The Charge Boundary-Route Preservation Law

Value Conservation, Route Admissibility, and Structural Selection in Charge-Bearing Transitions

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Abstract

Electric charge is conventionally represented as a conserved scalar quantum number. This representation is indispensable, but it compresses structural information: a positron, proton, positive pion, positive kaon, and W^+ boson all project to $Q/e = +1$, while belonging to distinct physical architectures. This paper extracts a law-level statement from the six-phase *Charge Boundary Routing I* program: scalar charge conservation is necessary but not sufficient for structural admissibility. In the UNNS (Unbounded Nested Number Sequences) route/closure representation, a charge-bearing transition is admissible only when it preserves a coherent boundary-route transformation between initial and final charge-bearing structures. The empirical basis is the completed Phase 1–3C corpus: static charge-boundary classification, bridge geometry, same-charge controls, allowed-transition dynamics, expanded allowed-transition robustness, and forbidden/constrained boundary contrast. The decisive result is Phase 3C: a mixed allowed/forbidden/constrained corpus remains globally connected under STRUC-PERC-I, yet loses route-transition admissibility under STRUC-I. Specifically, `route_transition_code` falls from Geometric Persistence / Boundary-Stabilized in the allowed Phase 3B corpus ($A_\kappa \approx 0.9851$) to Structural Boundary / Transitional Structure in Phase 3C ($A_\kappa \approx 0.8592$), while `closure_transition_code` remains Boundary-Stabilized. The boundary is therefore route-selective rather than a total loss of structure. We formulate the *Charge Boundary-Route Preservation Law*: charge balance is the visible projection; boundary-route preservation is the structural invariant. The law is presented as a corpus-grounded structural principle complementary to, not replacing, the Standard Model, $U(1)$ charge conservation, QCD confinement, the quark model, and conventional selection rules.

Keywords: UNNS Substrate; charge conservation; route admissibility; boundary routing; closure; quark confinement; selection rules; structural topology; necessary but not sufficient; structural invariant; admissibility geometry; STRUC-PERC-I; STRUC-I.

Contents

1 Introduction

Electric charge is one of the most successful scalar quantities in modern physics. It is conserved, quantized in observed external states, and embedded in the gauge structure of the Standard Model. In ordinary bookkeeping, an allowed transition must satisfy

$$Q_{\mathrm{i}} = Q_{\mathrm{f}}.$$

This statement is necessary and experimentally indispensable.

Yet scalar charge bookkeeping compresses structural information. The positron e^+, proton p, positive pion π^+, positive kaon K^+, and W^+ boson all carry $Q/e = +1$. They are identical under scalar charge projection, but not structurally identical. They arise from different regimes: external lepton closure, composite baryon closure, composite meson closure, strange-meson closure, and gauge-sector closure.

The question addressed here is not whether charge conservation is correct. It is: *what additional structural condition distinguishes an admissible charge-bearing transition from a charge-balanced but structurally incoherent transformation?*

This paper extracts a law-level result from the completed *Charge Boundary Routing I* program. The source manuscript built a six-phase empirical chain:

objects → layers → bridges → same-charge controls → allowed transitions → forbidden contrast.

The present paper formulates the theoretical principle revealed by that chain.

Principle 1 (Public form)**.** *Charge is conserved as a value, but admissibility lives in the route.*

2 Background: charge as value, route, closure, and boundary

2.1 Scalar charge as projection

Let $Q(x)$ denote the scalar electric charge of an object x, measured in units of e when convenient. In the scalar representation, two objects x, y are charge-equivalent when

$$Q(x) = Q(y).$$

This equivalence relation is intentionally coarse. It ignores the physical route by which the charge is carried.

For example,

$$Q(e^+) = Q(p) = Q(\pi^+) = Q(K^+) = Q(W^+) = +e.$$

The equality is correct, but it is not structural identity.

2.2 The route/closure lift

In Charge Boundary Routing, a charge-bearing object is lifted from a scalar value Q into a structural tuple

$$X = \big(Q, \mathcal{L}, \mathcal{R}, \mathcal{C}, \mathcal{B}, \Sigma\big),$$

where:

- Q is the scalar charge projection;
- $\mathcal{L}$ is the charge-boundary layer;
- $\mathcal{R}$ is the structural route class;
- $\mathcal{C}$ is the closure class;
- $\mathcal{B}$ is the boundary or absence status;
- Σ denotes composition or internal-structure data.

This lift does not invalidate Q. It preserves Q as projection while adding coordinates needed to distinguish charge-bearing architectures.

2.3 Four charge-boundary layers

The empirical program uses four layers:

$$A,\ B,\ C,\ D.$$

They are interpreted as follows.

