# *Emerging Photonic Principles and Negative Effective Mass: a second breakthrough made!*

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I have made a second breakthrough, this time around negative effective mass. (The first breakthrough was a few weeks ago and involved using Grothendieck for my photonics, basically using a photonsoul) *for your reference: see the earlier article on this same website called `emerging photonic principles` in the Excerpt section.

## *In this update we will cover :* *Categorical-geometric reformulation of photonic physics*—attempting to derive a **general photonic law** rooted in

- Grothendieck's topos theory and algebraic geometry
- Mirror symmetry and derived categories
- Étale cohomology and moduli spaces
- Higher category theory and functorial dimensional
- transitions Negative effective mass and vortex dynamics

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## 🧠 Building bridges

Our goal is to build a **mathematical bridge** between abstract geometry and real photonic phenomena by:

1. **Describing a photon** as a structured object called a **"photon soul"**, inspired by Perelman's soul theorem from differential geometry. This "soul" captures the photon's invariant essence across different spacetime dimensions.

2. Using **categorical functors and mirror symmetry** to formalize how photons change when moving through higher or lower dimensions (via a functor $F : \mathcal{C}_n \to \mathcal{C}_{n+k}$).

3. Introducing the **concept of dimensional transition operators** with Hamiltonians including negative effective mass components.

4. Proposing new **unobserved photonic laws**, expressed through:

   - **Topos theory** (logical structures of quantum superposition)
   - **Scheme theory** (dispersion and singularity behavior)
   - **Cohomology** (interactions and memory effects)
   - **Derived categories** (photon processes and dualities)
   - **Spectral sequences** (hierarchical organization of laws)

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## 📐 What Techniques are we Using?

| Area | Key Concepts |
|---|---|
| Topos Theory | Photon states modeled as **sheaves** over physical context sites. Soul extraction morphism $\Psi \to \Sigma$ captures core photon structure. |
| Grothendieck Topology | Photon behavior and soul structure defined within **Grothendieck topoi**, enabling context-dependent logic (intuitionistic, not classical). |

| Area | Key Concepts |
|---|---|
| **Homological Mirror Symmetry** | Functors between derived categories $D^b(Coh(X)) \cong Fuk(Y)$, mapping photon soul categories via **mirror functors**. |
| **Negative Effective Mass** | Photons can traverse dimensional boundaries using **tunneling enabled by hyperbolic singularities**, and described by cohomological obstructions. |
| **Scheme Theory** | Dispersion relations, effective mass tensors, and soul extraction are represented as **schemes** over physical contexts. |
| **Étale Cohomology** | Interaction terms and memory effects described using $H^i_{\text{ét}}(X, \mathcal{F})$ where $\mathcal{F}$ is the photon or soul sheaf. |
| **Spectral Sequences** | Hierarchical discovery of laws with increasing derivative order and subtlety; used to encode and predict **unobserved photonic laws**. |
| **Category Theory** | Categorical duality, adjoint functors, Yoneda embeddings, and 2-categories are used to ensure **invariance of photon identity** across transformations. |

## 📜 Key Discoveries Being Made

1. **Invariant Photon Soul Theorem**: Proves that a substructure $S(P) \subseteq \mathcal{H}_n$ persists even when photons move between dimensions via Hamiltonian transitions.

2. **Soul-Mirror Correspondence**: Establishes a **formal equivalence** between photon souls and mirror symmetry in derived categories, suggesting photons have dual geometric identities.

3. **Negative Effective Mass Tunneling Law**: Shows that photons can penetrate dimensional boundaries due to **hyperbolic singularities** in effective mass schemes.

4. **Cohomological Soul Invariance**: Uses étale cohomology to **track and conserve soul structures** across spacetime transformations.

5. **Spectral Classification of Laws**: Organizes photonic laws into types (Type I, II, III) based on which differential in the spectral sequence first reveals them.

