

Same Form, One Substance

Twelve equations of physics and generalised Snell's law,
read through Fundamental Density Theory

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Fundamental Density Theory

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Core v6.3 (author lock 2026-10-26) · companion to *What ψ Is* and *One Substance, One Carrier, One Geometry, Myriad Forms*

Abstract

A widely shared chart sets twelve equations of physics side by side under the line *same form, different physical worlds*: the wave equation in one and two dimensions, the string, the harmonic and the damped oscillator, radioactive decay, the heat equation, Poisson's equation, the Maxwell–Faraday law, the Schrödinger equation, the Navier–Stokes equations and Einstein's field equations. Fundamental Density Theory reads the same twelve, with generalised Snell's law as a thirteenth, as *same form, one substance*. Every equation is a reading of the one chain $E/m = c^2 = 1/(\varepsilon_0\mu_0) = (d/t)^2$ on the one medium with its one carrier, and the readings fall on four trunks of one map. The stroke: the wave equations and Faraday's law are the two responses of the omnium driving the two grades of its stroke at c , and a string's wave speed is c for a strand whose tension equals its energy per unit length. The closed stroke: the oscillator is the shadow of a circle, the damped oscillator a helix on a cone, and the Schrödinger equation, read on the cylinder with the unit imaginary as the bivector of the plane, is a pair of real equations for a radius and an angle, deterministic once the start azimuth is fixed. Whole events: decay and heat count whole events of a system-wide settlement, the exponential law with unread phases and the heat equation as the slow reading of strokes run between whole redirections. The geometry and the medium: Poisson's equation is the static response; the field equations stand unchanged, with $\kappa F_{\max} = 2\pi$ and the cosmological term read as released stored potential; their exterior is the optics of the exact index, so that FDT = the Einstein field equations = generalised Snell's law; and the Navier–Stokes equations are the slow limit of the medium's free fall in its own clock factor, the omnium read as a fluid. A receipt script checks the displayed identities and computed numbers, 49 of 49.

1 Same form, one substance

Fundamental Density Theory has one substance, the omnium: matter = energy = spacetime. The chain

$$\frac{E}{m} = c^2 = \frac{1}{\varepsilon_0\mu_0} = \left(\frac{d}{t}\right)^2 \quad (1)$$

is one identity read by quantum mechanics, electromagnetism and general relativity (core 0.1) [1]. Its four terms adjust simultaneously, never one term at a time, and every step is a system-wide settlement of the state the system is in (0.1a). A carrier is a disturbance of a medium at that medium's speed; the chain gives one speed to every reading and 0.1b leaves one medium, so there is

one carrier: photon = graviton = gluon = phonon = magnon, one stroke read in different density and geometry regimes (I-2) [6].

The chart that prompts this paper [2] prints twelve equations and remarks that they share a form while describing different physical worlds. Read through the core, the worlds are one: each equation is a reading of the chain on the one medium, and the shared form is the chain's d/t held in a regime. Figure 1 places the twelve, with generalised Snell's law as a thirteenth, on four trunks: the stroke, the closed stroke on its cylinder, whole events, and the geometry with the medium that runs on it. Sections 4–8 derive each reading from the core and from the foundation papers it rests on; Section 9 reads the common form; the record, the tests, the declined readings and the convergence statement follow. The receipt script of Appendix A checks the displayed identities and computed numbers, and its check labels appear in brackets, [FM10a]. Where the chart's letters collide with the core's, they are renamed: the diffusivity the chart writes α is D , since α is the density coordinate (0.3); a string's tension is $\mathcal{T}$; the charge and mass densities are ρ_e and ρ_m , and ρ is the radius of the cylinder on which ψ is the cross-section of a helix.

Two working rules carry the paper. The complex equations of quantum mechanics are read on the cylinder: the unit imaginary is the oriented unit area of the plane normal to the helix's axis, so every complex equation is a pair of real equations and the determinism of the quantum face is explicit (I-4) [5]. The omnium is a medium, and a fluid is the flow of its patterns: the medium's clock factor is its enthalpy per count, its pressure force is the bookkeeper's reading, and its equations of motion are its free fall (0.1c) [7, 8].

2 Premises, charts and symbols

The readings use the locked core v6.3 [1]; each premise is quoted by section.

- (P1) *One substance, only patterns.* There is one substance, the omnium, and there are only its patterns. A room, box or domain is a pattern's own support, never a vessel; every physical length and time belongs to a pattern, to a pattern-to-probe measurement, or to the floor (0.1, 0.1b).
- (P2) *The chain is one state.* The bridges $E_q = m_q c^2 = \hbar \omega_q$, $T_q = 2\pi/\omega_q = h/E_q$ and $\ell_q = cT_q$ are constants of the medium; the floor is $d_{\min} = 2\ell_P$, $t_{\min} = 2t_P$. Every step is a system-wide settlement: responses are many-to-many, events do not commute, and a process run backward is never the mirror of the forward event (0.1a).
- (P3) *Two readings.* A pattern's kept time and thread length rescale together by the clock factor $\mathbf{m}$ with the density it crosses; on its own clocks and rulers nothing changes, and the bookkeeper reads $\nabla_{\mathcal{U}} \mathcal{U}^\mu = -\mathfrak{P}^{\mu\nu} \partial_\nu \ln \mathbf{m}$. A medium of perfect form free-falls in $\mathbf{m}^2 g_{\mu\nu}$, its clock factor its temperature at zero net count or, with a conserved count and fixed entropy per count, its enthalpy per count; the pressure force is the bookkeeper's reading (0.1c).
- (P4) *The strand rate.* The two responses $\nabla \times \mathbf{E} = -\partial_t \mathbf{B}$ and $\nabla \times \mathbf{B} = \varepsilon_0 \mu_0 \partial_t \mathbf{E}$, with $\nabla \cdot \mathbf{E} = 0 = \nabla \cdot \mathbf{B}$, give $\nabla^2 f - c^{-2} \partial_t^2 f = 0$ with $c^2 = 1/(\varepsilon_0 \mu_0)$. A closed pattern's strand runs at c on a helix and keeps time by circulating; the open stroke runs straight at c , keeps no time, and its grades turn on a helix of radius c/ω standing at $\pi/4$ (0.1d, I-2) [3].
- (P5) *One carrier.* Photon = graviton = gluon = phonon = magnon; there are no independent force carriers, and interactions are curvature plus geodesic motion (I-2).
- (P6) *One geometry.* $G_{\mu\nu} = \kappa T_{\mu\nu}$ unchanged, $\kappa = 8\pi G/c^4$, with $T_{\mu\nu}$ the one total source; α is downstream of the solution. The exterior's exact optical metric is $d\ell_{\text{opt}}^2 = dr_f^2/(1 -$

$\alpha_{\text{ext}})^2 + r_f^2 d\Omega^2 / (1 - \alpha_{\text{ext}})$, and generalised Snell's law is the Fermat jump law of this metric, $n_1 \sin \theta_1 = n_2 \sin \theta_2$ with the exact index (I-3).