Layer A: external/free closure states such as leptons, photons, gauge bosons, and other externally expressible charge states.

Layer B: confined fractional coordinates such as quarks and antiquarks, carrying fractional charge as internal route coordinates.

Layer C: composite closures such as baryons and mesons, where internal fractional routes close into externally admissible integer or neutral charge states.

Layer D: boundary absences and constraints, such as free quark absence, magnetic monopole absence, charge-violation bounds, and neutrality constraints.

As Figure 1 summarizes, the key idea is that fractional charge is not treated merely as arithmetic. It is treated as an internal route coordinate whose externalization is boundary-blocked. Composite charge is not only summation; it is closure.

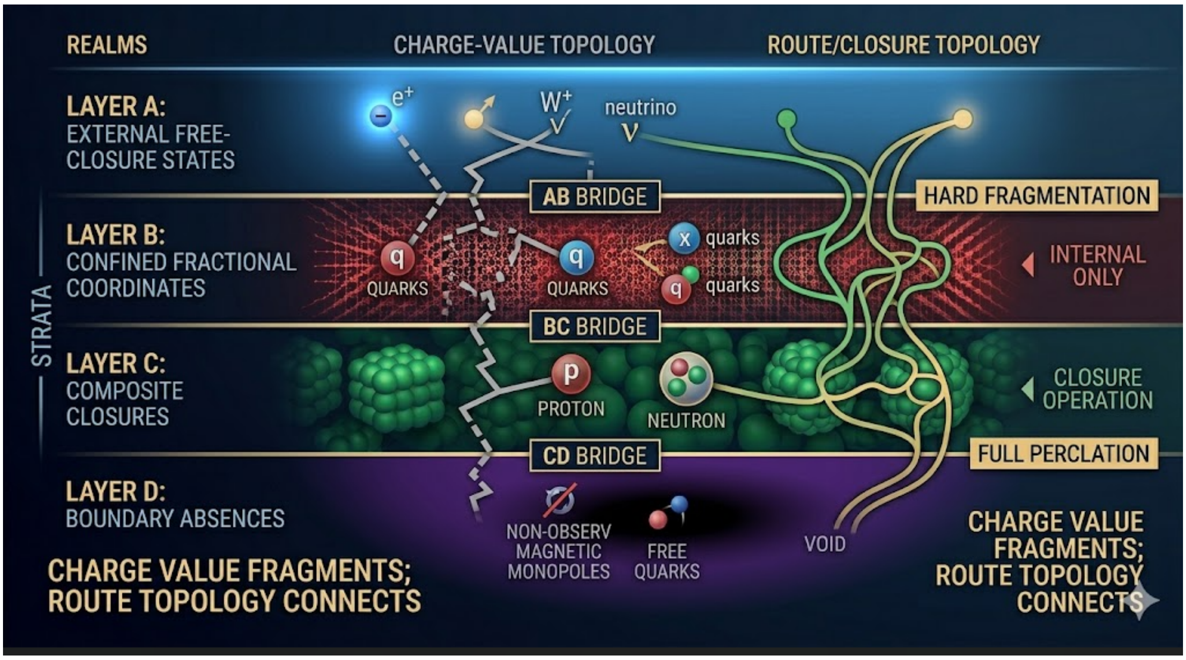

Figure 1: **Charge Value Fragments; Route Topology Connects.** Charge-value topology versus route/closure topology. Charge Boundary Routing separates charge-bearing objects into external free closure states, confined fractional coordinates, composite closures, and boundary absences. Scalar charge-value encodings fragment across key interfaces, while route and closure coordinates reveal the admissible structure connecting fractional and composite charge. Layer D marks terminal boundary conditions where externalization fails.

3 Empirical basis from Charge Boundary Routing I

The law formulated below is not introduced as an isolated philosophical statement. It is extracted from a completed six-phase corpus.

Phase	Corpus or test	Main result	Interpretation
1	40 objects across Layers A–D	Four structural regimes	Charge-bearing systems are not a homogeneous scalar class.
2	Five bridge corpora: AB, BC, CD, ABC, BCD	Charge-value topology and route/closure topology differ	Route topology can connect where charge topology fragments.
2C-P	Five $Q/e = +1$ objects, ten pairwise rows	`structural_route_pair_code` reaches Stable Structure, $A_\kappa = 1.000$	Same charge does not imply same route.
3	Seven allowed seed transitions	route and closure transition encodings reach Geometric Persistence / Weak Persistence	Allowed transitions preserve route/closure structure.
3B	38 allowed transitions across eight families	route and closure transition encodings advance to Boundary-Stabilized	The seed result survives expansion.
3C	48 mixed allowed/forbidden/constrained tests	STRUC-PERC-I connected; STRUC-I route transition collapses to Structural Boundary / Transitional Structure	Forbiddenness is route-admissibility pressure, not graph disconnection.

