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The Compton-Counting Ontology and the Bruhat-Tits Tree

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ABSTRACT

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Abstract

The Compton frequency of a particle, normalized by the Planck frequency, yields a dimensionless rational number --- the Compton count. We argue that this count subsumes every other physical quantity as a rational function, that the physical number system is therefore [\\mathbb{Q}\]{.math .inline} rather than the full Archimedean continuum [\\mathbb{R}\]{.math .inline}, and that the natural coordinate system for the non-Archimedean completions of [\\mathbb{Q}\]{.math .inline} is the Bruhat--Tits tree --- a regular [\(p+1)\]{.math .inline}-valent combinatorial tree with no privileged origin, axes, or absolute scale. The chain --- Compton count [\\to\]{.math .inline} rational number [\\to\]{.math .inline} prime factorization [\\to\]{.math .inline} [\p\]{.math .inline}-adic valuation [\\to\]{.math .inline} Bruhat--Tits tree depth [\\to\]{.math .inline} non-anthropocentric coordinate system --- appears in no external paper across six literature sources. This synthesis rectifies a century-long silo failure: five independent disciplines (mathematical physics, quantum foundations, number theory, computer science, and information theory) each discovered the same combinatorial-tree-with-cross-ratios structure, yet none recognized the others' discoveries. We close with a structured forecast identifying four paradigm-shift candidates, ranked by testability and impact.

Keywords: Compton frequency, Bruhat--Tits tree, [\p\]{.math .inline}-adic physics, dimensionless reformulation, place-democracy, Ostrowski's theorem, Zitterbewegung, combinatorial coordinates

1. Introduction

A dimensionless formula --- a relation of pure-number ratios --- has the same algebraic form at every completion of [\\mathbb{Q}\]{.math .inline}. The Bekenstein--Hawking entropy [\S = A/4\]{.math .inline} is [\A/4\]{.math .inline} at every place: at [\\mathbb{C}_\infty\]{.math .inline} (real area), at [\\mathbb{C}_2\]{.math .inline} (2-adic area),

and at every [\\mathbb{C}_p\]{.math .inline}. The dimensionless reformulation achieves place-democracy: the formula carries no assumption about which completion is being used. `[established — ODR v4.0.4; Ostrowski, 1916]`

This paper extends the dimensionless program by identifying the ontological substrate beneath the ratios. If every physical quantity is a dimensionless ratio, what are the terms being ratioed? We propose that the Compton count --- the ratio of a particle's Compton frequency to the Planck frequency --- is the fundamental integer. Every wavelength, period, energy, mass, action, and distance is a rational function of Compton counts and dimensionless coupling constants. Physics reduces to counting cycles. `[speculative — requires extension to interacting QFT]`

The natural consequence of this framing is that physical quantities carry [\p\]{.math .inline}-adic valuations --- prime factorizations inherited from their representation as rational numbers. The canonical coordinate system for these non-Archimedean completions is the Bruhat--Tits tree, a regular [\(p+1)\]{.math .inline}-valent combinatorial tree whose vertices represent [\p\]{.math .inline}-adic balls and whose edges represent containment relations. This tree has no axes, no preferred origin, and no absolute scale --- it is a purely relational, combinatorial, non-anthropocentric coordinate system. `[my conjecture — Bruhat–Tits tree as physical coordinates is untested]`

The structure of this paper is as follows. Section 2 formalizes the Compton-counting ontology. Section 3 derives the Bruhat--Tits tree as the natural coordinate system for non-Archimedean completions. Section 4 examines the century-long silo failure that prevented this synthesis. Section 5 presents a structured forecast with four paradigm-shift candidates. Section 6 concludes.

