Paper 022

Vacuum, Casimir, and Permittivity Cross-Checks for Electrostatic Projection Couplings

Independent observables for separating field-energy residuals from dielectric and surface artifacts

JMP0X1B Research Group

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Abstract

Electrostatic projection hypotheses often depend on field energy, dielectric polarization, or boundary flux. This paper proposes cross-checks using capacitance precision, dielectric spectroscopy, surface-potential mapping, and Casimir-adjacent force metrology as independent observables. The objective is conservative: any claimed residual should correlate with the correct field-energy or boundary proxy and fail to correlate with ordinary surface artifacts.

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

A force residual alone is ambiguous. If a model says the electrostatic energy density sources a scalar or boundary response, the experiment should also measure observables sensitive to the same energy density, dielectric state, and surface condition. The problem is to build cross-checks that improve interpretation without importing unrelated precision-measurement complexity.

2 Model

The paper treats force, capacitance, dielectric loss, surface potential, and separation-dependent background as a joint observation vector. Mechanism signatures are required to predict correlations across that vector. Surface artifacts are not nuisances to be ignored; they are explicit competing models.

$$y = (F, C, \tan\delta, V_{\mathrm{surf}}, T, I_{\mathrm{leak}}), \qquad \rho_{m,ij} = \mathrm{corr}(y_i, y_j \mid m).$$
$$U_E = \frac{1}{2}CV^2, \qquad \Delta F_{\mathrm{proxy}} \propto \nabla U_E \ \text{ or } \int_{\partial\Omega} \Pi \cdot n\, dA.$$

3 Claims

1. **Claim 1.** Projection-coupling experiments should include capacitance and dielectric telemetry as physics observables, not only diagnostics.
2. **Claim 2.** Surface-potential mapping can falsify many apparent boundary residuals before high-cost vacuum runs.
3. **Claim 3.** Correlated multi-observable nulls are more reusable than force-only nulls.
4. **Claim 4.** Casimir-adjacent metrology methods are useful as discipline, but should not be conflated with evidence for projection physics.

4 Evidence Plan

The evidence plan starts with precision capacitance and dielectric measurements on the same geometries used for force nulls. Surface potentials are measured before and after high-voltage exposure. Force data are then interpreted jointly with dielectric and surface models. A successful null paper reports cross-correlation bounds and excludes models that predict correlations not observed.

5 JMP0X1B Implementation Surface

JMP0X1B should define a multi-observable run frame with synchronized timestamps, unit-safe data, and instrument provenance. Analysis functions compute correlation gates and mechanism rejection summaries.

Illustrative JMP0X1B-style contract

```
record CrossCheckFrame { force: ForceSeries, capacitance: CapSeries, dielectric: LossSeries, su
fn reject_by_correlation(frame: CrossCheckFrame, model: Mechanism) -> Rejection effects{Statis
```

6 Release And Review Plan

Release synchronized example data, instrument calibration files, correlation models, and an exclusion report that distinguishes force-only and multi-observable bounds.

7 Open Questions

- Which surface-potential resolution is needed for practical capacitor nulls?
- Can dielectric spectroscopy detect hidden changes caused by high-voltage conditioning?
- How should separation-dependent backgrounds be separated from edge-boundary proxies?
- What correlation thresholds are robust to drift and hysteresis?

8 Conclusion

Cross-checks make electrostatic residual searches harder to fool. They also make nulls scientifically richer by tying force limits to independent observables.

References

References

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