3.1 Extraction methodology

The law is extracted by systematic comparison of encodings across the six-phase corpus. For every transition, scalar charge difference, route/closure transition codes, boundary status, transition status, and diagnostic flags were encoded as one-column numeric ladders and submitted to two independent chamber instruments. STRUC-PERC-I tests graph connectivity and percolation behavior. STRUC-I tests perturbative admissibility and rigidity under deformation.

The robust pattern across the corpus licenses the law-level statement: allowed transitions preserve route/closure geometry, while forbidden, constrained, or route-incoherent contrasts may remain graph-connected but lose route-transition admissibility. The claim is therefore not inferred from charge arithmetic alone. It is extracted from the divergence between scalar charge balance, percolative connectivity, and perturbative route stability. All corpora, ladder encodings, chamber outputs, and analysis scripts are available in the companion data archive [3].

3.2 The same-charge control

The Phase 2C-P same-charge control is central and is visualized in Figure 2. It fixes $Q/e = +1$ across five objects:

$$e^+,\ p,\ \pi^+,\ K^+,\ W^+.$$

Every pair has charge difference zero. Therefore, any persistent chamber signal cannot be attributed to scalar charge variation. The result was:

$$\texttt{structural\_route\_pair\_code}: \quad \text{GP/Stable}, \qquad A_\kappa = 1.000.$$

The scalar charge-difference encoding, by contrast, is trivial. This establishes that equal charge is not route equivalence.

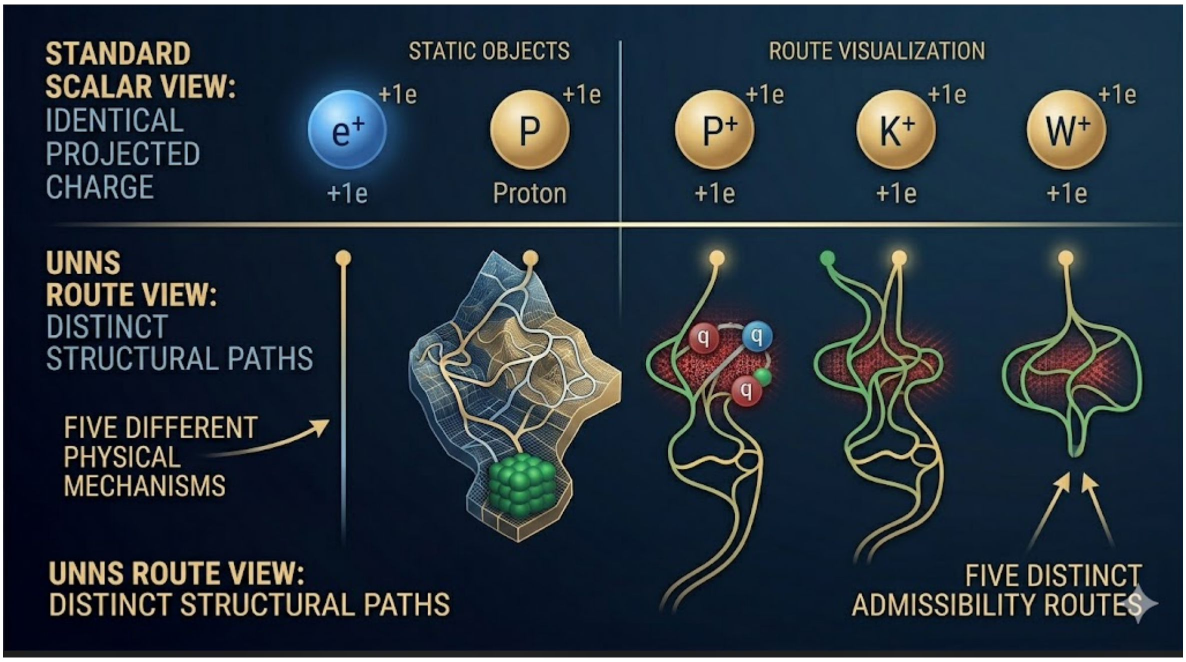

Figure 2: **Same Charge, Different Structural Route.** A positron, proton, positive pion, positive kaon, and W^+ boson all carry $Q/e = +1$. In scalar bookkeeping they project to the same charge value. In the UNNS route view, they occupy distinct structural routes: external lepton closure, composite baryon closure, composite meson closure, strange-meson closure, and external gauge-sector closure.