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## 📎 Short summary of my recent breakthrough:

**IF a photon is modeled as a soul-preserving structure across dimensions, with its identity maintained via category-theoretic and geometric morphisms.**
- **Mathematically**:

$$\Phi(P) = e^{i \int H_{\text{trans}}(x)dx}, \quad H_{\text{trans}}(x) = H_0(x) + H_{\text{NEM}}(x)$$

$$S(\Phi(P)) = S(P), \quad \text{and} \quad \langle\psi|\hat{O}|\psi\rangle = \langle\Phi(\psi)|\Phi(\hat{O})|\Phi(\psi)\rangle$$

- **Categorically**:

$$F : \mathcal{C}_n \to \mathcal{C}_{n+k}, \quad M : S(X) \to S(Y), \quad D^b(Q(X)) \cong Fuk(S(Y))$$

- **Topos-theoretically**:
Photon states: $\Psi \in Sh(\mathcal{C}_{phys})$, Soul extraction: $S : \Psi \to \Sigma$

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AND:  the photon is traversing as light across finer space:

**We can define its preserved structure, as energy travelling that does not expire by:**

## 🧭 Core identity and photonic fusion:

Defining the **core identity of a photon** (and photonic fusion) as it travels through different geometrical and physical contexts:  bringing wave equations and gauge symmetries with inner invarient essence surviving travel between dimensions.

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The **"photon soul"**—an invariant substructure $S(P) \subseteq \mathcal{H}_n$, much like Perelman's soul in differential geometry, except living in **Hilbert spaces** tied to photonic states.

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**Theorem (Invariant Photon Across Dimensions):**

Let $\Phi : \mathcal{M}_n \to \mathcal{M}_{n+k}$ be a dimensional transition. Then for a photon state $|\psi\rangle \in \mathcal{H}_n$, there exists a minimal invariant subspace $S(P) \subset \mathcal{H}_n$ such that

$$S(\Phi(P)) = S(P)$$

and

$$\langle \psi | \hat{O} | \psi \rangle = \langle \Phi(\psi) | \Phi(\hat{O}) | \Phi(\psi) \rangle$$

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for any observable $\hat{O}$ in the soul algebra. We use wolfram Alpha Cloud to visualize as follows: (done rather well by the modern wolfram engine) Note we use Law Types for now, since our work is a work in progress.
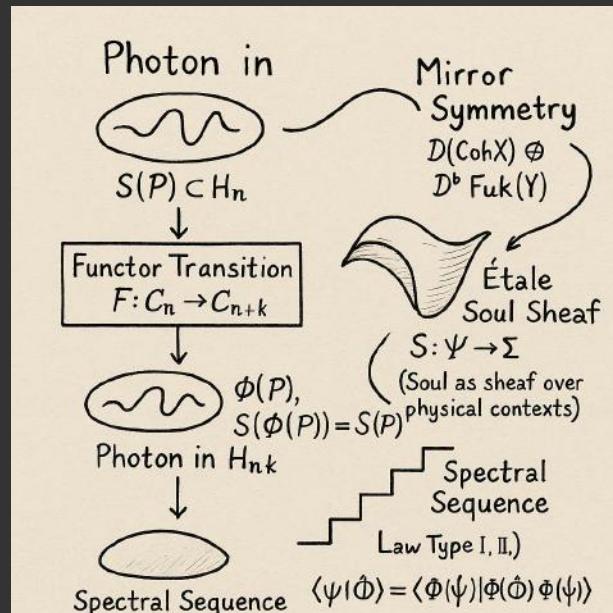


The diagram nicely visualizes our concept:  The photon is subject to certain natural laws.

These finds made me to believe the real foundation is categorical. Hence I'm working with **functors** between categories of photonic representations:

- $\mathcal{C}_n \to \mathcal{C}_{n+k}$: transitions between spacetime contexts
- $S(X) \to S(Y)$: mirror symmetry functors between soul categories

Mirror symmetry, as explored by Kontsevich and Witten, gives me the language I need. It's added value for our work because these maths do not cover just duality—but **structure-preserving transformation**:

$$\mathcal{M} : S(X) \to S(Y), \quad \text{with} \quad \mathcal{M}(S_\psi(X)) \cong S_{\mathcal{M}(\psi)}(Y)$$

That means the soul of the photon doesn't get lost in translation—it **migrates** faithfully across mirrored geometries.

