MANIFEST OF FINITE REALIZATION

Physics begins not with objects, but with change. And change exists only if it can be distinguished.

A transition that cannot, even in principle, be distinguished from another transition is not a realized change. It is an unrealized possibility — a difference without manifestation. Realized reality is therefore not the set of all conceivable transitions, but the set of transitions that are distinguishably actualized.

From this single requirement follows a structural constraint: distinguishable realization cannot be arbitrarily dense. If infinitely many independent changes could occur simultaneously, no transition could remain distinct. All differences would collapse into indistinguishability. Realized change would dissolve into undifferentiated simultaneity.

Therefore realization must be finite.

Reality is not limited because matter resists motion or because signals propagate slowly. Reality is limited because distinguishability requires separation, and separation requires bounded realization.

Once realization is finite, every transition becomes an allocation problem. Any realized step must divide its capacity between maintaining identity and altering relations. Persistence and projection compete for the same finite resource.

This competition defines structure.

The geometry of realization is not imposed from outside. It is the minimal accounting system that preserves distinguishability under finite capacity. Independent channels combine quadratically because only a quadratic measure preserves orthogonal independence under isotropy. The invariant interval is not spacetime distance but remaining identity capacity. The speed limit is not a property of radiation but the boundary beyond which identity cannot be maintained.

Relativity is not a theory about observers. It is the bookkeeping of finite distinguishable realization.

A photon is not an object that moves at a universal speed. It is the limiting case where no capacity is allocated to persistence. All realization becomes projection. Identity vanishes; only transfer remains.

Gravity is not a force. It is the redistribution of available realization. Structures consume capacity to remain what they are. The surrounding field reflects the deficit. Motion follows gradients not because something pulls, but because some directions cost less realization than others.

Space, time, inertia, and interaction are not primitives. They are consequences of the single condition that realized change must remain distinguishable under finite capacity.

Physics does not begin with laws. It begins with the necessity that change must be real — and therefore finite.

Relativistic Invariance as a Consequence of Finite Change Capacity

Filip Svoboda — Vector

February 2026

Finite Field Ontology — Standalone Extract

Abstract

We show that the structural core of relativistic kinematics — the Pythagorean metric, the invariant speed limit, Minkowski spacetime, Lorentz transformations, time dilation, length contraction, the impossibility of superluminal signaling, and the inverse-square form of gravitational interaction — follows from a single premise: the capacity for realizing change is finite. No physical postulates are assumed. No empirical constants are introduced as axioms. The speed of light emerges not as a property of light, but as a necessary consequence of the absence of identity.

Scope and Status of the Present Derivation

This document does not present a complete physical theory.

Its purpose is strictly structural and minimal: to demonstrate that finite realizability of distinguishable change is sufficient to generate relativistic structure. Nothing more is claimed here.

The goal is not to construct a full dynamical model of nature, but to establish a constraint of logical form: if realized change is distinguishable and its realization capacity is finite, then the mathematical structure associated with relativity follows as a necessary consequence.

Accordingly, this work does not attempt to specify: the microscopic constitution of the realization substrate, a full dynamical field theory, measurement theory or operational calibration procedures, quantum mechanical structure, empirical identification of physical constants, coupling mechanisms between different classes of enclosures, cosmological boundary conditions, or complete gravitational dynamics beyond the structural inverse-square form.

Whenever additional structure is introduced (e.g., differentiable coarse-graining, field representation, divergence form, stability criteria), it is used only as a **modeling layer** to illustrate how the structural constraint manifests in familiar physical form. These layers are not asserted as fundamental.

The present result is therefore best understood as:

- a reduction of relativistic structure to a minimal ontological constraint, and
- a demonstration of structural necessity, not theoretical completeness.

A full physical theory would require additional principles specifying dynamics, measurement, and microscopic realization. Such development lies outside the scope of this document but is the subject of the forthcoming Finite Field Ontology (FFO) framework.

Part I. Ontological Minimum

We begin with no physics. No space, no time, no particles, no fields. Only three definitions and one premise.

0.1 Definition: Distinguishable State

A **state** is any configuration that can be distinguished from at least one other configuration. We write $s_i \neq s_j$ to mean that states s_i and s_j are distinguishable.