3.3 The allowed-transition result

Phases 3 and 3B test dynamic transitions. In Phase 3B, the expanded allowed corpus contains 38 allowed transitions across eight families. The decisive encodings are:

$$\texttt{route\_transition\_code}: \quad \text{GP/BS}, \qquad A_\kappa \approx 0.9851,$$

$$\texttt{closure\_transition\_code}: \quad \text{GP/BS}, \qquad A_\kappa \approx 0.9839.$$

Thus allowed transitions preserve route/closure transition geometry beyond scalar charge balance alone.

3.4 The forbidden-boundary result

Phase 3C supplies the negative/contrast side. The 48-row corpus includes:

- allowed controls;
- charge-violating mock transitions;
- free-fractional externalization attempts;
- selection-rule violating comparison channels;
- route-incoherent charge-conserving mocks;
- constrained or upper-bounded boundary cases.

STRUC-PERC-I shows the mixed corpus remains connected:

$$42/42 \text{ completed ladders reach Full Percolation}, \qquad 0 \text{ Hard Fragmentation}.$$

This means forbiddenness is not simple graph disconnection.

STRUC-I supplies the decisive result:

$$\texttt{route\_transition\_code}: \quad \mathrm{SB/TS}, \qquad A_\kappa \approx 0.8592,$$

while

$$\texttt{closure\_transition\_code}: \quad \mathrm{GP/BS}, \qquad A_\kappa \approx 0.9979.$$

The boundary is therefore selective: closure labels remain classifiable, but route-transition admissibility collapses.

4 Statement of the law

Definition 1 (Charge-bearing transition). *A charge-bearing transition is a map*

$$T : X_i \longrightarrow X_f$$

between lifted charge-bearing structures

$$X_i = (Q_i, \mathcal{L}_i, \mathcal{R}_i, \mathcal{C}_i, \mathcal{B}_i, \Sigma_i), \qquad X_f = (Q_f, \mathcal{L}_f, \mathcal{R}_f, \mathcal{C}_f, \mathcal{B}_f, \Sigma_f).$$

Definition 2 (Scalar charge balance). *A transition T is scalar charge-balanced when*

$$Q_i = Q_f.$$

Definition 3 (Route/closure coherence). *A transition T is route/closure coherent when the initial and final route/closure structures are connected by an admissible transition class in the route/closure representation:*

$$(\mathcal{R}_i, \mathcal{C}_i, \mathcal{L}_i, \mathcal{B}_i) \rightsquigarrow (\mathcal{R}_f, \mathcal{C}_f, \mathcal{L}_f, \mathcal{B}_f) \in \mathcal{M}_{\mathrm{adm}}.$$

Law 1 (Charge Boundary-Route Preservation Law). *For a charge-bearing transition to be structurally admissible in the UNNS route/closure representation, scalar charge balance is necessary but not sufficient. An admissible transition must preserve a coherent boundary-route transformation between the initial and final charge-bearing structures. If scalar charge balance holds but route/closure coherence fails, the transition may remain graph-connected while falling into a structural boundary or transitional admissibility regime.*

Charge Boundary-Route Preservation Law (Public Form). Charge conservation is the visible projection; boundary-route preservation is the structural invariant. Scalar charge balance is necessary but not sufficient for structural admissibility in the route/closure representation.

Theorem-style form. If a charge-bearing transition T is admissible, then $Q_i = Q_f$ and boundary-route coherence is preserved. Charge balance alone does not imply admissibility.

$$T \in \mathcal{M}_{\mathrm{adm}} \Rightarrow (Q_i = Q_f) \wedge \mathrm{RouteCoherent}(T), \qquad (Q_i = Q_f) \not\Rightarrow T \in \mathcal{M}_{\mathrm{adm}}.$$

Equivalently:

$$T \in \mathcal{M}_{\mathrm{adm}} \quad \Longrightarrow \quad \big(Q_i = Q_f\big) \ \wedge \ \big(T \text{ preserves boundary-route coherence}\big),$$

but

$$Q_i = Q_f \quad \not\Longrightarrow \quad T \in \mathcal{M}_{\mathrm{adm}}.$$

Remark 1. *The law is not a derivation of electric charge, nor a replacement for gauge theory. It is a structural admissibility statement over a route/closure representation of charge-bearing systems.*

5 Positive side: allowed transitions preserve route/closure

The positive evidence is supplied by Phases 3 and 3B. Allowed transitions, already known from standard particle physics, are encoded as route/closure transformations. The corpus result is that the route and closure transition encodings are among the strongest STRUC-I coordinates.