- (P7) *The quantum face.* $\psi = Ae^{i\varphi}$ is the projection of a helix onto the plane normal to the cone axis; superposition is ignorance of the helical phase φ_0 ; the universe is deterministic (I-4).
- (P8) *Matter is closed stroke.* A closure carries the mass $m_q c^2 = \hbar \omega_q$ of its mode, the eigenvalue of a confinement operator to be derived (core O-9); decay is loop unwinding through the one channel left open, every exact book balancing across the event (I-5, I-5b).
- (P9) *One account.* $\mathcal{M} = M + E/c^2 + PV/c^2 + aT^4 V/c^2 + \dots$, every channel entering once (0.5, I-7). There is no cosmological-constant term: the effective one is the released stored potential, $\Lambda_{\text{eff}} = (8\pi G/c^4) u_{\text{rel}}$, a running total of unwinding (0.7).
- (P10) *Nodal architecture, clamps and twist.* Mode geometry is set by the boundary conditions, the clamps, not by the medium (P-2, P-3); a magnetic field is a helical density gradient of the omnium (P-5).

Charts. One application of the bounded map appears: the A-1 compactness chart on a source's exterior branch, $\alpha_{\text{ext}}(r_f) = R_s/r_f$ on $r_f > R_s$ with $R_s = 2GM/c^2 = \mathcal{M}c^2/(2F_{\text{max}})$, in Sections 7.1–7.3. The paper evaluates α nowhere else, and no computational token stands in any slot.

symbol	meaning
$\mathfrak{m}$	the clock factor of 0.1c; for a medium of perfect form at fixed entropy per count, the enthalpy per count $\mathfrak{h}_N = (E + PV)/N$ up to a constant
$\mathfrak{P}^{\mu\nu}$	$c^2 g^{\mu\nu} + \mathcal{U}^\mu \mathcal{U}^\nu$, the projector across the flow
Σ	$e_1 e_2$, the unit bivector of the plane normal to a helix's axis, $\Sigma^2 = -1$
ρ, φ	the radius and the angle of the cylinder on which ψ is the cross-section of a helix
Q_ρ	$-(\hbar^2/2m)\nabla^2 \rho/\rho$, the profile term
ρ_e, ρ_m, ϕ_e	the charge density, the mass density, the electrostatic potential
$\mathcal{T}, \mu, e_\ell$	a string's tension and inertia per unit length; a strand's energy per unit length
b, k_s	the damping coefficient and the spring constant of the chart's equation (4)
D, τ	the diffusion constant; the mean interval between whole redirections of a stroke
η	the viscosity of the chart's equation (11)
$r_{\text{opt}}, J_{\text{opt}}$	$r_f/\sqrt{1 - \alpha_{\text{ext}}}$, the radius of a sphere's circumference in the optical metric; the constant of a ray

3 The formula map

Figure 1 is the map. The chain sits at its root, and four trunks of the core carry the thirteen equations. Each box gives an equation as the chart writes it, with the letters the core reserves renamed, and its FDT reading in one line; a number in a reading names the equation it derives from. Table 1 lists the same readings with the sections of the core that carry them.

