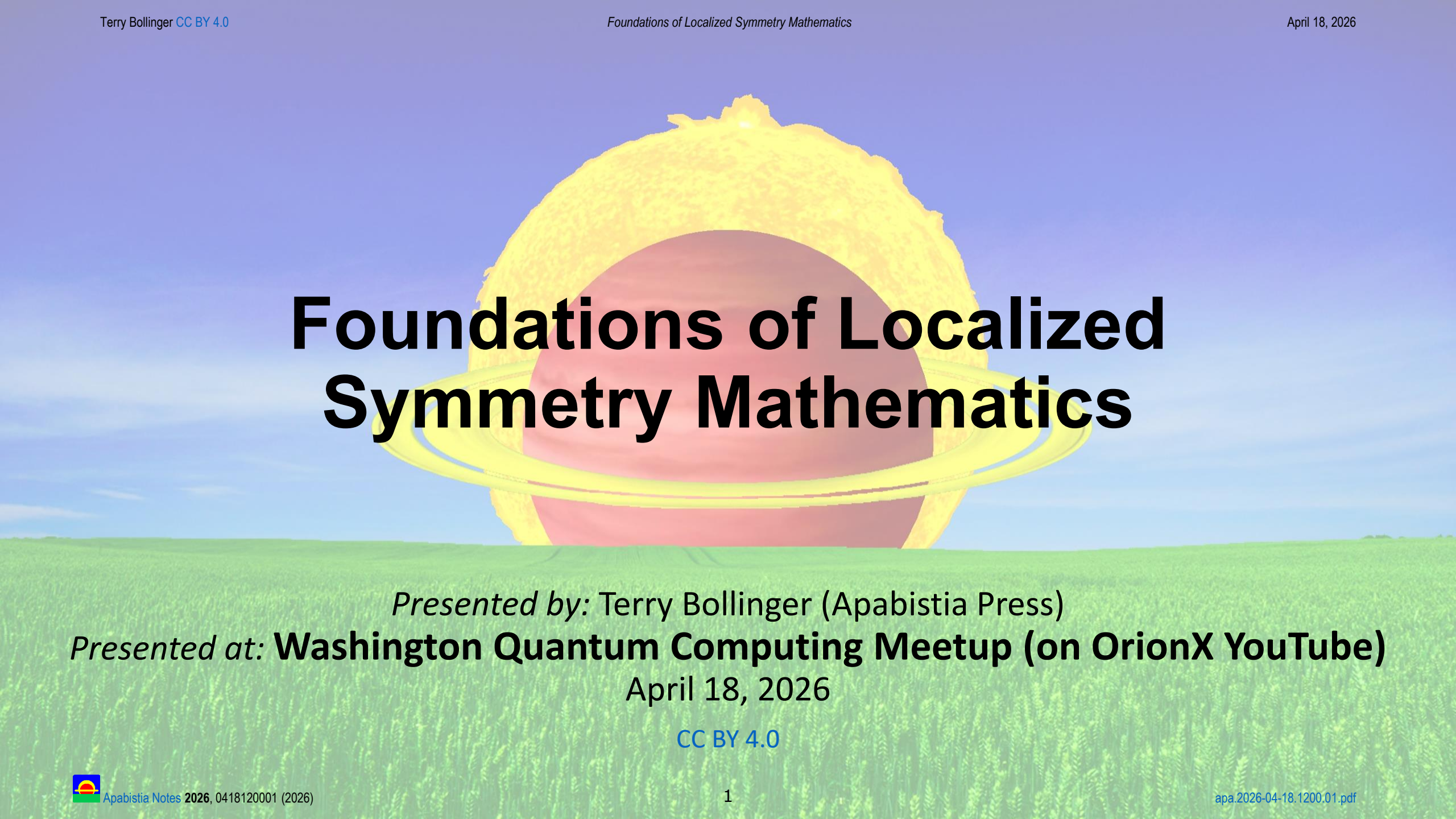

Foundations of Localized Symmetry Mathematics

Presented by: Terry Bollinger (Apabistia Press)

Presented at: **Washington Quantum Computing Meetup (on OrionX YouTube)**

April 18, 2026

Overview

I. Looking at Maxwell's Equations as Localized Symmetries

II. The Time Paradox in Ordinary Light

III. First, A Preview of the Conclusion

IV. A Quick Introduction to Electrodynamics

V. The Full Maxwell Equations

VI. A Shortcut to Understanding Light Waves

VII. The Wheeler-Feynman Advanced Photon Conundrum

VIII. Summary: Where to Next?

Part I.
Looking at Maxwell's Equations as Localized Symmetries

A Tale of Two Math-and-Physics Foundations

➢ Continuous Manifold (CM) Mathematics

- ➢ Points, lines, shapes, and numbers are real and fundamental
- ➢ Size, cost, and time are irrelevant in math and secondary in physics
- ➢ Smoothness is foundational to understanding reality

