{7}Li–^{6}Li contrast above the recoil scaling's interval, the sign of I-7's density channel, and T-3 to T-5 by an odd part, in the winding, the hand or the twist, where the consensus premise gives zero and P-5 gives a field.

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