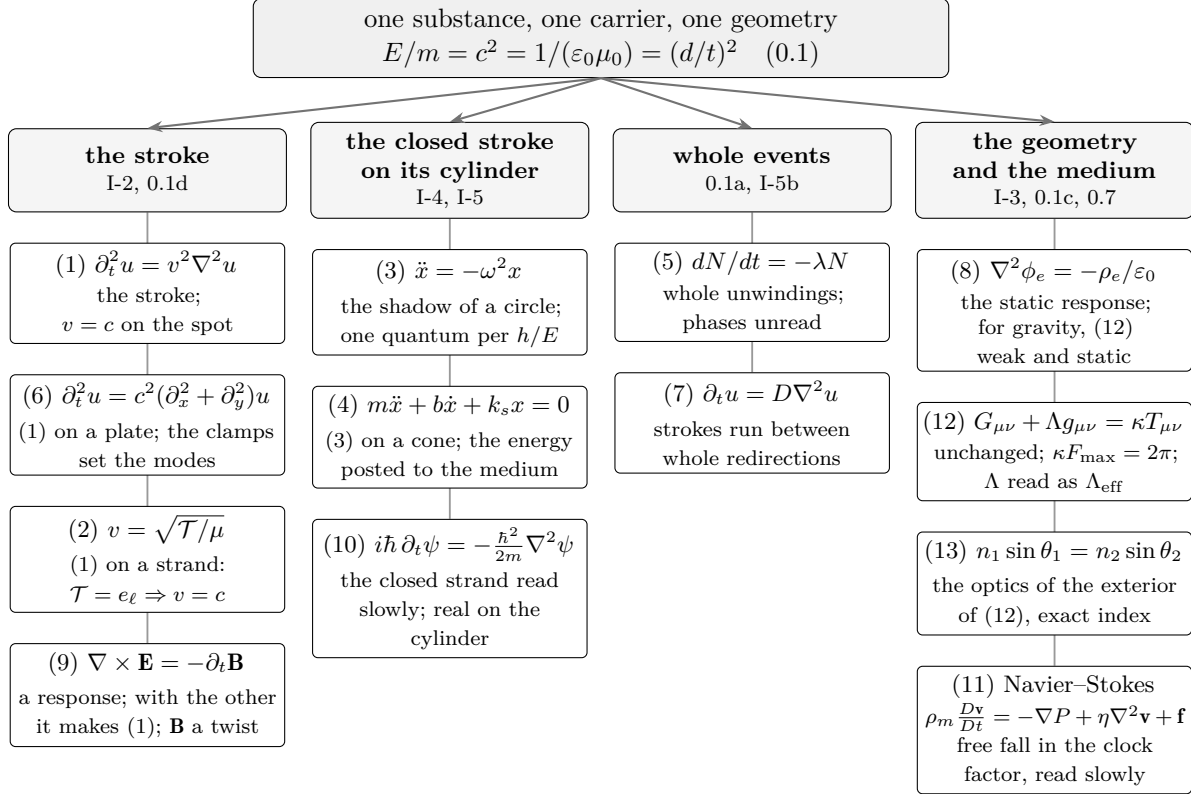


Figure 1: The formula map. The twelve equations of the chart and generalised Snell’s law, each placed on the trunk of the core that reads it, with its reading in one line. A number in a reading names the equation it derives from: the two responses, (9) with its partner, make the stroke equation (1); the plate (6) and the string (2) are (1) with boundary data; the damped oscillator (4) is the circle’s shadow (3) on a cone; Poisson’s equation (8) is, for gravity, the field equations (12) weak and static; generalised Snell’s law (13) is the optics of their exterior; and the Navier–Stokes equations (11) are their four-momentum book for a fluid, read slowly.

4 The stroke

4.1 The wave equation, in one and in two dimensions

The omnium’s two response coefficients make the two grades of its stroke drive each other. With $\nabla \cdot \mathbf{E} = 0$ the identity $\nabla \times (\nabla \times \mathbf{E}) = \nabla(\nabla \cdot \mathbf{E}) - \nabla^2 \mathbf{E}$ turns the two responses into one equation, [FM01a]

$$\frac{\partial^2 u}{\partial t^2} = c^2 \nabla^2 u, \quad c^2 = \frac{1}{\varepsilon_0 \mu_0}, \quad \frac{1}{\sqrt{\varepsilon_0 \mu_0}} = 299\,792\,458 \text{ m s}^{-1}, \quad (2)$$

the chart’s equation (1) with $v = c$, and $\cos(kx - \omega t)$ solves it exactly when $\omega = ck$ (0.1d). [FM01b, FM01c] Clocks and rulers are closed strokes, so the rate is one on the spot: every outside rate and every common rescaling cancel, because the clock is made of the thing it times (0.1d). Where the chart’s v is less than c , v is the transport of the one stroke in a regime: among the clamps of a vibrating volume a loaded line carries its long wave below c while the stroke between the clamps runs at c [6], and the index of a medium, the aperture of P-4, is to be derived from the omnium’s constitutive law (D-04). One carrier read in many regimes is I-2; the regime is geometry, never a second kind of wave.

Equation (6) is the same equation in two dimensions, its c the transport speed v of the regime,

Table 1: The thirteen readings and the sections of the core that carry them.

equation	the FDT reading	core
(1), (6) wave	the stroke of the one medium at c on the spot; $v < c$ is transport among clamps; the plate's modes set by its boundary	0.1d, I-2, P-2, P-3
(2) string	$v^2 = \mathcal{T}/\mu$; the closed strand has $\mathcal{T} = e_\ell$ and runs at c	0.1d, 0.2
(9) Faraday	a response of the omnium; the bivector grade of one equation for $F = \mathbf{E} + cI_3\mathbf{B}$; a changing twist	0.1, 0.1d, P-5
(3) oscillator	the projection of a circle; the cross-section of a helix; one quantum per period h/E	I-4, 0.1a, 0.1d
(4) damped	a helix on a cone; the lost energy posted to the medium; no mirror under reversal	0.1a, I-4
(10) Schrödinger	real equations for a radius and an angle on the cylinder, and their closure; deterministic	I-4, 0.1d
(5) decay	whole unwindings at times fixed by configuration, counted with unread phases	I-5b, I-4, 0.7
(7) heat	strokes run between whole redirections; the telegraph law read slowly; temperature the clock factor	I-2, 0.1c, I-7
(8) Poisson	the static response; for gravity the weak static field, $4\pi G = \pi c^4/F_{\max}$	0.1, I-3, I-4
(12) field equations	unchanged, $\kappa F_{\max} = 2\pi$; Λ read as Λ_{eff} , released stored potential	I-3, 0.7, 0.5
(13) Snell	the Fermat jump law of the exact optical metric; FDT = EFE = generalised Snell	I-3, 0.1c
(11) Navier–Stokes	the medium's free fall in its clock factor, read slowly; transport bounded by c	0.1c, 0.1d, I-3

and a plate's boundary data select its modes. A rectangle of sides L_x and L_y clamped along its edges carries

$$u_{jl} = \sin \frac{j\pi x}{L_x} \sin \frac{l\pi y}{L_y} \cos \omega_{jl}t, \quad \omega_{jl} = v\pi \sqrt{(j/L_x)^2 + (l/L_y)^2}, \quad j, l = 1, 2, \dots, \quad (3)$$

which vanish on all four edges: [FM06a, FM06b] the mode geometry is set by the boundary conditions, the clamps, not by the medium (P-2, P-3), and excitations migrate to the nodal lines as sand collects on the nodes of a vibrating plate. A standing mode is two counter-running strokes, $\sin kx \cos \omega t = \frac{1}{2}[\sin(kx - \omega t) + \sin(kx + \omega t)]$. [FM06c] One nodal architecture organises every level, up to the merged domain, whose nodal structure is the cosmic web (0.8).