➢ Pair Creation (PC) Mathematics

- ➢ The deepest operation in reality is virtual pair creation (“holes and heaps”)
- ➢ Physics, time, and math emerge via multi-level PC conflicts (no zero return)
- ➢ Smoothness emerges mostly from local exhaustion of PC resources
- ➢ Smoothness is always an approximation (quantization is fundamental)

Part II.
The Time Paradox in Ordinary Light

Wheeler, Feynman, and the Problem of Time

- Before developing his Nobel-Prize-Winning Quantum Electrodynamics (QED) method, Richard Feynman worked on a series of papers with his adviser, John Wheeler, in which they took decades-old time paradoxes in Maxwell's Equations seriously
- The result was a remarkable series of papers that questioned the nature of causality and inspired Feynman to develop his QED methodology. Here are two notable examples:
  - J. A. Wheeler and R. Feynman, *Interaction with the Absorber as the Mechanism of Radiation*. Reviews of Modern Physics, vol. **17** (2-3), 157 (1945) https://authors.library.caltech.edu/11095/1/WHErmp45.pdf
  - J. A. Wheeler and R. Feynman, *Classical Electrodynamics in Terms of Direct Interparticle Action*, Reviews of Modern Physics **21** (3), 425 (1949). https://journals.aps.org/rmp/abstract/10.1103/RevModPhys.21.425

Part III.
First, A Preview of the Conclusion

The Wheeler-Feynman Advanced Effects Paradox

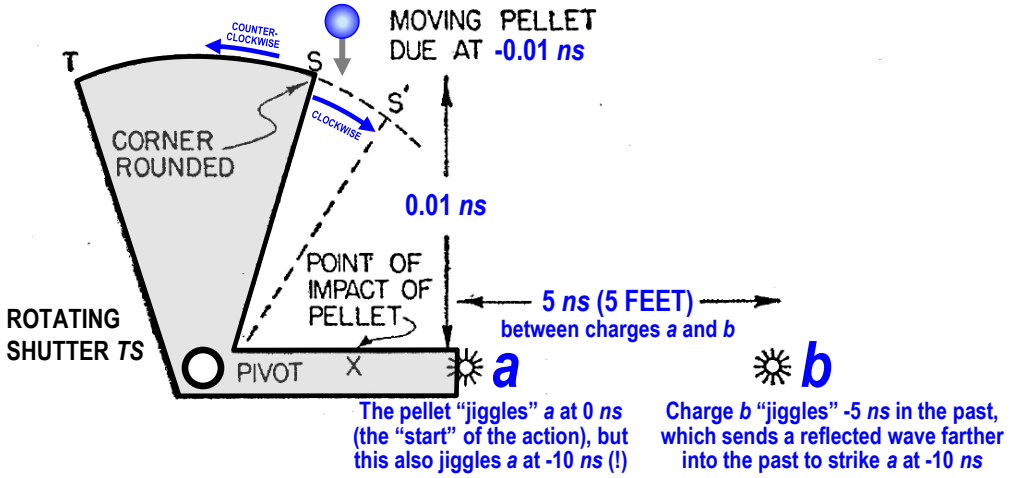

Fig. 1. The paradox of advanced effects. Does the pellet strike X at **0 *ns*** ? If so, the advanced field from ***a*** sets ***b*** in motion at **-5 *ns*** , and ***b*** moves ***a*** at **-10 *ns***. Thereby the shutter TS is set in motion and the path of the pellet is blocked, so it cannot strike X at **0 *ns***. If it does not strike X at **0 *ns*** , then its path is not blocked at **-0.01 *ns*** via this chain of actions, and therefore the pellet ought to strike X.

