# Emerging Photonic Principles and Negative EffectiveMass: a second breakthrough made!P De Ceuster May 2025

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.

<u>In this update we will cover</u>: 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

# 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  $F : C_n \to C_{n+k}$ ).
- 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)

### What Techniques are we Using?

Area	Key Concepts
Topos Theory	Photon states modeled as <b>sheaves</b> over physical context sites. Soul extraction morphism $\Psi  o \Sigma$ captures core photon structure.
Grothendieck Topology	Photon behavior and soul structure defined within <b>Grothendieck topoi</b> , 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 <b>mirror functors</b> .
Negative Effective Mass	Photons can traverse dimensional boundaries using <b>tunneling enabled by hyperbolic singularities</b> , and described by cohomological obstructions.
Scheme Theory	Dispersion relations, effective mass tensors, and soul extraction are represented as <b>schemes</b> over physical contexts.
Étale Cohomology	Interaction terms and memory effects described using $H^i_{\mathrm{\acute{e}t}}(X,\mathcal{F})$ 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 <b>unobserved photonic laws</b> .
Category Theory	Categorical duality, adjoint functors, Yoneda embeddings, and 2-categories are used to ensure <b>invariance of photon identity</b> 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.

### 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:

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

 $S(\Phi(P))=S(P), \hspace{1em} ext{and} \hspace{1em} \langle \psi | \hat{O} | \psi 
angle = \langle \Phi(\psi) | \Phi(\hat{O}) | \Phi(\psi) 
angle$ 

• Categorically:

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

Topos-theoretically:

Photon states:  $\Psi\in Sh(\mathcal{C}_{phys})$ , Soul extraction:  $S:\Psi
ightarrow\Sigma$ 

### 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.

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.

#### 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

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

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:

- $\mathcal{C}_n o \mathcal{C}_{n+k}$ : transitions between spacetime contexts
- S(X) 
  ightarrow 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**:

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

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

### 🜌 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:

 $m_{ij}^{ ext{eff}} = m_0 \delta_{ij} + \Delta m_{ij}, \hspace{1em} ext{with} \hspace{1em} \Delta m_{ij} < 0 ext{ (perpendicular to boundary)}$ 

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

$$\Phi = \exp\left(i\int H_{ ext{trans}}(x)dx
ight), \hspace{1em} H_{ ext{trans}} = H_0 + H_{ ext{NEM}}$$

# 🍩 Étale Cohomology and Soul Extraction

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

 $[\omega]\in H^2_{\mathrm{\acute{e}t}}(U,\mathcal{F}) \quad ext{such that} \quad [\omega]\cup [\omega]<0$ 

# 🔄 Spectral Sequence of Laws:

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

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

Where we might expand:

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

# 🕥 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.

### 📍 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

# <u> What the future brings..</u>

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.

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.