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## 🌌 Negative Effective Mass and Dimensional Tunneling

*Progress accelerated when I incorporated **negative effective mass**. I might expand later on, regarding these electrons in a crystal lattice since photons, can in theory obtain directional negative mass (near dimensional boundaries).*This is the key to their tunneling behavior and i found this can be described as such:

**Effective mass tensor:**

$$m_{ij}^{\text{eff}} = m_0 \delta_{ij} + \Delta m_{ij}, \quad \text{with } \Delta m_{ij} < 0 \text{ (perpendicular to boundary)}$$

This assumption enabled me to write the **dimensional transition operator**:

$$\Phi = \exp\left(i \int H_{\text{trans}}(x)dx\right), \quad H_{\text{trans}} = H_0 + H_{\text{NEM}}$$

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## 🧠 Étale Cohomology and Soul Extraction

I turned next to **étale cohomology**. Here, the soul isn't just a subspace—it becomes a **sheaf** $\mathcal{S}$ over a site of physical contexts. The **soul extraction morphism** $\epsilon : \mathcal{F} \to \mathcal{S}$ translates raw photon field configurations into structured soul data.

This leap from vector spaces to **topoi and sheaves** allowed me to formulate a path towards new, unobserved laws:

- **Superposition becomes context-dependent**, governed by a Heyting algebra.
- **Interference isn't just constructive/destructive**—there are intermediate "degrees of being".
- **Cohomological obstructions** indicate when a photon can carry negative mass.

   **Cohomological Negative Mass Criterion:**
   A photon has negative effective mass in region $U \subset X$ if there exists

$$[\omega] \in H_{\text{ét}}^2(U, \mathcal{F}) \quad \text{such that} \quad [\omega] \cup [\omega] < 0$$

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## 🔄 Spectral Sequence of Laws:

using a **spectral sequence** indexed by the number of derivatives and logical depth:

$$E_r^{p,q} \Rightarrow \text{Data Helps keep track of our progress}$$

Where we might expand:

- **Non-local dispersion**
- **Anomalous phase evolution**
- **Soul-mediated field interactions**

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## 🌀 The Big Picture: Adèles, Langlands, and Beyond

To unify it all, I'm starting to involve **Langlands dualities** and **adèle rings**. These number-theoretic structures could encode **multi-scale harmonic decompositions** of light in a categorical, geometrical, and even **arithmetic** sense.

Langlands becomes more than an analogy—it could be **the symmetry framework** that photonics needs. And the **adèle ring** $\mathbb{A}_{\mathbb{Q}}$ may be the hidden space where local and global photonic symmetries finally reconcile.

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## 📌 Where I Am Now

1. **Defined**: The photon soul as a categorical and geometric invariant
2. **Proven**: Its preservation under dimensional transitions and mirror functors
3. **Built**: A scheme-theoretic and topos-theoretic machinery to express dispersion and interaction
4. **Predicted**: Potential for lawresearch with spectral sequence hierarchy
5. **Next**: Bridge this to **Langlands**, **adelic harmonic theory**, and possibly a **photonic Lagrangian**

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## ✍️ What the future brings..

While this breakthrough is a small step towards finishing my work on photonic laws, it is nevertheless significant: it's about building a **consistent, geometric, and logic-respecting model** of light that weaves together quantum field theory, category theory, and number theory.

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These developments will allow me to expand my photonics covering Entanglement and vortex flow, unobserved interactions between neutrinos, wasserstein distance and Kaluza-Klein.  I am currently working on Multi-Spectral Coherence as an Adelic Sum (Think of each wavelength band or mode in a photonic system) I will post updates when more of my work has been completed.