Paper 014

Topological Boundary Conditions for Edge-Localized Projection Electromagnetism

From hypersurface flux terms to homology-aware null observables

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Abstract

Boundary-flux projection models suggest that effective electromagnetic residuals may localize near edges, apertures, guards, seams, and dielectric interfaces. This paper proposes a topology-aware version of that idea. Instead of treating edge sensitivity as a geometry anecdote, it classifies conductor-dielectric assemblies by boundary components, oriented seams, guard surfaces, and homology classes. The result is a research program for null observables that distinguish ordinary field concentration from projection-style boundary flux.

Status. Draft manuscript for review and revision. This paper is not an empirical claim of new physics or field-ready technology. It is a structured proposal, theory note, protocol, or application architecture intended to be auditable, falsifiable, and publishable with source.

Contents

1 Problem

Existing boundary-flux notes emphasize embedded hypersurfaces and normal components but do not yet provide a systematic vocabulary for complicated laboratory hardware. Real capacitors have feedthroughs, guards, dielectric supports, shield seams, solder joints, and finite conductor thickness. The problem is to decide which boundary features are mathematically relevant to a projected source term and experimentally controllable.

2 Model

Let the laboratory device be represented by a stratified domain Omega with conductor, dielectric, vacuum, shield, and support strata. A boundary-flux residual is expressed as an integral over codimension-one and codimension-two features. Topological invariants do not determine amplitudes, but they define equivalence classes of geometries that should be compared before mechanism inference.

$$Q_{\mathrm{eff}}(\Omega) = \int_{\partial\Omega} \Pi \cdot n \, dA + \sum_{\ell \in \mathcal{E}(\Omega)} \int_{\ell} \beta_\ell(E, \epsilon, K) \, ds.$$

$$R_{\mathrm{edge}} = \frac{F(\Omega) - F(\Omega_{\mathrm{smoothed}})}{U_E}, \qquad R_{\mathrm{seam}} = \frac{F(\Omega_{\mathrm{seam\ rotated}}) - F(\Omega)}{U_E}.$$

3 Claims

1. **Claim 1.** Edge-localized projection hypotheses require a device-topology manifest, not only a CAD file.
2. **Claim 2.** Smooth, guarded, and seam-rotated variants are stronger controls than a single symmetric dummy.
3. **Claim 3.** Homology-equivalent but geometrically distinct devices can separate pure field-concentration artifacts from boundary-class residual proxies.
4. **Claim 4.** A topology-first atlas can make boundary-flux nulls portable across labs.

4 Evidence Plan

The evidence plan pairs FEM solutions with topology manifests. Each device variant is represented by a CAD mesh and a boundary-feature graph. The atlas reports ordinary Maxwell stress, leakage paths, thermal contact surfaces, and projection proxy integrals over the same graph. The first publishable result can be a negative one: no force residual, plus an exclusion bound conditioned on specified edge classes.

5 JMP0X1B Implementation Surface

The implementation should parse mesh tags into a typed boundary graph and compute invariant summaries. JMP0X1B is a natural fit because artifact digests, mesh provenance, and effect declarations can be carried through every build step.

Illustrative JMP0X1B-style contract

```
record BoundaryFeature { id: Text, kind: Edge | Seam | Guard | Aperture, orientation: Frame, ma
record TopologyManifest { mesh_digest: Digest, features: List<BoundaryFeature>, homology_rank:
fn boundary_proxy(mesh: Mesh, topo: TopologyManifest, field: EField) -> ProxyVector effects{De
```

6 Release And Review Plan

Release topology manifests, mesh snapshots, field solutions, and executable proxy calculations. The paper should include a small library of canonical topology controls: guarded plate, seam-rotated shield, edge-smoothed asymmetric capacitor, and aperture-swapped Faraday enclosure.

7 Open Questions

- Which topology features survive mesh refinement as stable predictors?
- Can seam controls distinguish shield artifacts from internal edge terms?
- How should feedthrough topology be represented without overfitting?
- What minimum feature graph is needed for a reproducible boundary-flux null?

8 Conclusion

The paper upgrades boundary flux from a qualitative edge story to a topology-indexed experimental program. Its value is practical even if the speculative residual is absent: it improves how capacitor null experiments report geometry and controls.

References

References

[1] JMP0X1B Research Group. *Boundary-Flux Electromagnetism on Embedded Four-Manifolds and Null Observables for Capacitor Residuals*. Working paper, 2026. https://research.jmp0x1b.com/papers/boundary-flux-hypersurface-nulls.html

[2] JMP0X1B Research Group. *Finite-Element Discrimination of Boundary-Flux, Scalar, and Conventional Artifact Forces in Asymmetric Capacitors*. Working paper, 2026. https://research.jmp0x1b.com/papers/fem-capacitor-force-discrimination.html

[3] A. Logg, K.-A. Mardal, and G. N. Wells, editors. *Automated Solution of Differential Equations by the Finite Element Method*. Springer, 2012.

[4] M. S. Alnæs et al. The FEniCS Project Version 1.5. *Archive of Numerical Software*, 3(100), 2015.

[5] J. C. Maxwell. A dynamical theory of the electromagnetic field. *Philosophical Transactions of the Royal Society of London*, 155:459–512, 1865.