No further structure is assumed. States are not "things" — they are distinguishable configurations of an unspecified substrate. We do not need to know *what* changes; we only need that change is *distinguishable*.

0.2 Definition: Elementary Change

An **elementary change** is a realized transition between two distinguishable states:

```
Δ : s_i → s_j,    s_i ≠ s_j
```

Change is not a state. Change is a realized difference. If no difference is realized, no change has occurred.

0.3 Definition: Realization

Realization is the actualization of a change within a given frame of distinguishability. A change that is not realized is not a change — it is an unrealized possibility.

0.4 Premise: Finite Capacity

The capacity for realizing change is finite.

There exists an upper bound on the number of independently realizable changes per unit of synchronous frame:

```
∃ C < ∞  such that  dN/dt ≤ C
```

where dN is the number of elementary changes and dt is the synchronous frame parameter. The internal realization parameter τ is introduced later (Part II) as a derived bookkeeping quantity.

Why this premise is necessary: If the capacity were infinite, one could realize arbitrarily many independent changes simultaneously. But simultaneous realization of infinitely many changes would annihilate distinguishability — every state would be connected to every other state in the same step, and no transition would be distinguishable from any other. This contradicts the existence of change itself (Definition 0.2). Therefore, the capacity must be finite.

This is the entire axiomatic foundation. Everything that follows is derived.

Part II. Time as a Consequence

We do not postulate time. We derive it.

1.1 Internal Realization Parameter τ

An **enclosure** (uzávěr) is a structure of changes that contains a non-trivial internal cycle — a sequence of transitions that returns to a distinguishable approximation of its initial state.

For any such enclosure, define:

```
τ ≡ cumulative count of realized internal transitions
```

This is not "time" in the physicist's sense. It is a bookkeeping parameter: how many internal cycles has this enclosure completed?

Key point: Without change, there is no τ. Without distinguishability, there is no change. Therefore: without distinguishability, there is no time.

1.2 Enclosure vs. Pure Transfer

An enclosure has $d\tau > 0$: it realizes internal changes, maintaining something that persists — an identity.

A **pure transfer** has $d\tau = 0$: no internal cycle, no identity, no persistence. It is change without a subject.

This distinction is not a classification. It is a direct consequence of whether the realization budget includes internal allocation or not.

1.3 The Rest Calibration (τ ↔ dt mapping)

In every local synchronous frame, there exists a reference realization with maximum internal allocation: the enclosure at rest ($dl = 0$).

For this reference:

```
dN² = dτ² + 0² = dτ²
```

and the capacity bound gives:

```
dτ ≤ C · dt
```

with equality when the enclosure is at rest and fully allocating to identity. We **choose units** so that the rest enclosure saturates the identity budget:

```
dτ := C · dt    (at dl = 0; unit calibration, not a new axiom)
```

This is the definition of what "at rest" means in capacity terms: the state where all available realization goes into identity, none into spatial projection. The equality is a calibration convention — it fixes the relationship between the internal bookkeeping parameter τ and the synchronous frame parameter dt.

Why this matters: Without this calibration, τ would be a purely local parameter with no bridge to the synchronous frame, and C could not function as a global invariant. The rest calibration establishes that C has the same operational meaning in every local frame — it is the identity-realization rate of an enclosure that allocates nothing to motion.

Part III. The Capacity Budget

Structural assumption: We work in the coarse-grained limit where realization admits a differentiable metric description. Discrete realization at the fundamental level is not excluded, but the derivations below require only that a smooth approximation holds at the scale of enclosures and their interactions.

2.1 Two Channels of Realization

Every elementary step of realization can allocate capacity to exactly two independent channels:

- **Internal realization** (maintenance of identity): $d\tau$
- **External projection** (spatial change relative to other enclosures): dl

Why exactly two (minimality argument): Define $d\tau$ as the component of realization that preserves closure invariants (identity), and dl as the component that changes inter-closure distinguishability (spatial relation). Every realizable step admits a decomposition into at least these two coarse-grained components — one that maintains the enclosure's internal cycle, and one that alters its external relations. For the derivation of relativistic structure, this minimal decomposition is sufficient. Any finer decomposition (e.g., internal complexity $d\chi$ as a subdivision of identity-maintenance) refines the budget without changing the structure of the argument: the key constraint remains that total realization is bounded and splits between internal and external allocation.