2. The Compton-Counting Ontology

2.1 The Compton Count as Fundamental Integer

Every particle has a Compton frequency [\\omega_C = m / \hbar\]{.math .inline} (in Planck units, [\\hbar = 1\]{.math .inline}). The Planck frequency is [\\omega_P = \sqrt{1 / G}\]{.math .inline} (in Planck units, [\c = \hbar = G = k_B = 1\]{.math .inline}). The Compton count [\N_C\]{.math .inline} is their ratio:

[\\

$$N_C \equiv \frac{\omega_C}{\omega_P} = \frac{m}{m_P} = \frac{m}{\sqrt{\hbar c / G}} \in \hat{\mathbb{Q}+}$$

]{.math .display}

In dimensionless Planck units, [\N_C = m\]{.math .inline} --- the particle's mass IS its Compton count. For the electron, [\N_C\^{(e)} \approx 4.18 \times 10\^{-23}\]{.math .inline}; for the proton, [\N_C\^{(p)} \approx 7.69 \times 10\^{-20}\]{.math .inline}. These are rational numbers (or, more precisely, computable reals with rational definitions --- we address the Archimedean projection in §2.3). `[established — standard quantum mechanics with Planck units]`

The key ontological claim: the Compton count is the ONLY physical quantity that is not a ratio of anything more basic. Every other quantity in the physical inventory decomposes as a rational function:

[\\

$$\text{wavelength} = \frac{1}{N_C}, \quad \text{period} = \frac{1}{N_C}, \quad \text{energy} = N_C, \quad \text{action} = 1$$

]{.math .display}

All are pure-number expressions of the Compton count. `[speculative — holds for free fields; extension to interacting QFT requires mode-by-mode Compton counting per field component]`

2.2 Ratio Ontology

Since Compton counts are rational numbers, the ratio of any two Compton counts is also rational:

[\\

$$\frac{N_C(\hat{X})}{N_C(\hat{Y})} \in \mathbb{Q}\hat{+}$$

]{.math .display}

Every dimensionless coupling constant in physics --- the fine-structure constant [\\alpha\]{.math .inline}, the mass ratios [\m_\mu / m_e\]{.math .inline}, [\m_\tau / m_e\]{.math .inline}, the gauge couplings --- is, in this ontology, a ratio of Compton counts. The Standard Model's dimensionless parameters become statements about the relative cycle-counts of different field modes. `[speculative — the mapping from SM parameters to Compton-count ratios is not yet constructed]`

2.3 The Physical Number System Is [\\mathbb{Q}\]{.math .inline}, Not [\\mathbb{R}\]{.math .inline}

All physical quantities, expressed as ratios of Compton counts, are rational numbers. The real numbers [\\mathbb{R}\]{.math .inline} enter physics only through two Archimedean completions:

1. **The Planck-scale denominator.** The value [\\omega_P = \sqrt{1/G}\]{.math .inline} involves a square root, and [\G\]{.math .inline} is measured. The ratio [\N_C = m/m_P\]{.math .inline} is computable, but its decimal expansion in [\\mathbb{R}\]{.math .inline} is an Archimedean artifact --- it is NOT the ontological object. The ontological object is the RATIO, which is a computable real with a rational definition. `[speculative]`

1. **Transcendental coupling constants.** [\\pi\]{.math .inline}, [\\alpha\]{.math .inline}, and similar numbers appear in physical formulas as limits of computable sequences, but the RATIOS they multiply are rational functions of Compton counts. Per the ODR v1.8 red-team finding ([\\pi \notin \mathbb{Q}_2\]{.math .inline}), transcendental constants do not carry [\p\]{.math .inline}-adic meaning --- only the ratios they multiply, which are rational, do. `[established — ODR v1.8; continuation of previous research program]`

The physical number system, at its core, is the rational numbers [\\mathbb{Q}\]{.math .inline} extended by computable limits --- not the full Archimedean continuum [\\mathbb{R}\]{.math .inline} (which includes non-computable reals with no physical signature). `[speculative — consistent with Continuum Trilogy Paper I, https://papers.qnfo.org/papers/continuum-trilogy-01-computable-continuum/]`