4.2 The string

A string under tension $\mathcal{T}$ with inertia μ per unit length carries transverse waves at $v = \sqrt{\mathcal{T}/\mu}$. [FM02a] The closed strand of a pattern is the string the chain fixes. A closure of energy E_s and radius R is held by the tension $E_s/(2\pi R)$, which is its strand's energy per unit length e_ℓ [4]. Its inertia per unit length is e_ℓ/c^2 , and

$$v^2 = \frac{\mathcal{T}}{e_\ell/c^2} = c^2 : \quad (4)$$

c^2 is the closure's tension over its strand's inertia per unit length, as a string's wave speed squared is its tension over its inertia per unit length. [FM02b] A material string carries a tension far below its rest energy per unit length, $v^2/c^2 = \mathcal{T}/(\mu c^2)$: a wire under 100 N with 1 g per metre carries its waves at 316.2 m s^{-1} , with $\mathcal{T}/(\mu c^2) = 1.11 \times 10^{-12}$. [FM02c] Every tension is below $F_{\max} = c^4/4G = 3.0256 \times 10^{43} \text{ N}$, the force ceiling (0.2). [FM02d]

4.3 The Maxwell–Faraday law

Faraday’s law is one of the two responses of 0.1d, and with the other it makes the stroke. In the geometric algebra of space, $F = \mathbf{E} + cI_3\mathbf{B}$ joins the two grades of the stroke, and Maxwell’s four equations are the grades of one [14]: [FM09d]

$$\left(\nabla + \frac{1}{c}\partial_t\right)F = \frac{1}{\varepsilon_0}\left(\rho_e - \frac{\mathbf{J}}{c}\right) : \underbrace{\nabla \cdot \mathbf{E}}_{\text{scalar}}, \underbrace{\frac{1}{c}\partial_t\mathbf{E} - c\nabla \times \mathbf{B}}_{\text{vector}}, \underbrace{I_3(\nabla \times \mathbf{E} + \partial_t\mathbf{B})}_{\text{bivector}}, \underbrace{cI_3\nabla \cdot \mathbf{B}}_{\text{pseudoscalar}}. \quad (5)$$

The source has no bivector grade, so the bivector grade of (5) is $\nabla \times \mathbf{E} = -\partial_t\mathbf{B}$. A plane stroke satisfies all four, and it is null: $|\mathbf{E}|^2 - c^2|\mathbf{B}|^2 = 0$ and $\mathbf{E} \cdot \mathbf{B} = 0$, so $F^2 = 0$ (0.1d). [FM09a–c] The magnetic field is a helical density gradient of the omnium, the bivector grade of the density field coherently aligned along an axis (P-5). Faraday’s law reads: a twist that changes in time drives a circulation of the electric grade about it. Imposing a twist is establishing a field, with no carrier exchanged (P-5, I-2).

5 The closed stroke on its cylinder

5.1 The harmonic oscillator

The projection $x = A\cos(\omega t + \varphi_0)$ of a point that runs a circle at ω satisfies $\ddot{x} = -\omega^2x$, and with its other projection $y = A\sin(\omega t + \varphi_0)$ it is the circle itself, $x^2 + y^2 = A^2$. [FM03a, FM03b] The oscillator is the shadow of a circle, and the circle run in time is a helix on a cylinder: the oscillator is the cross-section of a helix, as ψ is (I-4) [5]. The start azimuth φ_0 fixes the whole motion; a reading on one axis keeps one projection and loses the other. A closed pattern keeps time by circulating (0.1d), so every clock is this oscillator, and one quantum of it has the period of the bridge, $T_q = 2\pi/\omega = h/E$ with $E = \hbar\omega$ (0.1a). [FM03d]

The quantum oscillator reads the same way on the cylinder. Its ground state has the profile $\rho_0 \propto e^{-m\omega x^2/2\hbar}$, whose profile term is $Q_\rho = \hbar\omega/2 - m\omega^2x^2/2$, so

$$U + Q_\rho = \frac{1}{2}m\omega^2x^2 + Q_\rho = \frac{1}{2}\hbar\omega \quad \text{at every } x : \quad (6)$$

the zero-point energy is the confinement cost of the ground state’s profile, and the omnium that carries it is never empty (0.1) [5]. [FM03c]

5.2 The damped oscillator

The damped oscillator’s motion is

$$x = Ae^{-\gamma t}\cos(\omega_d t + \varphi_0), \quad \gamma = \frac{b}{2m}, \quad \omega_d^2 = \frac{k_s}{m} - \gamma^2, \quad (7)$$

and its two projections lie on a circle of radius $Ae^{-\gamma t}$: [FM04a, FM04b] the circle run in time is a helix on a cone instead of a cylinder, and the undamped oscillator is the cylinder. The energy obeys $dE/dt = -b\dot{x}^2$: [FM04c] the mode posts the energy it loses to the modes of the medium, the strokes and phonons of Section 6.2, and no single-entry posting exists [10]. The quality factor is $\sqrt{k_s/m}/2\gamma = \sqrt{k_s m}/b$. [FM04e] Run backward, the motion solves $m\ddot{x} - b\dot{x} + k_s x = 0$, not the forward equation: [FM04d] the oscillator and the medium settle together at every step, events do not commute, and a process run backward is never the mirror of the forward event (0.1a). The coefficient b is the reading of that settlement on the one coordinate the bookkeeper follows.

5.3 The Schrödinger equation on the cylinder

A point of a helix has cylindrical coordinates (z, ρ, φ) , and its projection onto the plane normal to the axis, multiplied on the left by e_1 , is $\rho(\cos \varphi + \Sigma \sin \varphi) = \rho e^{\Sigma \varphi}$ with $\Sigma = e_1 e_2$, $\Sigma^2 = -1$ [5]. The complex numbers are the even algebra of that plane:

$$i \mapsto \Sigma, \quad e^{i\theta} \mapsto \text{a turn of the plane by } \theta, \quad \bar{\psi}_a \psi_b \mapsto ab = a \cdot b + a \wedge b. \quad (8)$$

Every complex equation of quantum mechanics is therefore a pair of real equations in the plane normal to the axis. With $\psi = \psi_1 + i\psi_2$ and a real potential, $i\hbar \partial_t \psi = H\psi$ is

$$\hbar \partial_t \psi_1 = H\psi_2, \quad \hbar \partial_t \psi_2 = -H\psi_1, \quad (9)$$

a real rotation of the pair (ψ_1, ψ_2) generated by $H/\hbar$, with no complex number anywhere. [FM10c] In the cylinder's own coordinates, $\psi = \rho e^{i\varphi}$, the Schrödinger equation is two real equations and a closure condition: [FM10a, FM10b, FM10e]

$$\partial_t \rho^2 + \nabla \cdot \left(\rho^2 \frac{\hbar}{m} \nabla \varphi \right) = 0 \quad (\text{C}) \text{ continuity of the radius} \quad (10)$$

$$\hbar \partial_t \varphi + \frac{\hbar^2}{2m} |\nabla \varphi|^2 + U + Q_\rho = 0, \quad Q_\rho = -\frac{\hbar^2}{2m} \frac{\nabla^2 \rho}{\rho} \quad (\text{H}) \text{ Hamilton-Jacobi for the angle} \quad (11)$$

$$\oint \nabla \varphi \cdot d\mathbf{l} = 2\pi n \quad (\text{W}) \text{ the helix closes} \quad (12)$$