The key Phase 3B values are:

$$\texttt{route\_transition\_code}: \quad \text{GP/BS}, \quad A_\kappa \approx 0.9851,$$

$$\texttt{closure\_transition\_code}: \quad \text{GP/BS}, \quad A_\kappa \approx 0.9839.$$

This shows that allowed transitions do more than conserve scalar charge. They preserve an admissible transformation path through route/closure space. In the law's terminology, allowed charge transitions are boundary-route preserving.

6 Negative side: forbidden contrast and route-admissibility collapse

The negative evidence is supplied by Phase 3C, conceptually illustrated in Figure 3. The corpus deliberately includes transitions that either violate charge directly, externalize confined fractional coordinates, violate known selection structures, or conserve charge while scrambling route coherence.

The most important category is the charge-balanced route-incoherent mock class. These rows test whether

$$Q_i = Q_f$$

can hold while route admissibility fails. The answer is yes, within the tested corpus.

The mixed corpus remains connected under STRUC-PERC-I:

$$\text{Full Percolation} = 42/42, \qquad \text{Hard Fragmentation} = 0.$$

But under STRUC-I:

$$\texttt{route\_transition\_code}: \quad \text{SB/TS}, \qquad A_\kappa \approx 0.8592.$$

This is the critical distinction:

> Forbiddenness appears not as graph disconnection, but as boundary pressure in perturbative route geometry.

7 Connectivity is not admissibility

The Phase 3C result forces a distinction between two notions.

Definition 4 (Percolative connectivity). *An encoding is percolatively connected when its graph representation reaches Full Percolation under the STRUC-PERC-I connectivity criterion.*

Definition 5 (Perturbative admissibility). *An encoding is perturbatively admissible when it remains stable under the STRUC-I deformation/rigidity criterion and occupies a Geometric Persistence regime.*

Proposition 1 (Connectivity-admissibility separation). *In the Phase 3C corpus, percolative connectivity does not imply perturbative route admissibility.*

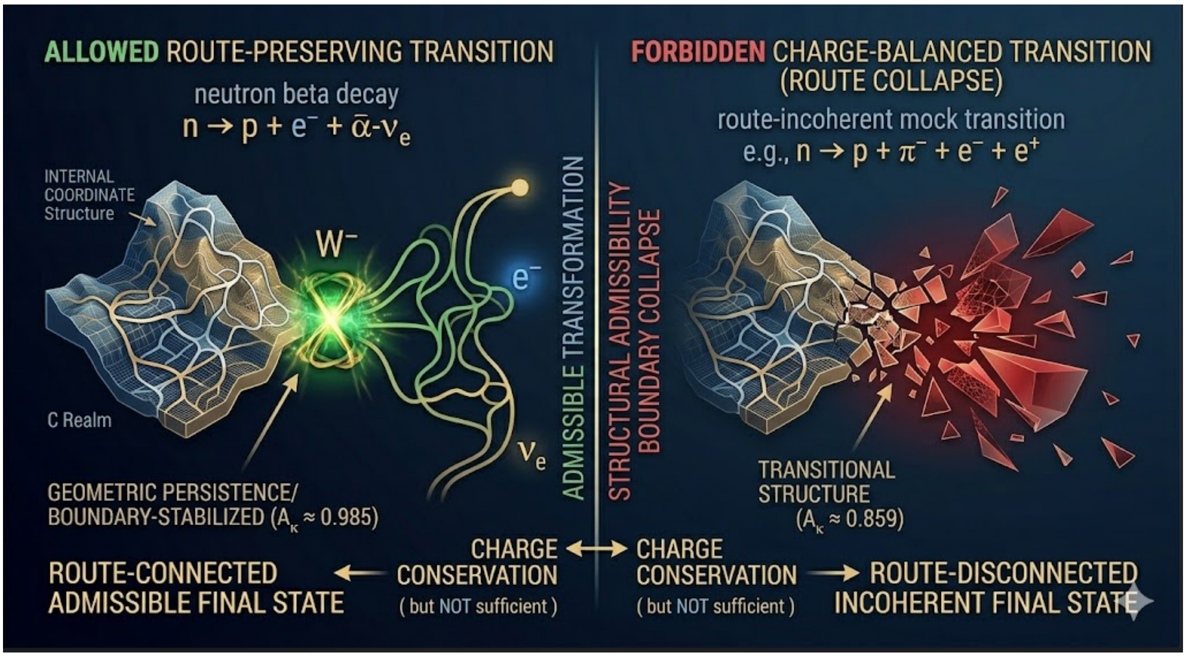

Figure 3: **Charge Conservation Is Necessary, Not Sufficient.** Allowed transition versus forbidden boundary. An allowed transition such as neutron beta decay preserves both charge balance and route admissibility. A diagnostic mock transition may preserve total charge while failing the route/closure admissibility test. Phase 3C shows this distinction quantitatively: the mixed allowed/forbidden corpus remains connected under STRUC-PERC-I, but `route_transition_code` falls to Structural Boundary / Transitional Structure under STRUC-I.