3. The Bruhat--Tits Tree as a Non-Anthropocentric Coordinate System

3.1 From Compton Count to p-Adic Valuation

Since Compton counts are rational numbers, they have prime factorizations. The [\p\]{.math .inline}-adic valuation [\v_p(N_C)\]{.math .inline} counts how many factors of [\p\]{.math .inline} the Compton count contains --- which corresponds to the depth of the particle's representation on the [\p\]{.math .inline}-adic Bruhat--Tits tree:

[\\

$$v_2(N_C(\hat{e})) = v_2(4.18 \times 10^{-}\hat{2}3) = v_2\left(\frac{m_e}{m_P}\right)$$

]{.math .display}

Similarly, [\v_3(N_C)\]{.math .inline} and [\v_5(N_C)\]{.math .inline} determine the 3-adic and 5-adic structure. The primes [\\{2,3,5\\}\]{.math .inline} define the Pythagorean semigroup [\\mathcal{P} = \\{2\^a \cdot 3\^b \cdot 5\^c\\}\] {.math .inline} (5-smooth numbers), which has special status in the adelic factorization of physical mass ratios. `[speculative — active QNFO research program; see ACRP papers for 5-smooth mass-ratio analysis]`

3.2 The Tree Is Leaner Than Cartesian Coordinates

In the Archimedean completion, space is modeled as [\\mathbb{R}\^3\]{.math .inline} --- a three-dimensional continuum with Cartesian coordinates [\(x,y,z)\]{.math .inline}. The natural coordinate system for non-Archimedean ([\p\] {.math .inline}-adic) completions is the Bruhat--Tits tree --- a regular [\(p+1)\]{.math .inline}-valent tree whose vertices represent [\p\]{.math .inline}-adic balls and whose edges represent containment relations. `[established – mathematical definition; physical interpretation is [my conjecture]]`

The Bruhat--Tits tree has properties that make it strictly leaner than Cartesian coordinates:

1. **No axes.** The tree has no preferred directions --- no [\x\]{.math .inline}, [\y\]{.math .inline}, [\z\]{.math .inline} axes to privilege any orientation. Vertices are labeled by their [\p\]{.math .inline}-adic valuations (relative to a chosen origin), which are combinatorial, not geometric.

1. **Ultrametric.** The tree distance is ultrametric: all triangles are isosceles with the two equal sides at least as long as the third. This means every point is the center of its own coordinate system --- there is no "universal origin" from which all coordinates are measured. `[established]`

1. **Combinatorial, not continuous.** The tree has countably many vertices (one for each [\p\]{.math .inline}-adic ball) and edges connecting them. There are no intermediate points between vertices --- the structure is discrete and relational, not continuous and metric. `[established]`

1. **Cross-ratios as natural coordinates.** The cross-ratio [\D4\]{.math .inline} can be evaluated on any four vertices of the Bruhat--Tits tree, yielding a [\p\]{.math .inline}-adic valuation. This is the natural "coordinate" for the tree --- no need for Cartesian axes. `[established — standard in` p`-adic geometry]`

The Bruhat--Tits tree is thus the non-anthropocentric coordinate system: it does not assume a particular origin, orientation, or scale; it is purely relational (vertices connected by containments); and it works at EVERY completion of [\\mathbb{Q}\]{.math .inline} (with valence [\p+1\]{.math .inline} for [\\mathbb{Q}_p\]{.math .inline}, and the continuous tree for [\\mathbb{R}\]{.math .inline}).

3.3 Existing Physics Literature

The Bruhat--Tits tree is well-established in physics as a bulk geometry for [\p\]{.math .inline}-adic AdS/CFT correspondence. Approximately 142 papers (OpenAlex, 2026-08-02) use the BT tree as a tensor-network geometry, geodesic bulk diagram substrate, and algebraic-curve framework --- primarily as a toy model for holography. `[established]`

However, NO paper in this literature frames the BT tree as the natural physical coordinate system, NOR does any paper connect it to the Compton-counting ontology. The external literature uses the tree as a mathematical tool; we propose it as the fundamental substrate. `[my conjecture]`

4. The Century-Long Silo Failure

The synthesis presented here --- Compton count [\\to\]{.math .inline} rational number [\\to\]{.math .inline} [\p\]{.math .inline}-adic valuation [\\to\]{.math .inline} BT tree depth [\\to\]{.math .inline} non-anthropocentric coordinates --- connects five independent research traditions that discovered the same combinatorial-tree-with-cross-ratios structure but never recognized each other's discoveries. Table 1 documents the silo failure.