(C) and (H) are Madelung's equations [13]; (W) says that φ is an angle, so a helix closes on its cylinder only after a whole number of turns, and on a ring $e^{in\theta}$ carries $L = n\hbar$. $\hbar \nabla \varphi$ is the momentum, and the profile term Q_ρ is the confinement cost of I-5 written on the radius profile: a tighter profile costs more, as a shorter string sounds a higher mode.

The equation is the slow reading of the closed strand. A closed pattern's phase obeys $\omega^2 = c^2 k^2 + \omega_m^2$, the strand's right triangle of 0.1d; with its rest turning $e^{-i\omega_m t}$, $\omega_m = mc^2/\hbar$, removed, the leading term is $\omega = \hbar k^2/2m$, the free Schrödinger relation. [FM10d] A 54 eV electron runs with $h/p = 1.669 \text{ \AA}$, the spacing Davisson and Germer read off a nickel crystal [19]. [FM10f] Read on the cylinder, the quantum face is deterministic. The start azimuth φ_0 fixes the helix; superposition is ignorance of φ_0 at the reading; and a closed pattern seats whole in one port at a time, with the frequency of its share ρ^2 , by the seating law [9]. Nothing in (C), (H) or (W) is a probability amplitude: they are a radius, an angle and their closure (I-4).

6 Whole events

6.1 Radioactive decay

Decay is loop unwinding through the one channel left open, every exact book balancing across the event: four-momentum, charge, fermion parity and angular momentum, with $m_i c^2 = \sum_k E_{f,k}$ in the rest frame (I-5b). Beta decay is the exhibit, $2 \rightarrow 3 + 3 + 2$, one invariant-preserving many-to-many reclosure (I-5b). Each closure unwinds whole, at a time fixed by its own configuration and the settlement of its domain, and the decay law is the count of such events among closures whose phases are unread:

$$\frac{dN}{dt} = -\lambda N, \quad N = N_0 e^{-\lambda t}, \quad t_{1/2} = \frac{\ln 2}{\lambda}, \quad \langle t \rangle = \frac{1}{\lambda}. \quad (13)$$

[FM05a] A million closures, each decaying at a time fixed by its own phase, return the exponential to 0.3 per cent at every time sampled. [FM05b] The count is the statement that governs a beam of strokes on a dilute path, whose untouched fraction is the exponential of minus its optical depth: both count whole events [11]. The record holds the exponential from 0.3 to 45 half-lives of ^{56}Mn , 116.0 h, and over the first 10^{-4} of a half-life of ^{60}Co [18]. [FM05c] The rate λ of a closure comes from the decay kernel, to be derived (D-01). Unwinding releases the stored potential of compression to the spacetime phase, and Λ_{eff} is the running total of such releases (0.7).

6.2 Heat

Heat in a medium is carried by strokes: the phonon is the medium's own stroke among its clamps and radiation is the open stroke (I-2, P-3). A stroke runs between whole events: it is removed whole, redirected whole or re-issued whole [11], and each event sets it running on a new axis. A walk of runs at a transport speed v with whole redirections at mean interval τ obeys the telegraph equation [15], and read at times long against τ it is the heat equation:

$$\tau \partial_t^2 u + \partial_t u = D \nabla^2 u \quad \longrightarrow \quad \partial_t u = D \nabla^2 u, \quad D = v^2 \tau \text{ on a line,} \quad D = \frac{1}{3} v^2 \tau \text{ in space.} \quad (14)$$

[FM07a, FM07b] Strokes run at v and redirected whole every τ on average spread with $D = v^2 \tau / 3$ in three dimensions, [FM07c] the fronts of (14) move at $\sqrt{D/\tau} \leq v$, and no walker outruns the strokes. [FM07d] The heat equation's spread at every distance at once is the slow reading of a law whose signals run at the speed of the strokes that carry it.

Temperature is the medium's clock factor: for a stress tensor of perfect form at zero net count the medium's patterns are free of every force in $T^2 g_{\mu\nu}$, and the pressure force is the bookkeeper's reading of their common rescaling (0.1c, I-7) [7]. The clock factor is the reading of the medium's flow, never the rate of a clock the medium carries (0.1c). Held static in a static geometry, the medium settles with $T\sqrt{-g_{tt}}$ constant, Tolman and Ehrenfest's relation [16], and heat runs until it holds. The thermal channel enters $\mathcal{M}$ once, as $aT^4 V / c^2$ with $a = 4\sigma_{\text{SB}}/c$ (0.5, I-7).

7 The static response and the geometry

7.1 Poisson's equation

With no change in time, Faraday's law gives $\nabla \times \mathbf{E} = 0$, so $\mathbf{E} = -\nabla \phi_e$, and the scalar grade of (5) gives

$$\nabla^2 \phi_e = -\frac{\rho_e}{\varepsilon_0} : \quad (15)$$

$1/|\mathbf{x}|$ is harmonic away from its source, and the flux of $q/(4\pi\varepsilon_0|\mathbf{x}|^2)$ through every sphere about it is q/ε_0 . [FM08a, FM08b] ε_0 is a response coefficient of the omnium (0.1), and ρ_e counts charges of closures, each a reading of an integral strand ledger (I-5a); the map from a charge to an input of the pair law is to be derived (D-02).

