Causality, Rotor Closure, Relativistic Mass Increase, and the Origin of the de Broglie Wavelength

Within the Differential Expansion Framework (DEF)

John Sikora
Independent Researcher

February 23, 2026

Abstract

The Differential Expansion Framework (DEF) models matter as stable circulations of a universal causal expansion field. This paper presents a unified explanation linking electron stabilisation, radiative shrinkage, relativistic time dilation, mass increase, and the de Broglie wavelength through a single causal throughput constraint. Rather than treating relativistic and quantum effects as separate postulates, DEF shows that they emerge naturally from redistribution of phase transport within a causally saturated rotor.

1 Introduction

Modern physics treats relativity and quantum mechanics as fundamentally separate frameworks. Relativity explains time dilation and mass increase, while quantum theory introduces wave–particle duality via the de Broglie relation.

Within the Differential Expansion Framework (DEF), both behaviours arise from a single geometric principle:

Local phase transport cannot exceed the causal speed c.

Particles are described as closed circulations of the expansion field. The electron represents the minimal stable rotor satisfying causal closure.

2 The Causal Rotor Model

2.1 Electron as a closed circulation

In DEF, the electron consists of two coupled phase motions:

- Toroidal circulation (around the major ring),
- Poloidal circulation (around the tube cross-section).

Causal saturation requires the combined phase velocity to satisfy

$$v_r^2 + v_\theta^2 = c^2. \tag{1}$$

This relation represents the causal budget of the rotor.

Figure 1 — Electron rotor geometry (diagram description)

- Draw a torus.
- Show arrows around the major axis (toroidal motion).
- Show arrows around the minor axis (poloidal motion).
- Label both components and annotate:

$$\text{Total phase speed} = c.$$

The figure demonstrates that mass corresponds to circulating phase rather than static substance.

3 Radiative Shrinkage and Stable Electron Size

A newly formed rotor may initially exceed causal limits if its geometric scale is too large:

$$v_r^2 + v_\theta^2 > c^2. \tag{2}$$

Such a configuration is causally inconsistent. DEF predicts that excess phase energy must be shed as electromagnetic radiation, causing the rotor to contract.

The contraction continues until causal saturation is achieved:

$$v_r^2 + v_\theta^2 = c^2. \tag{3}$$

The resulting structure is the minimal non-radiating electron.

Figure 2 — Radiative stabilisation sequence

- Panel 1: large unstable rotor emitting waves.
- Panel 2: shrinking rotor.
- Panel 3: stable saturated rotor.
- Labels: "causal overflow", "radiative loss", "stable closure".

4 Motion and Time Dilation

When the rotor moves through space at velocity v, the same causal limit applies. External motion must share the causal budget:

$$v_{\text{internal}}^2 + v^2 = c^2. \tag{4}$$

Thus internal circulation slows as translational velocity increases.

Because internal phase circulation defines the local clock rate, reduced internal circulation implies slower phase evolution. This is observed as relativistic time dilation.

The standard Lorentz factor follows immediately:

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}. \tag{5}$$

Figure 3 — Causal budget triangle

- Right triangle.
- Hypotenuse = c.
- Vertical side = internal phase velocity.
- Horizontal side = external velocity v.

This figure visually reproduces Lorentz geometry.

5 Relativistic Mass Increase

The total phase required for 4π closure is fixed by topology. If internal circulation slows, phase becomes more densely packed along the rotor.

In DEF:

Mass corresponds to internal phase density.

Hence motion increases inertia because denser phase circulation resists acceleration more strongly.

The observed relation becomes

$$m = \gamma m_0. \tag{6}$$

Mass increase and time dilation therefore arise from the same causal redistribution.

Figure 4 — Phase compression

- Left: widely spaced phase loops (particle at rest).
- Right: compressed phase loops (moving particle).
- Annotation: "same total phase, slower turnover".

6 Origin of the de Broglie Wavelength

The moving rotor contains two simultaneous motions:

1. Internal phase rotation,
2. External translation.

Because the rotor advances during each internal cycle, successive phase alignments occur at shifted spatial locations. This creates a spatial beat pattern.

The resulting wavelength is

$$\lambda = \frac{h}{p} = \frac{h}{mv}. \tag{7}$$

In DEF, this wavelength is not a separate wave entity but the envelope formed by phase alignment points of a moving causal rotor.

Figure 5 — Moving rotor generating de Broglie envelope

- Draw a translating spinning circle.
- Mark identical phase points each cycle.
- Connect markers to form a sinusoidal envelope.
- Label envelope as the de Broglie wavelength.

7 Unified Interpretation

Within DEF, several phenomena arise from a single mechanism:

Effect	DEF interpretation
Radiation during formation	Causal overflow
Stable electron size	Saturated closure
Time dilation	Reduced internal phase rate
Mass increase	Increased phase density
de Broglie wavelength	Phase slip envelope

8 Conclusion

The Differential Expansion Framework provides a unified geometric interpretation of relativistic and quantum behaviour. Electron stabilisation, time dilation, relativistic mass increase, and matter-wave behaviour emerge from a single causal constraint governing phase transport.

The de Broglie wavelength appears naturally as the spatial beat produced by a moving causally saturated rotor, eliminating the need for separate wave–particle duality assumptions.