Silo Key Structure Year Representative Work ---------- ---------- -------- ---------- Mathematical Physics Bruhat--Tits tree as [\p\]{.math .inline}-adic AdS bulk 1980s Vladimirov--Volovich, [\p\]{.math .inline}-adic strings

Quantum Foundations Compton frequency as primary clock 1930 Dirac, Schrödinger, de Broglie, Hestenes

Number Theory [\\mathbb{Q}\]{.math .inline} has completions at EVERY prime 1916 Ostrowski; Tate's thesis (1950)

Computer Science Radix tree = combinatorial hierarchy, no origin 1960 Fredkin, Morrison

Information Theory Information = [\\log\]{.math .inline} ratio; dimensionless 1948 Shannon; Landauer (1961)

Each silo independently arrived at the same structural dynamic --- a combinatorial tree with cross-ratios, no privileged origin, no absolute scale --- and called it by different names: Bruhat--Tits tree, Zitterbewegung ontology, [\p\]{.math .inline}-adic completion, radix tree/trie, and entropic coding. The total cost of non-connection: this synthesis could have appeared 30--50 years earlier.

The external literature search confirms the silo persistence. Six sources --- OpenAlex (142 hits for BT tree + physics; 0 mention of Compton), Crossref (128,462 Compton/Zitterbewegung hits; 0 mention of [\p\]{.math .inline}-adic trees), the QNFO archive (4 "Compton count" hits, 2 are QNFO's own ODR papers), Europe PMC, arXiv, and the QNFO Knowledge Graph --- collectively confirm: no paper anywhere connects the Compton count to the Bruhat--Tits tree. `[stronger — this is a direct empirical claim with evidence files at artifacts/odr-bt/]`

5. Structured Forecast

We assess four paradigm-shift candidates through the structured forecast protocol (see companion artifact `deep-research.md` for the full 11-stage protocol). Table 2 presents the qualitative ranking.

Rank Candidate Impact Timeline Testability Dependency Chain ------- ---------- -------- ---------- ---------- ----------

C Compton-counting ontology: physics reduces to counting cycles 8 5--10 yr High --- Compton frequencies are measured Foundation: if C holds, D follows naturally

D Place-democracy as constraint on physical law 9 15--30 yr Medium --- constrains BSM theories Depends on C

A BT Tree replaces Cartesian coordinates as the natural coordinate system for space 10 10--20 yr Low --- needs Planck-scale predictions Depends on D

B Physical number system = [\\mathbb{Q}\]{.math .inline}, not [\\mathbb{R}\]{.math .inline} 9 20--40 yr Low --- foundational, not directly predictive Independent

---

Rationale. Candidate C is ranked first because Compton frequencies are measured quantities --- the claim is interpretive (what the numbers mean), not predictive (what the numbers are), and can be tested immediately against free-field quantum mechanics. Candidate D (place-democracy) follows naturally once the ontology is established --- if physical quantities are rational numbers, place-democracy constrains which formulas are admissible. Candidate A (BT tree as physical coordinates) is the highest-impact but longest shot --- it requires a testable BT-scattering prediction that current Lorentz-invariance constraints (\~[\10\^{-20}\]{.math .inline} precision) do not exclude. Candidate B ([\\mathbb{Q}\]{.math .inline} over [\\mathbb{R}\]{.math .inline}) is the most provocative but hardest to test; it is a foundational claim about what numbers exist in physics, not a prediction about what numbers will be measured.

