The PNP Description of Energy Flow

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August 8, 2025

Abstract

We formalize a scalar-field-based ontology of energy flow in the Point–Not–Point (PNP) framework. All structure is modeled as oscillatory modes of a single real scalar field $U(x,t)$, with topological closure conditions defining observable form. We derive, from $F = d(\star dU)$, the mode equations, closure constraints, and quantized winding numbers (m,n). Mode (1), the minimal self-inverting oscillation, is shown to sustain a continuous energy flow with Möbius-like phase inversion, without requiring vector potentials or a pre-existing space. Higher modes yield quantized circulation, topological charge, and helicity, reproducing key features of electromagnetic and quantum structures from first principles. This work also provides a symbolic and conceptual description of the PNP framework, complementing our previously published PNP theory of gravitation.

1 Introduction

The PNP framework encodes electromagnetism and matter structure in a single scalar energy field U. No gauge potentials or primitive background geometry are assumed. Physical quantities emerge from the topology of closed oscillations in U. In this view, "particles," "waves," and "fields" are relational expressions of U's internal phase structure.

We develop here the mathematical description of PNP energy flow: 1. Scalar field formulation and its equivalence to source-free Maxwell electrodynamics. 2. Mode closure conditions for self-sustaining configurations. 3. Quantization of circulation and helicity from topology. 4. Ontological consequences: orientation, inside/outside, and even "space" are emergent.

2 Scalar field dynamics

Let $U : \mathbb{R}^3 \times \mathbb{R} \to \mathbb{R}$ be a smooth scalar field. We define the field strength 2-form:

$$F = d(\star dU)$$

The source-free conditions are:

$$dF = 0, \quad d\star F = 0$$

Identifying:

$$\mathbf{B} = \star dU, \qquad \mathbf{E} = \star d\star dU$$

yields the standard Maxwell equations in vacuum. Thus, all electromagnetic dynamics are encoded in U without a vector potential.

Energy density and Poynting vector follow from the stress–energy tensor:

$$u = \frac{\varepsilon_0}{2}(E^2 + c^2 B^2), \quad \mathbf{S} = \frac{1}{\mu_0}\mathbf{E} \times \mathbf{B}$$

These quantities are completely determined by U.

3 Mode structure and closure

We define a **mode** (m, n) as a topologically closed oscillation of U characterized by two winding numbers: - m: loops around the major cycle of a toroidal embedding - n: loops around the minor cycle

For a minimal spherical configuration (mode 1), use radial coordinate r:

$$U(r, t) = A \sin(kr - \omega t)$$

Boundary conditions for closure:

$$U(0, t) = 0 = U(R, t)$$

The standing-wave condition is:

$$kR = \pi$$

The field completes half a wavelength across radius R, inverting phase at the center.

4 Orientation reversal and Möbius-like phase inversion

At $r = 0$, U and its gradient vanish:

$$\nabla U = 0, \quad |U| = 0$$

Define normalized orientation:

$$\hat{n}(r) = \frac{\nabla U}{|\nabla U|}$$

Approaching the node:

$$\lim_{r \to 0^-} \hat{n} = -\lim_{r \to 0^+} \hat{n}$$

This is continuous in phase space though discontinuous in naive vector representation — a Möbius-like inversion in field orientation, not in physical space. The energy flow inverts through a node, allowing a closed loop without a geometric twist.

5 Higher modes and topological invariants

For a toroidal configuration:

$$U(\theta, \phi, t) = A \sin(m\theta + n\phi - \omega t)$$

Here $(m, n) \in \mathbb{Z}^2$ are winding numbers.

Topological charge:

$$Q = (m, n)$$

Helicity (linking of field lines):

$$H \propto \int \mathbf{A} \cdot \mathbf{B} \, d^3x \;\; \propto \;\; mn$$

Higher modes correspond to more complex knotted and linked field structures. Quantization of (m, n) yields discrete circulation and helicity.

6 Ontological implications

Mode (1) shows that "flow" is definable purely from U's oscillation pattern. There is no requirement for a background space: the apparent "in" and "out" directions are projections of phase behavior. Inside/outside, orientation, and geometric separation are emergent from the topology of U's closed modes.

This supports a relational ontology: - Space is the set of relations defined by U's configuration. - Orientation is a local property of phase transitions. - Complex structure = nested, stable oscillations in U.

7 Conclusion

We have given a rigorous scalar-field derivation of electromagnetic-like dynamics from $F = d(\star dU)$ and classified the closed modes of U by winding numbers (m, n). Mode (1) provides the minimal self-inverting energy loop, while higher modes generate quantized topological invariants. Orientation and space emerge as relational features of U's phase structure. This paper establishes the formal basis of the PNP ontology and complements our previously published PNP theory of gravitation.

References

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