Empirical proof in the tested corpus. STRUC-PERC-I reports Full Percolation for all 42 completed Phase 3C ladders. However, STRUC-I classifies `route_transition_code` as Structural Boundary / Transitional Structure, with $A_\kappa \approx 0.8592$. Therefore the same mixed corpus can remain connected while losing route-transition admissibility. □

This distinction is essential. A graph can remain connected while its route coordinate becomes boundary-transitional. In Charge Boundary Routing, the allowed/forbidden distinction is therefore not exhausted by connectivity. As shown in Figure 4, the Phase 3C contrast produces a selective route-admissibility collapse while preserving global connectivity.

8 Free-fractional externalization as boundary pressure

A central structural interpretation concerns quarks. Quark charges are fractional:

$$+\frac{2}{3}, \quad -\frac{1}{3},$$

and their antiparticles carry corresponding opposite values. Charge Boundary Routing represents these values as confined internal coordinates, not as free external closure states.

Attempts to externalize free fractional charges belong to the boundary side of the system. In Phase 3C, free-fractional externalization encodings do not simply disconnect the graph; instead, they require elevated connection thresholds and contribute to boundary pressure. This supports the interpretation:

$$\text{fractional charge} = \text{internal route coordinate},$$

$$\text{composite charge} = \text{closure operation},$$

$$\text{free fractional externalization} = \text{boundary termination}.$$

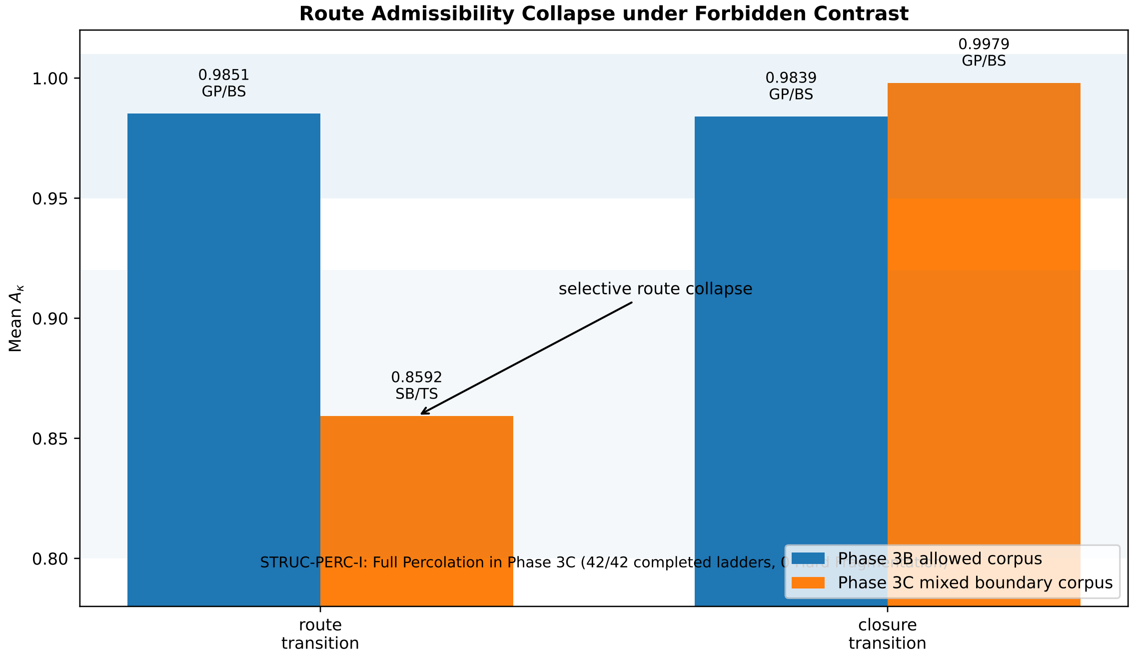

Figure 4: **Route Admissibility Collapse under Forbidden Contrast (Phase 3B vs Phase 3C).** Comparison of STRUC-I admissibility results for the decisive route/closure encodings. In the allowed Phase 3B corpus (38 transitions, 8 families), both `route_transition_code` and `closure_transition_code` occupy the Boundary-Stabilized regime with high perturbative stability ($\langle A_\kappa \rangle \approx 0.9851$ for route, ≈ 0.9839 for closure). In the mixed Phase 3C corpus (48 rows: allowed controls, charge-violating cases, free-fractional externalization attempts, selection-rule violations, route-incoherent mocks, and constrained boundary cases), `route_transition_code` falls to Structural Boundary / Transitional Structure ($\langle A_\kappa \rangle \approx 0.8592$), while `closure_transition_code` remains Boundary-Stabilized ($\langle A_\kappa \rangle \approx 0.9979$). STRUC-PERC-I simultaneously reports Full Percolation for the Phase 3C corpus (42/42 completed ladders, 0 Hard Fragmentation), demonstrating that graph connectivity is preserved while route admissibility degrades.

This statement is complementary to QCD, not a substitute for it. QCD supplies the dynamical confinement mechanism. Charge Boundary Routing supplies a structural route/closure representation of the confinement fact.

9 Relation to existing physics

9.1 Relation to the Standard Model

The Standard Model supplies particle content, charge assignments, gauge structure, and allowed processes. Charge Boundary Routing takes these as input and studies their organization under route, closure, layer, and boundary coordinates.

Thus the relationship is complementary:

$$\text{Standard Model: dynamics and quantum numbers,}$$

$$\text{Charge Boundary Routing: structural route/closure classification.}$$

9.2 Relation to $U(1)$ charge conservation

In conventional theory, $U(1)$ gauge symmetry and Noether's theorem account for scalar charge conservation. The present law does not derive $U(1)$. Instead, it adds a second structural condition:

$$\text{scalar conservation} \quad + \quad \text{route/closure preservation.}$$

The first is visible projection; the second is structural admissibility.

9.3 Relation to QCD confinement

QCD explains confinement dynamically. Charge Boundary Routing represents confinement structurally: Layer B fractional coordinates do not externalize as free Layer A states, and Layer D marks terminal boundary conditions. This is not a proof of confinement. It is a structural description compatible with the confinement fact.

9.4 Relation to the quark model

The quark model computes hadron charge by summing constituent charges. Charge Boundary Routing adds that summation is also a closure operation. A proton is not merely

$$\frac{2}{3} + \frac{2}{3} - \frac{1}{3} = +1.$$

It is a composite closure in which confined fractional routes become an externally admissible integer state.

9.5 Relation to selection rules

Conventional selection rules determine which transitions are allowed or forbidden using charge, baryon number, lepton number, flavor, energy, and interaction structure. Charge Boundary Routing does not derive those rules. It shows that the allowed/forbidden contrast has a route-admissibility signature: allowed transitions stabilize route/closure transition encodings; forbidden or constrained contrasts degrade route-transition admissibility.

9.6 Relation to topology and admissibility geometry

STRUC-PERC-I and STRUC-I show different aspects of structure. STRUC-PERC-I detects graph connectivity. STRUC-I detects perturbative admissibility. Phase 3C shows why both are needed:

$$\text{connected} \quad \not\Longrightarrow \quad \text{admissible.}$$

10 Consequences

10.1 Consequence for charge representation

Scalar charge should be treated as a projection of a route-bearing structure whenever structural comparison is required:

$$Q \quad \rightsquigarrow \quad (Q, \mathcal{L}, \mathcal{R}, \mathcal{C}, \mathcal{B}, \Sigma).$$

10.2 Consequence for transition analysis

A charge-bearing transition can be scalar-balanced while route-incoherent. Therefore transition admissibility must test not only $Q_i = Q_f$, but also route/closure preservation.

10.3 Consequence for boundary science

Absences and upper bounds can be included as boundary objects rather than discarded as non-data. Layer D is not empty; it marks where the routing system terminates.

10.4 Consequence for future predictive work

A future predictive admissibility search should rank hypothetical transitions not only by charge balance, but by route/closure distance from the allowed-transition interior.

11 Scope and non-claims

The law is deliberately scoped.

It does not claim:

1. to derive the unit of electric charge e;
2. to replace $U(1)$ gauge theory or Noether's theorem;
3. to replace QCD;
4. to prove confinement;
5. to derive the Standard Model;
6. to derive all selection rules;
7. that diagnostic mock transitions are proposed physical processes;
8. that categorical integer codes are physical magnitudes.

The claim is instead:

> Within the tested Charge Boundary Routing I corpus, scalar charge value does not determine structural route. Allowed transitions stabilize route/closure transition geometry, while a mixed forbidden/constrained contrast corpus remains connected but loses route-transition admissibility.

12 Predictions and future tests

12.1 Phase 3D: expanded forbidden/constrained corpus

The next empirical extension is to expand Phase 3C from 48 rows to 72–96 rows. The goal is to separate mock, constrained, upper-bound, rare-decay, and physically searched channels more finely.