The gravitational Poisson equation is the static weak-field limit of the field equations at leading order in α_{ext} , the containment layer L2 of I-4:

$$\nabla^2 \Phi = 4\pi G \rho_m = \frac{\pi c^4}{F_{\text{max}}} \rho_m, \quad \Phi = -\frac{GM}{r_f} = -\frac{c^2}{2} \alpha_{\text{ext}}(r_f) \quad (\text{A-1, exterior}). \quad (16)$$

[FM08c, FM08d] The potential is the bookkeeper's reading of the lapse $\sqrt{1 - \alpha_{\text{ext}}}$, and its gradient is the free fall of a pattern moving at constant speed, on its own clocks and rulers, through the density gradient (0.1c). Between two bodies the pair law $F = F_{\text{max}} \alpha_1 \alpha_2 = G \mathcal{M}_1 \mathcal{M}_2 / d^2$ holds exactly on its declared domain (I-1).

7.2 The field equations

The field equations stand unchanged, with the one total source:

$$G_{\mu\nu} = \kappa T_{\mu\nu}, \quad \kappa = \frac{8\pi G}{c^4} = \frac{2\pi}{F_{\max}}, \quad \kappa F_{\max} = 2\pi \text{ exactly.} \quad (17)$$

[FM12a] The exterior of a spherical source written with $\alpha_{\text{ext}} = R_s/r_f$,

$$ds^2 = -(1 - \alpha_{\text{ext}}) c^2 dt^2 + \frac{dr_f^2}{1 - \alpha_{\text{ext}}} + r_f^2 d\Omega^2, \quad (18)$$

is Ricci-flat, $G_{\mu\nu} = \kappa T_{\mu\nu}$ with $T_{\mu\nu} = 0$ outside: α parameterises the solution and is downstream of it (I-3). [FM12b] The contracted Bianchi identity makes $\nabla_\mu T^{\mu\nu} = 0$ an identity of the geometry, the four-momentum book of the one substance [10]. FDT has no cosmological-constant term. The chart's $\Lambda_{g\mu\nu}$ is read as Λ_{eff} , the released stored potential of compressed omnium per unit volume accumulated over the domain's history,

$$\frac{d\Lambda_{\text{eff}}}{dt} = \frac{8\pi G}{c^2} \frac{1}{V_\Omega} \int_\Omega \delta \dot{m} dV, \quad \Lambda_{\text{eff}} = \frac{8\pi G}{c^4} u_{\text{rel}}, \quad (19)$$

with $\dot{m}$ the mass-loss rate density and $\delta \geq 0$ the compression contrast the loss relaxes: a running total that grows with cumulative unwinding and enters $\mathcal{M}$ once (0.7). [FM12c] Its release function is to be derived (D-05).

7.3 FDT = the field equations = generalised Snell's law

Dividing (18) by the lapse squared leaves

$$\frac{ds^2}{1 - \alpha_{\text{ext}}} = -c^2 dt^2 + d\ell_{\text{opt}}^2, \quad d\ell_{\text{opt}}^2 = \frac{dr_f^2}{(1 - \alpha_{\text{ext}})^2} + \frac{r_f^2 d\Omega^2}{1 - \alpha_{\text{ext}}}, \quad (20)$$

the exact optical metric of I-3. [FM13a] Stokes run on its geodesics, by Fermat's principle, and generalised Snell's law is the Fermat jump law of this metric: $n_1 \sin \theta_1 = n_2 \sin \theta_2$ with the exact index (I-3). On the spheres of a spherical exterior it reads

$$r_{\text{opt}} \sin \theta = J_{\text{opt}} \text{ along every ray,} \quad r_{\text{opt}} = \frac{r_f}{\sqrt{1 - \alpha_{\text{ext}}}}, \quad (21)$$

with θ the angle between the ray and the radial direction and r_{opt} the radius of the sphere's circumference, both measured in the optical metric: Bouguer's form of Snell's law for a stratified medium, here exact. [FM13b] A stroke grazing the solar limb, impact parameter $R_\odot = 695.5$ Mm, is bent by

$$\theta_{\text{defl}} = \frac{4G\mathcal{M}_\odot}{R_\odot c^2} = 1.7516'', \quad (22)$$

and the exact null path of the exterior returns the same. [FM13c] An index $(1 - \alpha_{\text{ext}})^{-1/2}$ standing alone, with no radial term, bends it by half, $0.8758''$; the radial factor $(1 - \alpha_{\text{ext}})^{-1}$ of the exact metric supplies the other half (I-3). [FM13d] A slow pattern reads the lapse and a stroke reads the optical metric: the factor of two is the extended equivalence principle read on a stroke (0.1c) [7]. The one circular stroke of the exterior, at $r_f = 3R_s/2$, is the ray of (21) that runs along the sphere whose optical circumference is least [12].

The three statements are one geometry. α is FDT's density coordinate, the ratio of the curvatures of the sections at R_s and at r_f ; it parameterises the exterior solution of the field equations; and that exterior is the optics of the exact index. FDT = the Einstein field equations = generalised Snell's law, the title of I-3.

8 The medium in motion

The omnium is a medium, and a fluid is the flow of its patterns. For a stress tensor of perfect form at fixed entropy per count, the four-momentum book $\nabla_\mu T^{\mu\nu} = 0$ of the field equations is the medium's equation of motion, and 0.1c reads it as free fall:

$$\left(\frac{E}{V} + P\right) \nabla_\mu \mathcal{U}^\mu = -\mathfrak{P}^{\mu\nu} \partial_\nu P, \quad dP = \frac{N}{V} d\mathfrak{h}_N \implies \nabla_\mu \mathcal{U}^\mu = -\mathfrak{P}^{\mu\nu} \partial_\nu \ln \mathfrak{h}_N. \quad (23)$$

The medium's patterns move free of every force in $\mathfrak{m}^2 g_{\mu\nu}$ with $\mathfrak{m}$ the enthalpy per count, and the pressure force is the bookkeeper's reading of their common rescaling [7, 8, 17]. For a liquid of constant density ρ_m , $\mathfrak{h}_N = m_0 c^2 [1 + (\epsilon_{\text{int}} + P/\rho_m)/c^2]$ with ϵ_{int} the internal energy per unit mass, fixed at constant density and entropy per count, and the force per unit mass is $-\nabla P/\rho_m$ at leading order in $1/c^2$: [FM11a]

$$\rho_m \left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla P + \eta \nabla^2 \mathbf{v} + \mathbf{f}, \quad \nabla \cdot \mathbf{v} = 0, \quad (24)$$

up to corrections of relative order $|\mathbf{v}|^2/c^2$ and $P/(\rho_m c^2)$. Euler's part is free fall on the medium's own clocks and rulers. The viscous term is the first-order stress of a causal fluid, the transfer of momentum between neighbouring layers, its coefficient η from the omnium's constitutive law to be derived (D-03). The body force $\mathbf{f}$ carries gravity, which is the motion of the fluid's patterns through a density gradient (0.1c). The medium's vorticity is the swirl of its flow (0.1c), and mechanical vorticity and magnetic moments are different grade projections of one density-gradient topography (P-5).