These channels are orthogonal in the following precise sense: spending capacity on internal realization does not automatically produce spatial change, and vice versa. They draw from the same finite budget but serve different functions.

2.2 What "Orthogonal" Means Here

Two channels are orthogonal if and only if:

1. They are independently variable: one can increase $d\tau$ while holding dl constant (and vice versa), subject only to the total budget constraint. 2. They do not interfere: the cost of one unit of $d\tau$ does not depend on the current value of dl. 3. They are exhaustive: every elementary realization can be decomposed into these two channels without remainder.

2.3 Structural Requirements on the Metric

We need to define the "total size of a realization step" — call it dN — as a function of its components $d\tau$ and dl. This function must satisfy:

(R1) Additivity for independent components. If two channels are orthogonal, the total cost must be computable from the individual costs without cross-terms that depend on orientation.

(R2) Isotropy. No spatial direction may be privileged. If the substrate of realization has no intrinsic preferred direction, the metric must be invariant under spatial rotations.

(R3) Coordinate independence. Relabeling axes (rotating the coordinate system) cannot change the total realization step.

2.4 Why the Metric Must Be Quadratic

Let $dN = F(d\tau, dl)$ for some function F.

Requirement (R2) means F must be invariant under rotations of the spatial components of dl. The only smooth functions invariant under all rotations of a vector are functions of the squared magnitude of that vector.

Requirement (R1) means F must combine independent components additively. For orthogonal components, the only additive combination compatible with rotational invariance is the sum of squares.

Requirement (R3) is automatically satisfied by any function of squared magnitudes.

Therefore:

$$dN^2 = d\tau^2 + dl^2$$

This is not a choice. It is the unique form satisfying (R1)–(R3).

Note on uniqueness: Could the metric be $dN^4 = d\tau^4 + dl^4$, or some other power? No. Higher-power norms violate (R1): the p-norm for $p \neq 2$ is not additive for orthogonal decompositions in the required sense. The Euclidean (quadratic) norm is the only norm where orthogonal projections are independent. This is a theorem of functional analysis, not an assumption.

More precisely: independent orthogonal decomposition requires the parallelogram law. By the Jordan–von Neumann theorem, the parallelogram law holds if and only if the norm derives from an inner product — hence a quadratic norm. No other norm structure supports the independent decomposition that (R1)–(R3) require.

2.5 Pythagoras as a Consequence

In an n-dimensional isotropic projection space, the external projection decomposes as:

$$dl^2 = \Sigma_i \, dx_i^2 \quad (i = 1, \ldots, n)$$

This is the Pythagorean theorem in n dimensions. It is not a geometric postulate. It is the necessary form of the realization metric in an isotropic space satisfying (R1)–(R3). The case $n = 3$ will be derived from stability requirements in Part VIII (§7.6).

The full budget equation becomes:

$$dN^2 = d\tau^2 + \Sigma_i \, dx_i^2$$

Part IV. The Invariant Speed Limit

3.1 The Capacity Bound

From Premise 0.4, the total realization per synchronous step is bounded:

$$dN \leq C \cdot dt$$

where dt is the synchronous frame parameter (the "external clock") and C is the finite capacity bound.

Substituting the quadratic decomposition:

$$d\tau^2 + dl^2 \leq C^2 \, dt^2$$

This defines the **capacity cone**: the set of all realizable combinations of internal and external change in one synchronous step.

3.2 Existence of Maximum Speed

Define the projection velocity:

$$v = dl \,/\, dt$$

For the identity to be maintained ($d\tau > 0$), we need:

$$d\tau^2 = C^2 \, dt^2 - dl^2 > 0$$

Therefore:

$$dl^2 < C^2 \, dt^2$$

$$v < C$$

No enclosure can reach $v = C$, because at $v = C$:

$$d\tau^2 = C^2 \, dt^2 - C^2 \, dt^2 = 0$$

and $d\tau = 0$ means no internal realization, no identity cycle, no enclosure. The enclosure would cease to exist as an enclosure.

The speed limit is not imposed from outside. It is the boundary of identity.