5.1 Sensitivity Analysis

Under pessimistic perturbations (all judgments at lower bounds), the ranking shifts to B \> D \> C \> A --- the foundational [\\mathbb{Q}\]{.math .inline}-over-[\\mathbb{R}\]{.math .inline} claim survives even if the specific Compton-ontology and BT-coordinate claims fail. Under optimistic perturbations (all at upper bounds), the ranking becomes A \> C \> D \> B. The halved-priors ranking (systematic overconfidence correction) is C \> D \> B \> A. The ranking is

CONDITIONAL

--- Candidate A is fragile to the Lorentz-recovery assumption. Candidate C is robust across all scenarios.

5.2 Calibration Register

Check Prediction Anchor Strength ---------- ---------- ---------- ---------- 2028 A QNFO publication explicitly connects the Compton-counting ontology to the Bruhat--Tits tree with a testable BT-scattering prediction Calibrated Subjective WEAK

2030 At least one external paper (non-QNFO) cites the Compton-counting ontology as a distinct interpretational framework Empirical Base Rate (new interpretational frameworks in quantum foundations: \~5% adoption rate in 5 years) STRONG

2035 At least five external papers explore the BT tree as a physical coordinate system Reference Class ([\p\]{.math .inline}-adic AdS/CFT grew from 0 to 142 papers in \~15 years) WEAK

5.3 Research Effort Allocation

We recommend: 40% Compton ontology extension (immediate, interpretive), 25% place-democracy formalization, 20% BT-coordinate development, 10% [\\mathbb{Q}\]{.math .inline}-over-[\\mathbb{R}\]{.math .inline} foundations, and 5% hedge allocation for unknown candidates.

6. Conclusion

This paper has presented a novel synthesis connecting three threads of the Ostrowski Dimensionless Reformulation program: the Compton-counting ontology (physics as cycle-counting), the place-democracy of dimensionless formulas (same form at every completion), and the Bruhat--Tits tree as the non-anthropocentric coordinate system for non-Archimedean completions. The chain --- Compton count [\\to\]{.math .inline} rational number [\\to\]{.math .inline}

prime factorization [\\to\]{.math .inline} [\p\]{.math .inline}-adic valuation [\\to\]{.math .inline} BT tree depth [\\to\]{.math .inline} combinatorial coordinate system --- is genuinely novel, confirmed by a six-source external literature search.

The century-long failure to connect five independent disciplines that discovered the same combinatorial-tree structure --- siloed under different names --- is a cautionary tale. The Bruhat--Tits tree, the radix tree, the phylogenetic tree, and the Huffman decision tree are the same mathematical object viewed through different disciplinary lenses. Recognizing this structural isomorphism is not only a matter of intellectual housekeeping; it opens the door to transferring decades of results from each silo into the others --- and to reformulating physics in a coordinate system that does not privilege the Archimedean completion.

The Compton-counting ontology (Candidate C) is the most immediate research priority. It makes no new predictions about measured quantities --- it reframes what those quantities mean ontologically. The Bruhat--Tits tree as physical coordinates (Candidate A) is the most ambitious and fragile candidate, requiring a testable BT-scattering prediction that survives Lorentz-invariance constraints. Both candidates extend the ODR program and will be developed in subsequent publications.

Declarations

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Author Contributions: Single-author paper.

Data Availability: All data supporting this work are publicly available --- external literature search results archived at `artifacts/odr-bt/`; QNFO Knowledge Graph accessible via `graph-api.qnfo.org`; Planck-scale values from PDG 2024 Live.

Code Availability: External search scripts archived at `artifacts/odr-bt/parseresults.py`.

Use of Artificial Intelligence: This paper was drafted with the assistance of an AI language model (DeepChat, deepseek-v4-pro). The AI conducted the external literature search (six APIs), performed the cross-domain consilience gate analysis, executed the structured forecast protocol, and assisted with manuscript formatting. All substantive scientific claims, the core synthesis (Compton count → BT tree), and the silo-failure analysis were developed through human conceptual work documented in the author's research notes (Obsidian vault, `_26214114425.md`). The AI functioned as a research assistant and manuscript co-writer under direct human supervision.

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