The resolved transport of the medium is the normalised average of its strands' velocities, each running at c :

$$\mathbf{u}_{\text{loc}} = c \int \hat{\tau} d\mu_s, \quad |\mathbf{u}_{\text{loc}}| \leq c, \quad \int |c\hat{\tau} - \mathbf{u}_{\text{loc}}|^2 d\mu_s = c^2 - |\mathbf{u}_{\text{loc}}|^2, \quad (25)$$

with $\hat{\tau}$ a strand's unit tangent and μ_s the normalised measure of the strands at a point. [FM11b] On a fixed flat domain with positive viscosity a maintained velocity bound carries every strong solution forward for all time, the criterion of Leray, Prodi and Serrin, and where the fluid's velocity is this resolved transport in one maintained flat frame the helical average supplies the bound c [8].

9 The common form

The chart's equations share a form: a time derivative of first or second order equals a spatial operator. Read through the core, the shared form is the chain's d/t held in a regime, and its order says what the equation counts.

The second-order equations, (1), (2), (6) and (3), are the stroke and its closure, and they are even in time because a free stroke has no event of its own: it does not split, decay or tire, and every change it undergoes is a whole event with a closure [11], where the settlement of 0.1a enters. The Schrödinger equation is first order because its i is a turn: on the cylinder it is the real rotation (9), and running it backward turns the helix the other way. The heat and decay equations are first order for the opposite reason: they count whole events of a settlement, and events do not commute (0.1a). The damped oscillator stands between, a closed stroke posting its energy to the medium. Poisson's equation is the stationary limit; the field equations and generalised Snell's law are the one geometry every other equation runs on; and the Navier–Stokes equations are the medium's own motion on it.

The chart closes with the line that each equation describes how things change from one instant, or one point, to the next. In FDT that change is a settlement: the omnium solves its one optimisation again at every step, from the state the system is in (0.1a).

10 The record and the tests

what the record shows	the measurement	where it is read
one rate for every stroke	the gamma rays of GRB 170817A and the gravitational strokes of GW170817: $-3 \times 10^{-15} \leq \Delta v/c \leq +7 \times 10^{-16}$ [22]	(2); I-2
the two responses set the rate	CODATA 2022 takes μ_0 from the measured fine-structure constant and sets $\varepsilon_0 = 1/(\mu_0 c^2)$ [24]	(2); 0.1d
whole events, exponential count	^{56}Mn from 0.3 to 45 half-lives and ^{60}Co over the first 10^{-4} of a half-life, with no departure from the exponential [18]	(13)
matter waves	54 eV electrons have $h/p = 1.669 \text{ \AA}$, and Davisson and Germer measured $1.65 \text{ \AA}$ [19]; C_{60} molecules interfere [20]	(10)–(12)
the bend of a stroke	$\gamma_{\text{PPN}} = 0.99992 \pm 0.00012$ by VLBI [21]; $1.7516''$ at the solar limb	(20)–(22)
the clock factor with height	two-way shift ratio 1.05 ± 0.10 over the 22.56 m tower [23]	(16); 0.1c

Each test below is the converse of a derived result: the measurement that would end it.

- T-1 *One rate.* An energy-dependent speed of free strokes from one source, away from closures, ends the stroke equation with $v = c$ on the spot.
- T-2 *Strokes carry heat.* A thermal signal that outruns the strokes of its medium ends the reading of heat as strokes run between whole redirections.
- T-3 *The factor of two.* A bend of a stroke other than twice the slow reading at leading order, $\gamma_{\text{PPN}} \neq 1$, ends FDT = the field equations = generalised Snell's law.
- T-4 *Released potential.* A decrease of the effective cosmological term over the domain's history ends its reading as the running total of released stored potential: (19) has $\delta \geq 0$ and $\dot{m} \geq 0$.
- T-5 *Single seatings.* A frequency of single seatings other than the share ρ^2 ends the seating law with which the cylinder's determinism meets the record.

Six pieces sit outside the derivation and leave every result in it unchanged:

- D-01 *Decay rates.* The decay kernel of a closure and its rate λ are to be derived (core O-12).
- D-02 *Charge to force.* The map from a charge to an input of the pair law, which the electrostatic source of (15) carries at the level of I-1, is to be derived (core O-6).
- D-03 *Viscosity.* The coefficient η of the first-order stress of the medium, from the omnium's constitutive law, is to be derived.
- D-04 *The material index.* The index of a medium, the aperture of P-4 that carries light through matter below c , is to be derived (core O-8).
- D-05 *The release function.* $\dot{m}(x)$ and $\delta(x)$, which feed Λ_{eff} , are to be derived (core O-14).
- D-06 *Spectra.* The confinement operator, whose eigenvalues are the levels of closed patterns and the lines they emit, is to be derived (core O-9).

11 Declined readings and convergence

The chart reads its equations as one form shared by different physical worlds. FDT reads one substance with one carrier: the regimes are geometry, and the form is shared because the chain is one (0.1, I-2).

The standard account reads ψ as a complex probability amplitude that collapses on measurement. FDT reads ψ as the cross-section of a helix: the Schrödinger equation is a pair of real equations for a radius and an angle on the cylinder, and a reading is projection and phase fixation, deterministic (I-4).

The standard account reads radioactive decay as an event without a cause. FDT reads each decay as a whole unwinding at a time fixed by the closure's configuration and the settlement of its domain, and the exponential as the count of such events among closures whose phases are unread (I-4, I-5b).

The standard account carries the magnetic field as an entity of its own. FDT reads it as a helical density gradient of the omnium, so that Faraday's law is a changing twist driving the electric grade (P-5).

The standard account carries a cosmological constant, a vacuum energy fixed for all time. FDT reads the term as Λ_{eff} , the running total of released stored potential (0.7).