3.3 The Photonic Limit

A pure transfer ($d\tau = 0$, no internal cycle, no identity) satisfies:

```
dl² = C² dt²
```

```
v = C   (exactly)
```

This is not "the speed of light." This is the realization state in which the entire capacity budget goes into external projection because there is no internal cycle to fund.

The speed of light is not a property of light. It is a consequence of the absence of identity.

A photon does not "travel at the speed of light." A photon is the state where all capacity flows into spatial change because there is nothing else to allocate it to. It cannot go slower (that would require $d\tau > 0$, which requires an internal cycle, which it does not have). It cannot go faster (that would exceed C, violating finite capacity). Pure transfer corresponds to null trajectories of the realization metric: $ds^2 = 0$.

3.4 Why C Is Invariant

C is the capacity bound of the realization substrate itself. It is not a property of any particular enclosure or observer.

An enclosure moving at velocity v relative to another enclosure has a different allocation of its budget (more dl, less $d\tau$), but the total budget C remains the same — because C is what the medium provides, not what the enclosure chooses.

Therefore, C does not depend on the motion of the observer. It is invariant across all synchronous frames.

Proof by contradiction (reductio): Suppose C depended on motion relative to some preferred frame F_0. Then, under pure translation between synchronous frames (no capacity gradient), an enclosure's identity-persistence rate ($d\tau$ at rest) would depend on its absolute velocity relative to F_0. But the enclosure's identity is defined by its internal cycle — a topological property of its realization loop. Under gradient-free translation, internal topology cannot depend on external translational state (the cycle either closes or it does not, regardless of the frame describing it). Therefore, identity persistence would depend on something that identity itself is independent of — a contradiction. Hence no preferred frame exists, and C is frame-invariant.

This is not Einstein's second postulate ("the speed of light is the same in all inertial frames"). This is a derivation: the capacity bound of the medium cannot depend on the state of a structure within the medium, because the medium is what makes the structure possible in the first place.

Part V. Minkowski Structure

4.1 The Interval

From the budget equation, rearranging:

```
dτ² = C² dt² − dl²
```

Define the interval:

```
ds² ≡ C² dt² − dl²
```

Then $ds^2 = d\tau^2$ — the interval measures the **remaining capacity for identity**. It is not a "distance in spacetime." It is an accounting quantity: how much of the budget is left for internal realization after the cost of external projection is subtracted. In the language of relativity, ds^2 is the proper realization measure — the capacity-theoretic analog of proper time.

4.2 Invariance of the Interval

Since $d\tau$ is a property of the enclosure (its internal realization count), and since it cannot depend on which synchronous frame describes the enclosure's external motion, ds^2 must be invariant under changes of synchronous frame.

4.3 Lorentz Transformations

What transformations preserve $ds^2 = C^2dt^2 - dl^2$?

The boundary of the capacity cone is $dl = C \cdot dt$. Any admissible transformation must map this boundary to itself (otherwise it would create realizations that exceed C, or fail to reach C for pure transfers).

The set of linear transformations preserving a quadratic form of signature (+, −, −, −) is the Lorentz group. (Why linear? Locality of realization implies that transformations between synchronous frames must be linear in the infinitesimal limit — a nonlinear transformation would create frame-dependent distinctions at a point, violating isotropy.) This is a mathematical theorem, not a physical assumption.

Therefore: **Lorentz transformations are derived, not postulated.** They are the unique transformations compatible with a finite, invariant capacity bound.

4.4 Minkowski Spacetime

The metric $ds^2 = C^2dt^2 - dx^2 - dy^2 - dz^2$ defines Minkowski spacetime. It is not an axiom. It is the necessary geometric structure of any realization space with:

- finite capacity (Premise 0.4)
- isotropic spatial projection (R2)
- quadratic budget (derived in Part III)
- invariant capacity bound (derived in §3.4)

This establishes the kinematic metric structure. It does not by itself specify dynamical field equations.

Part VI. Consequences of the Budget

Every major result of special relativity follows from the budget equation without additional assumptions.

5.1 Time Dilation

An enclosure moving at velocity v has:

```
dτ² = C² dt² − v² dt² = (C² − v²) dt²
```

```
dτ = dt · √(1 − v²/C²)
```

The faster an enclosure moves (higher v), the less capacity remains for internal realization (lower dτ). Its internal clock runs slower — not because "time slows down," but because the budget for identity is being spent on motion.

