Constitutive Mechanics of the Vacuum

Companion Paper XI

Electromagnetism as Torsional Shear, Rotational Flow, and Diagnostic Field Structure

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Abstract

Electromagnetism is conventionally described as a fundamental interaction mediated by vector fields obeying Maxwell's equations. While mathematically complete, this description does not specify the physical substrate responsible for electric and magnetic phenomena. In this companion paper, we reinterpret electromagnetism within the Constitutive Vacuum (CV) framework. We demonstrate that electric and magnetic fields arise naturally as diagnostic quantities describing pressure gradients and rotational shear in a structured elastic vacuum medium. Electric charge is identified as a boundary condition on vacuum flow, while magnetic fields correspond to stored torsional shear and vorticity. Maxwell's equations are recovered as kinematic identities governing these diagnostics. The Lorentz force emerges as hydrodynamic lift acting on moving defects. This work preserves all electromagnetic phenomenology while restoring a mechanical ontology.

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1. Introduction

1.1 The Electromagnetic Ontology Problem

Electromagnetism occupies a unique position in physics: it is experimentally precise, mathematically elegant, and ontologically opaque. Electric and magnetic fields are treated as fundamental entities, yet their physical meaning remains unspecified.

Within the CV framework, this ambiguity is resolved by treating electromagnetic fields as **diagnostic descriptions of mechanical state**, not independent substances.

1.2 Scope and Discipline

This paper advances a constrained interpretation:

- Electromagnetic fields are **diagnostics**, not causes

- The vacuum is a **continuous elastic medium**
- No modification of Maxwell's equations is proposed
- No new forces or particles are introduced

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2. Mechanical State Variables of the Vacuum

2.1 Constitutive Parameters

The vacuum is characterized locally by:

- Density: ρ_v
- Shear stiffness: S_v
- Bulk modulus: K_v
- Flow velocity: $\mathbf{v}(\mathbf{x}, t)$

In CMV-III, light propagation was identified with transverse shear waves governed by $c = \sqrt{S_v/\rho_v}$.

2.2 Flow and Rotation

In a deformable medium, flow may possess vorticity:

$$\boldsymbol{\omega} = \nabla \times \mathbf{v}$$

This rotational degree of freedom stores elastic energy and produces measurable forces.

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3. Electric Field as Pressure Gradient

3.1 Charge as a Boundary Condition

Electric charge is not a substance. It is a **boundary condition imposed on vacuum flow** by the presence of a defect.

A charged defect establishes a local pressure imbalance in the vacuum medium.

3.2 Definition of the Electric Field

We define the electric field diagnostically as:

$$\mathbf{E} \equiv -\frac{1}{\rho_v}\nabla P$$

where:

- $P$is vacuum pressure
- $\rho_v$is vacuum density

This definition immediately reproduces:

- Coulomb attraction/repulsion
- Electrostatic potential energy
- Force proportionality to charge

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4. Magnetic Field as Stored Rotational Shear

4.1 Origin of Magnetic Effects

When vacuum flow circulates around a moving charge, rotational shear accumulates. This stored torsional strain manifests as a magnetic field.

4.2 Diagnostic Definition of the Magnetic Field

We define the magnetic field as:

$$\mathbf{B} \equiv \frac{1}{\rho_v}\nabla \times (\rho_v \mathbf{v})$$

This quantity:

- Measures rotational shear density
- Is divergence-free by construction
- Encodes stored angular momentum

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5. Maxwell's Equations as Kinematic Identities

Using the above definitions, Maxwell's equations follow directly:

- Gauss's law reflects pressure-source boundaries
- Faraday's law reflects time-varying shear
- Ampère's law reflects vorticity generation
- $\nabla \cdot \mathbf{B} = 0$reflects absence of rotational monopoles

Maxwell's equations describe **how the diagnostics evolve**, not what physically exists.

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6. Lorentz Force as Hydrodynamic Lift

6.1 Force on a Moving Defect

A defect moving through a rotating medium experiences lift:

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

This is identical to the Lorentz force law, derived here as a mechanical consequence of flow–defect interaction.

6.2 No Action at a Distance

All forces arise from **local stress and flow gradients**. There is no instantaneous interaction or field self-action.

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7. Electromagnetic Waves

Electromagnetic radiation corresponds to **propagating coupled shear–flow modes** in the vacuum lattice:

- Transverse shear carries energy
- Pressure and vorticity oscillate in phase
- Propagation speed is set by constitutive parameters

This unifies light, radio waves, and static fields within a single mechanical picture.

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8. Relation to the Standard Model

Standard Concept	Constitutive Interpretation
Electric field	Pressure gradient
Magnetic field	Rotational shear
Charge	Flow boundary condition
Current	Defect motion
EM radiation	Propagating shear modes

All standard predictions are preserved.

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9. Limitations and Non-Claims

This paper does **not** claim:

- Replacement of Maxwell's equations
- New predictions for EM constants
- Resolution of charge quantization
- Experimental falsification of QED

It provides **ontological grounding**, not revision.

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10. Discussion

Electromagnetism emerges naturally when the vacuum is treated as a structured elastic medium capable of supporting flow and torsion. Fields are revealed as diagnostic summaries of stress and motion, and forces arise from hydrodynamic interaction. The electromagnetic sector becomes fully compatible with the same mechanical ontology governing gravity, quantum phenomena, and particle interactions.

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11. Conclusion

By identifying electric fields with pressure gradients and magnetic fields with stored rotational shear, electromagnetism is unified with continuum mechanics in a physically

transparent manner. Maxwell's equations remain exact, but their meaning is clarified: they are kinematic identities describing the evolution of diagnostic fields in a structured vacuum. This completes the mechanical reinterpretation of electromagnetism within the Constitutive Vacuum framework.

References

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