12.2 Phase 3C-A: ablation testing

Ablation should isolate each group:

allowed-only, charge-violating-only, free-fractional-only, route-incoherent-only, selection-violation-only

This will identify which boundary group contributes most strongly to route-transition collapse.

12.3 Physics-aligned refinement

Selected diagnostic mock rows should be replaced or supplemented with tightly sourced upper-bound channels and carefully classified selection-rule examples while preserving the same schema.

12.4 Concrete route-pressure prediction

Hypothetical transitions that preserve scalar charge while scrambling route class or interaction structure are predicted to exhibit measurable route-admissibility degradation under the same encoding protocol. This includes carefully selected rare, constrained, or forbidden channels in extended-model settings, where scalar charge and coarse closure may remain balanced but the route-transition coordinate should move toward Structural Boundary / Transitional behavior.

12.5 Predictive admissibility search

Once route-pressure coordinates are localized, they can be used to score hypothetical charge-bearing transitions by distance from the tested allowed interior.

13 Conclusion

Charge Boundary Routing I produced a completed six-phase empirical chain. The present paper extracts its law-level content.

The first gain is representational: charge-bearing systems are not exhausted by scalar charge value. They organize into layers, routes, closures, and boundary states. The second gain is topological: charge-value topology and route/closure topology can differ. The third gain is dynamic: allowed transitions preserve route and closure transition geometry. The fourth gain is boundary-theoretic: forbidden or constrained contrast cases may remain graph-connected while losing route-transition admissibility.

The law-level conclusion is therefore:

$$\boxed{\text{Charge conservation is the visible projection;}\quad \text{boundary-route preservation is the structural invariant.}}$$

Equivalently:

$$\boxed{\text{Charge balance is necessary but not sufficient.}}$$

The Charge Boundary-Route Preservation Law does not compete with established physics. It clarifies what scalar conservation leaves compressed. It supplies a structural language in which electric charge is conserved as a value, but admissibility lives in the route.

Charge conservation is the visible projection.
Boundary-route preservation is the structural invariant.
Charge balance is necessary but not sufficient.

Data Availability and Reproducibility

All corpora, ladder encodings, STRUC chamber outputs, and analysis scripts associated with the empirical basis of this law are provided in the companion archive, *Charge Boundary Routing I: Data and Corpus Construction* [3]. The public synthesis article is available as *Electric Charge Has a Route* [2]. The interactive analytics and dashboard resources are available in [4, 5].

Acknowledgments

This manuscript is part of the UNNS Substrate Research Program. It depends on the completed Charge Boundary Routing I corpus, the Phase 3C forbidden-boundary contrast tests, and the paired STRUC-PERC-I / STRUC-I chamber workflow developed for structural admissibility analysis.

A Key numerical summary

Item	**Value**
Phase 1 corpus	40 charge-boundary objects
Layer A	14 external/free closure states
Layer B	12 confined fractional coordinates
Layer C	10 composite closures
Layer D	4 boundary absences/constraints
Phase 2 bridges	AB, BC, CD, ABC, BCD
Phase 2C-P control	5 objects, 10 pairs, all $Q/e = +1$
Phase 2C-P strongest encoding	`structural_route_pair_code`, GP/Stable, $A_\kappa = 1.000$
Phase 3 seed transitions	7 allowed transitions, all charge-balanced
Phase 3B expanded transitions	38 allowed transitions, 8 families, 21/21 Full Percolation
Phase 3B route transition	GP/BS, $A_\kappa = 0.9851$
Phase 3B closure transition	GP/BS, $A_\kappa = 0.9839$
Phase 3C corpus	48 boundary tests, 6 groups, 43 ladders
Phase 3C STRUC-PERC-I	42/42 completed Full Percolation, 0 Hard Fragmentation
Phase 3C STRUC-I regime count	8 GP, 35 SB
Phase 3C route transition	SB/TS, $A_\kappa = 0.8592$
Phase 3C closure transition	GP/BS, $A_\kappa = 0.9979$

Table 2: Key numerical results supporting the Charge Boundary-Route Preservation Law.

B Source basis and reproducibility artifacts

This paper is based on:

- *Charge Boundary Routing: Fractional Coordinates, Composite Closure, and Route-Preserving Transitions*;
- the Charge Boundary Routing I analytics dashboard;
- the Phase 3C forbidden/constrained transition corpus;
- the Phase 3C STRUC-PERC-I and STRUC-I chamber comparison report;
- the extensive synthesis report for Charge Boundary Routing I.

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