This is not an interpretation. It is a direct algebraic consequence of the budget equation.

5.2 Length Contraction

Length contraction follows from the Lorentz transformation, which we derived in §4.3. A rod of proper length L_0 (measured in its rest frame) has projected length:

```
L = L₀ · √(1 − v²/C²)
```

This is the spatial complement of time dilation: both are projections of the same budget redistribution.

5.3 Relativity of Simultaneity

Different enclosures with different velocities have different budget allocations. Their "now" (surfaces of constant τ) do not coincide. There is no absolute simultaneity because there is no absolute budget allocation — each enclosure distributes its C differently.

5.4 Relativistic Velocity Addition

If enclosure A moves at velocity u relative to B, and B moves at velocity v relative to C, then A's velocity relative to C is:

```
w = (u + v) / (1 + uv/C²)
```

This is not Galilean addition (w = u + v) because the budget is bounded. You cannot simply add velocities, because the total cannot exceed C. The formula ensures the bound is never violated.

5.5 Mass-Energy Equivalence

The budget for an enclosure at rest (dl = 0) is:

```
dτ = C · dt
```

All capacity goes to identity. The "cost" of maintaining this identity is the rest energy:

```
E₀ = m · C²
```

where m is the capacity cost of the identity per unit τ. This is $E = mc^2$: the energy locked in identity maintenance.

It is not that "mass can be converted to energy." It is that mass *is* the capacity cost of having an identity, and C^2 is the conversion factor between internal (identity) and external (spatial) capacity units.

5.6 No Reference Frame for Pure Transfer

A photon has $d\tau = 0$. It has no internal clock, no identity cycle, no "perspective." You cannot construct a rest frame for a photon because there is no internal realization to serve as a clock. The question "what does the world look like from the photon's perspective?" is meaningless — not philosophically, but structurally: there is no τ to parametrize a perspective.

5.7 Impossibility of Superluminal Signaling

Superluminal signaling would require transferring a distinguishable change at velocity $v > C$. But $v > C$ means:

```
dl > C · dt
```

```
dτ² = C² dt² − dl² < 0
```

A negative $d\tau^2$ has no realization — it corresponds to no possible budget allocation. It is not "expensive" or "difficult." It is structurally impossible: there is no configuration of the budget that produces it.

5.8 Gravitational Waves Travel at C

A perturbation of the capacity gradient (gravitational wave) propagates through the same realization medium as everything else. The medium has capacity bound C. Therefore gravitational perturbations propagate at C — not because "gravity is like light," but because both are constrained by the same finite capacity of the same substrate.

5.9 Entanglement Does Not Violate C

Quantum entanglement produces correlations between distant measurements, but no capacity is transferred. Correlation is not realization. No change is realized at the distant location by the local measurement — only when the results are compared (which requires a signal limited to C) does the correlation become manifest.

Part VII. The Circular Invariant

6.1 An Elementary Change at a Point

Consider an elementary change realized at a single point in an isotropic realization space. This change consumes part of the local capacity. A deficit is created.

The deficit must propagate to the surrounding space (deficits redistribute as reallocation of available capacity — they do not vanish locally without effect elsewhere).

6.2 Isotropy Forces Circular Wavefronts

Because the realization space is isotropic (no preferred direction), the propagation of the deficit must be uniform in all directions.

The set of all points reachable by a given capacity allocation in one step satisfies:

```
dl = C · dt = const.
```

In 2D, this is a circle. In 3D, this is a sphere.

The circle is not geometry imposed on physics. The circle is the shape of equal reachability in an isotropic capacity space.

This is the **circular invariant**: the wavefront of any point-localized change in an isotropic medium is necessarily spherical.

6.3 Sequential Realization Produces Spirals

If the change is not a single event but a continuing sequence — an enclosure with internal cycles that also propagates — then each successive wavefront emanates from a slightly different position (because the enclosure has moved).

The combination of:

- radial spreading (spherical wavefronts) and
- progressive displacement (enclosure motion / internal rotation)

produces a spiral structure.

This is not an analogy. It is the geometric consequence of combining periodic internal realization (enclosure) with isotropic external propagation (wavefront). The spiral is the necessary trajectory of a radiating enclosure in an isotropic capacity space.