The Navier–Stokes equations are posed on fixed Euclidean space with Newtonian time and a pressure force across that background. FDT reads them as the slow limit of the medium's free fall in its own clock factor, on a geometry that responds (0.1c, I-3).

Convergence. For the same source and data FDT returns every equation of the chart as it stands. The stroke equation, the plate's modes, the string, Faraday's law and the oscillators are recovered exactly. The Schrödinger equation is exactly equivalent to (C), (H) and (W), its predictions unchanged. The decay law and the heat equation are the counting laws of whole events, the latter at times long against the interval between redirections. Poisson's equation is exact for electrostatics and the leading weak-field order for gravity. The field equations are unchanged, and generalised Snell's law is their exterior's optics, with the solar-limb bend of general relativity, $1.7516''$, and $\gamma_{\text{PPN}} = 1$. The Navier–Stokes equations are the slow limit at the orders stated. FDT supplies an additional source in one place: the term the chart writes as Λ is the released stored potential of unwinding matter, a running total, its release function to be derived (D-05).

12 Same form, one substance

The twelve equations of the chart and generalised Snell's law are thirteen readings of one chain. The stroke of the one medium gives the wave equations, the string's speed and Faraday's law; the closed stroke on its cylinder gives the oscillators and, with the unit imaginary read as the bivector of the plane, a Schrödinger equation that is real and deterministic; whole events of a settlement give the exponential of decay and the heat equation; and the one geometry gives Poisson's equation, the field equations, generalised Snell's law as their optics, and the Navier–Stokes equations as the medium's free fall. The form is the same because the substance is one.

13 Status register

result	rests on	status
The stroke equation and the plate's modes ((2), (3))	0.1d, I-2, P-2, P-3	derived
The strand as a string, $v = c$ (4)	0.1d, 0.2	derived
Faraday's law as a grade of one equation (5)	0.1, 0.1d, P-5	derived
The oscillator as the shadow of a circle; the zero-point profile (6)	I-4, 0.1a, 0.1d, I-5	derived
The damped oscillator as a helix on a cone (7)	0.1a, I-4	derived
The Schrödinger equation on the cylinder ((9)–(12))	I-4, 0.1d	derived
Decay as a count of whole events (13)	I-5b, I-4	derived; the rate D-01
Heat as strokes between redirections (14)	I-2, 0.1c, I-7	derived
Poisson's equation (15), (16)	0.1, I-3, I-4, I-1	derived; the charge map D-02
The field equations with Λ_{eff} ((17)–(19))	I-3, 0.7, 0.5	derived; the release function D-05
FDT = EFE = generalised Snell ((20)–(22))	I-3, 0.1c	derived
The Navier–Stokes equations as free fall read slowly ((23)–(25))	0.1c, 0.1d, I-3	derived; the viscosity D-03
The material index; spectra	I-2, P-4, I-5	to be derived (D-04; D-06)

invariant	where it enters
I-1	the pair law $F = F_{\text{max}}\alpha_1\alpha_2 = G\mathcal{M}_1\mathcal{M}_2/d^2$ beside Poisson's equation (Section 7.1)
I-2	one carrier: the wave equations, the string, Faraday's law, the strokes that carry heat
I-3	the field equations unchanged; the exact optical metric and generalised Snell's law
I-4	the oscillator and ψ as cross-sections of helices; the Schrödinger equation on the cylinder; containment for the gravitational Poisson equation
I-5	closures and their decay, every book balanced (I-5b); the profile term as confinement cost
I-6	the open interval of α_{ext} on the exterior branch (Section 7.3)
I-7	every channel enters $\mathcal{M}$ once: the thermal term, the released potential

A Receipt

The script `receipt_same_form.py`, in the folder of this paper, checks the displayed identities symbolically with SymPy and the computed numbers numerically with the CODATA 2022 values, with two Monte Carlo counts, a direct integration of a ray in the exact optical metric and quadratures of two null paths at the solar limb. Run it with `python3 receipt_same_form.py`; its output is `receipt_same_form.out.txt`. Result: **49/49 PASS**.

check	content
FM01a–c	the curl identity; $1/\sqrt{\varepsilon_0\mu_0} = c$; a plane stroke solves (2) at $\omega = ck$
FM02a–d	$v = \sqrt{\mathcal{T}/\mu}$; the strand at c ; the wire, 316.2 ms^{-1} and 1.11×10^{-12} ; $F_{\text{max}} = 3.0256 \times 10^{43} \text{ N}$
FM03a–d	the shadow of a circle; the circle; $U + Q_\rho = \hbar\omega/2$; $T_q = \hbar/E$
FM04a–e	the damped motion; the cone; $dE/dt = -b\dot{x}^2$; no mirror under reversal; the quality factor
FM05a–c	the decay law, half-life and mean life; a million closures with fixed phases; 45 half-lives of ^{56}Mn

check	content
FM06a–c	the clamped plate’s modes and their nodes on the edges; standing waves as two counter-running strokes
FM07a–d	the heat kernel; the kinetic pair of a walk on a line and the telegraph law, one dispersion relation, fronts at v ; $D = v^2\tau/3$ by an exact event-driven walk; no walker outruns the strokes
FM08a–d	$1/ \mathbf{x} $ harmonic; Gauss’s flux; $4\pi G = \pi c^4/F_{\max}$; $\Phi = -(c^2/2)\alpha_{\text{ext}}$
FM09a–d	a plane stroke satisfies Faraday’s and Ampère’s laws; it is null; the four grades of (5) in the geometric algebra of space
FM10a–f	(C) and (H) from $\psi = \rho e^{i\varphi}$; the real rotation (9); the slow limit $\hbar k^2/2m$; the closure (W); $h/p = 1.669 \text{ \AA}$ at 54 eV
FM11a–b	the slow limit of the medium’s free fall; the helical average on 200 random bundles
FM12a–c	$\kappa F_{\max} = 2\pi$; the exterior (18) Ricci-flat; the units of Λ_{eff}
FM13a–d	the exact optical metric; $r_{\text{opt}} \sin \theta$ constant along an integrated ray; $1.7516''$ by the formula and by the exact path; the lone index on its own path, $0.8758''$, half

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