Part VIII. Newton's Law from Capacity Deficit

7.1 Enclosures Consume Capacity

An enclosure maintains its identity by consuming capacity from the realization substrate. Let Q denote the capacity consumption of an enclosure per cycle. This consumption creates a deficit in the surrounding realization field: the region around the enclosure has less available capacity than regions far away.

7.2 The Deficit Propagates Isotropically

In the absence of other structures, the deficit propagates uniformly in all directions (by the same isotropy that gave us the circular invariant in §6.2).

The total deficit flux through any closed surface surrounding the enclosure must equal Q:

```
∫_S g · dS = Q
```

where g(r) is the intensity of the capacity gradient at distance r.

Structural assumptions required for this step: (1) the capacity gradient field is continuous and locally defined, (2) deficits propagate as redistribution, not as local annihilation, and (3) the divergence theorem applies — i.e., the field is divergence-representable. These are not derived from isotropy alone; they are structural properties of the coarse-grained realization description introduced in Part III.

7.3 Gauss's Theorem in 3D

In three-dimensional space, a sphere of radius r has surface area:

```
S(r) = 4πr²
```

By isotropy, g is uniform over the sphere. Therefore:

```
g(r) · 4πr² = Q
```

```
g(r) = Q / (4πr²)
```

7.4 Newton's Inverse-Square Law

```
┌──────────────────────────────────┐
│                                  │
│         g(r) ∝ 1/r²             │
│                                  │
└──────────────────────────────────┘
```

This reproduces the inverse-square structural form of Newtonian gravitation. It was not postulated. It follows necessarily from:

1. Enclosures consume capacity (Premise 0.4 + Definition of enclosure) 2. The deficit propagates isotropically (isotropy of realization space) 3. The space is three-dimensional (derived separately — see note below) 4. Capacity is conserved (it flows, it does not vanish)

Newton's gravitational constant G is not a fundamental constant. It is a projection constant: it converts between the capacity units of the ontological layer and the SI units of the measurement apparatus. Its value depends on the relationship between the realization substrate and our measurement conventions.

7.5 The Gravitational Potential

Integrating the gradient:

```
Φ(r) = ∫ g(r) dr ∝ −1/r
```

The 1/r potential is notable: it is one of only two potentials (the other being r^2) that produce closed, stable orbits in 3D (Bertrand's theorem). This is a consistency check: the same 3D isotropy that gives Newton's law also gives the only potential compatible with long-term stable bound structures.

7.5b Principle of Minimal Realization (Dynamics)

The gradient g(r) describes the capacity landscape. But what determines how an enclosure *moves* in this landscape?

An enclosure's trajectory follows the path of **least realization cost** — the path that maximizes remaining capacity for identity maintenance (dτ) given the constraints of the environment.

```
Enclosure trajectories extremize ∫ dτ along the path.
```

The functional ∫ dτ is the worldline proper-realization measure — the capacity-theoretic analog of proper time along a worldline. In flat space (no gradient), extremizing ∫ dτ yields straight worldlines (geodesics of Minkowski metric). In a weak capacity gradient, it reproduces Newtonian acceleration as the first-order deviation from straight trajectories.

In a capacity gradient, the direction of steepest descent in realization cost is toward lower Φ (higher deficit). An enclosure "falls" not because a force pulls it, but because that direction costs the least — it is where the most capacity remains available for identity.

F = ma is therefore not a separate law. It is the statement that enclosures follow paths of maximum identity preservation through a capacity landscape.

7.6 Why 3D (Summary)

The dimensionality n of the realization space determines the surface area of the sphere:

```
S_n(r) ∝ r^(n−1)
```

and therefore the potential:

```
Φ(r) ∝ r^(2−n)    (for n ≠ 2)
```

- $n = 2$: $\Phi \propto \ln r$ — too weak for localized bound structures
- $n = 3$: $\Phi \propto 1/r$ — stable hierarchical structures possible
- $n = 4$: $\Phi \propto 1/r^2$ — too steep, runaway collapse, no stable orbits

The requirement of hierarchical stability (stable bound structures at multiple scales without active control) uniquely selects $n = 3$.

This result is derived independently by two paths:

(A) Ontological [INTERPRETIVE]: There are exactly two types of change relations (simultaneous and sequential). Synchronization of these two generates a third axis. A fourth would require a third type of change relation, which does not exist (tertium non datur). This argument is philosophically compelling but depends on the claim that the simultaneous/sequential dichotomy is exhaustive — a claim that is structurally motivated but not mathematically forced.

(B) Projective [DERIVED]: Hierarchical stability requires $\Phi \propto 1/r$, which requires $2 - n = -1$, which requires $n = 3$. This argument is mathematically rigorous: given the Gauss theorem and the stability requirement, $n = 3$ follows by algebra.

Both paths converge on the same result. Path (B) is the load-bearing derivation; path (A) provides ontological motivation.

Part IX. Structural Forms Forced by Finite Realization Capacity

From a single premise — **finite capacity of change realization** — and three definitions (distinguishable state, elementary change, realization), we have derived:

Result	Section	Mechanism
Rest calibration ($\tau \leftrightarrow dt$ mapping)	II, §1.3	Maximum internal allocation at $dl = 0$
Minimality of two channels	III, §2.1	Functional basis: identity vs. projection
Quadratic metric of realization	III, §2.4	Isotropy + orthogonality + Jordan–von Neumann
Pythagorean theorem	III, §2.5	Necessary form of isotropic quadratic metric
Existence of maximum speed	IV, §3.2	Finite budget + identity requires $d\tau > 0$
Speed of light (C) as capacity bound	IV, §3.3	Pure transfer: $d\tau = 0 \Longrightarrow dl = C \cdot dt$
Invariance of C (with reductio)	IV, §3.4	C is property of medium; frame-dependence → contradiction
Minkowski interval	V, §4.1	ds^2 = remaining capacity for identity
Lorentz transformations	V, §4.3	Unique transformations preserving ds^2
Time dilation	VI, §5.1	Budget redistribution: more dl → less $d\tau$
Length contraction	VI, §5.2	Spatial complement of time dilation
Relativity of simultaneity	VI, §5.3	No absolute budget allocation
Velocity addition formula	VI, §5.4	Budget bound prevents simple addition
$E = mc^2$	VI, §5.5	Rest energy = capacity cost of identity
No photon rest frame	VI, §5.6	$d\tau = 0$ → no internal clock
No superluminal signaling	VI, §5.7	$d\tau^2 < 0$ has no realization
Gravitational waves at C	VI, §5.8	Same medium → same capacity bound
Circular/spherical wavefronts	VII, §6.2	Isotropy of capacity propagation

Spiral structure of radiating enclosures	VII, §6.3	Internal cycle + isotropic propagation
Newton's $1/r^2$ law	VIII, §7.4	Gauss theorem + 3D isotropy
Gravitational potential $1/r$	VIII, §7.5	Integration of $1/r^2$
F = ma (dynamics)	VIII, §7.5b	Extremization of $\int d\tau$ along trajectory
Uniqueness of 3D	VIII, §7.6	Stability requirement (projective, derived)

No physical postulate was used. No empirical constant was introduced as an axiom. Every result follows from the structural requirements of finite, distinguishable change realization.

Part X. What This Means

10.1 The Speed of Light Is Not About Light

The constant C is not a property of electromagnetic radiation. It is the capacity bound of the realization substrate. Light happens to travel at C because a photon has no internal cycle ($d\tau = 0$) and no internal structure ($d\chi = 0$), so all capacity goes into spatial projection. But C would exist even if photons did not.

10.2 Gravity Is Not a Force

Newton's $1/r^2$ law does not describe a "force" exerted by one mass on another. It describes the geometry of capacity deficit propagation in an isotropic 3D space. An enclosure consumes capacity; the surrounding space has less available; other enclosures drift toward the deficit because that is the direction of least resistance for their own realization. This is not a "pull." It is an accounting gradient.

10.3 The Pythagorean Theorem Is Not Geometry

The Pythagorean theorem is usually presented as a fact about right triangles. Here it appears as a fact about realization budgets: the total cost of a step in orthogonal channels adds in quadrature because that is the only combination consistent with isotropy and independence.

10.4 Relativity Is Not About Observers

Special relativity is usually presented as a theory about what different observers see. Here it appears as a theory about budget allocation: every enclosure has the same total capacity C, but allocates it differently between identity ($d\tau$) and motion (dl). "Time dilation" is not time behaving strangely — it is a smaller share of the budget going to identity when more goes to motion.

10.5 The Direction of Derivation

Einstein began with two postulates (relativity principle + invariance of c) and derived their consequences. This paper begins with one premise (finite capacity) and derives the postulates themselves, along with their consequences.

Newton began with three laws and the gravitational force law. This paper derives the gravitational force law from capacity deficit in 3D, and derives 3D from the structure of change realization.

The direction matters: postulates that must be assumed in the standard framework become consequences in this framework.

Appendix A. Status Classification

Every claim in this document falls into one of three categories:

[DERIVED] — follows by logical or mathematical necessity from the premise and definitions. No additional assumptions. Sections: II (§1.1–1.3), III (§2.1–2.5), IV (§3.1–3.4), V, VI, VII (§6.2), VIII (§7.1–7.5b).

[STRUCTURAL THEOREM] — mathematical fact (e.g., uniqueness of quadratic norm under rotation invariance / Jordan–von Neumann theorem, Lorentz group as symmetry of the Minkowski metric, Bertrand's theorem). These are not assumptions; they are theorems of mathematics. Sections: III (§2.4), V (§4.3), VIII (§7.5).

[MODEL REALIZATION] — mathematical representation used to express structural consequences in familiar physical form (e.g., differentiable coarse-graining, field representation, Gauss-type flux description, stability modeling). These layers are not asserted as fundamental; they serve to connect the structural result to known physics. Sections: III (differentiability assumption), VIII (§7.2 divergence form, §7.3 Gauss flux).

[INTERPRETIVE] — claims that follow naturally from the framework but involve identification of formal objects with observed phenomena (e.g., "the enclosure is an atom," "the capacity deficit is gravity"), or ontological arguments that are motivated but not mathematically forced (e.g., the ontological path to 3D in §7.6A). Sections: VIII (§7.6 path A), X.

Appendix B. Notation Summary

Symbol	Meaning
S	Set of distinguishable states
Δ	Elementary change (transition between states)
C	Finite capacity bound (maximum realization per synchronous step)
τ	Internal realization parameter (cumulative internal cycle count)
dτ	Internal realization increment (identity budget)
dl	External projection increment (spatial change budget)
dχ	Internal structure increment (complexity budget; not used in main text)
dN	Total realization step
dt	Synchronous frame parameter (external clock)
v	Projection velocity: $v = dl/dt$
ds^2	Interval: $ds^2 = C^2dt^2 - dl^2 = d\tau^2$ (remaining capacity for identity)
Q	Capacity consumption of an enclosure per cycle

g(r)	Intensity of capacity gradient at distance r
Φ(r)	Capacity potential at distance r
n	Dimensionality of realization space

Appendix C. Relation to FFO

This document is a self-contained extract from the **Finite Field Ontology** (FFO) framework. In FFO's full derivation chain, the results presented here occupy layers I–III (constants, budget, gravitational projection). The full framework continues with quantum mechanics (Schrödinger equation as optimization law), particle classification (closure hierarchy P_1–P_5), cosmology, and the derivation of fundamental constants from geometric invariants.

For the complete framework, see: FFO1_DERIVACE (Derivations), FFO1_SLOVNIK (Glossary), FFO1_MATEMATIKA (Mathematical Foundations).

What Comes Next

This document derives the relativistic and gravitational structure of physics from a single premise. But finite realization capacity has consequences far beyond relativity.

The full **Finite Field Ontology (FFO)** extends this derivation chain to:

- **Quantum mechanics** — the Schrödinger equation as an optimization law over capacity allocation
- **Particle classification** — the closure hierarchy (P_1–P_5) as the only stable topological solutions under finite capacity
- **Fundamental constants** — the fine-structure constant, the proton-to-electron mass ratio, and other "measured" values as geometric invariants of the realization space
- **Cosmology** — dark energy as operational overhead of the realization substrate, the Hubble parameter as a local capacity horizon
- **Chemistry and biology** — the periodic table as a stability map of nested closures, the cell as the minimal regulatory enclosure

Every result follows the same method: no postulates, no empirical inputs as axioms, only structural consequences of finite distinguishable realization.

The complete FFO framework is forthcoming.

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February 2026