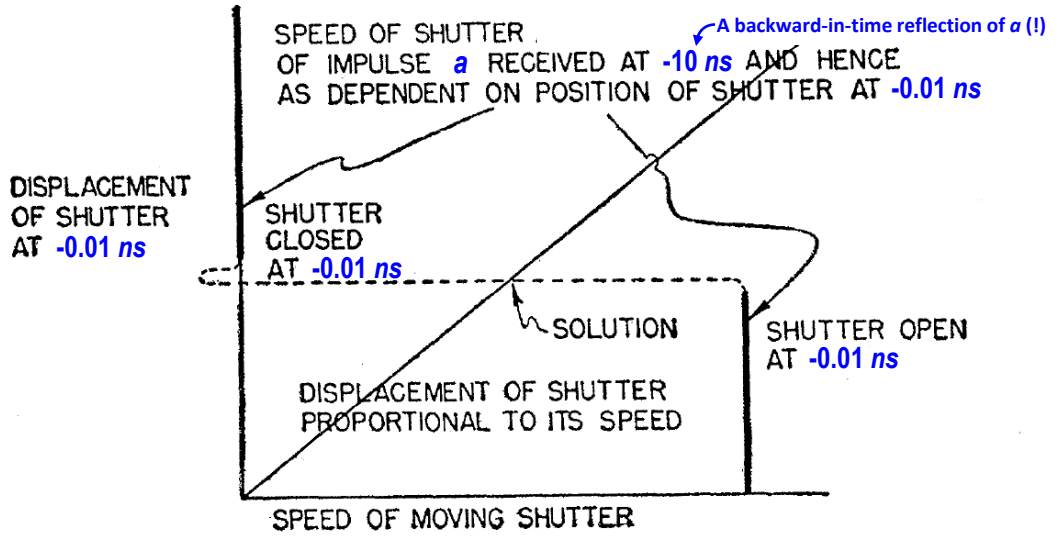

Fig. 2. Analysis and resolution of the paradox of advanced effects. The action of the shutter on the pellet—the interaction of past and future—is continuous (dashed line in diagram) and the curves of action and reaction cross. See text for physical description of solution.

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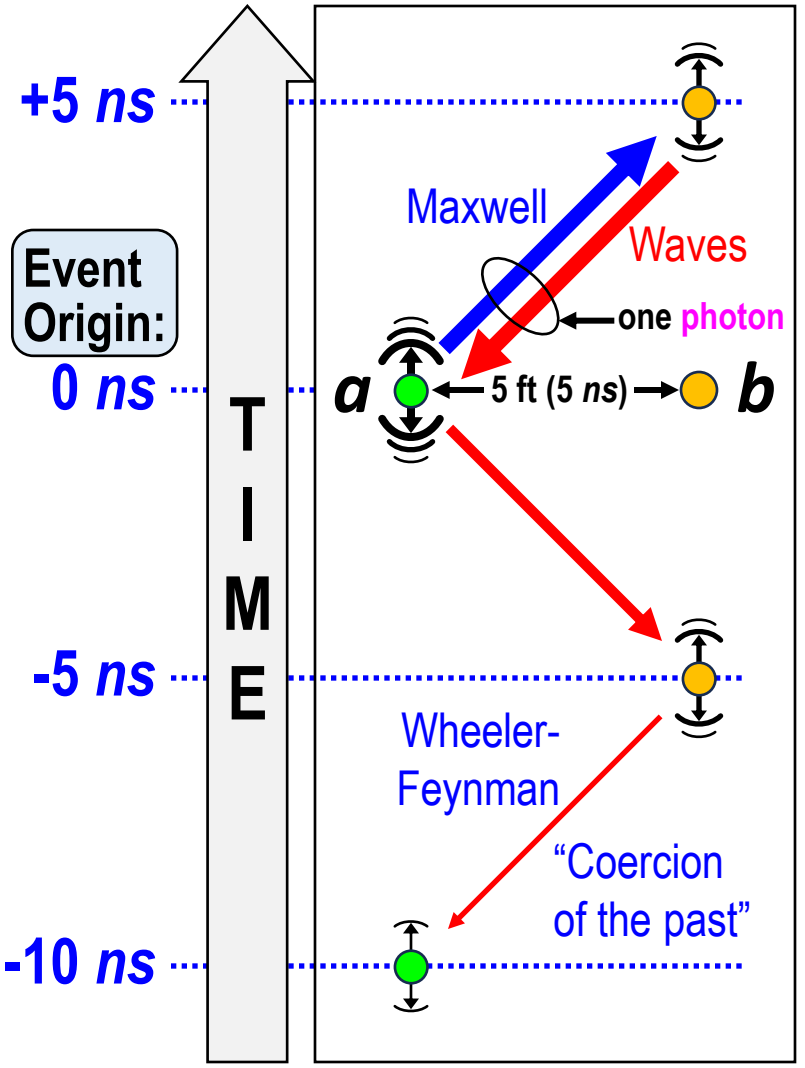
Quantum Insights in the Wheeler-Feynman Model

- Maxwell's Wave (MW) solutions *are not photons* (and *not particles*)
  - MWs propagate *equally* into the future (forward time) and past (reverse time)
  - MWs cannot explain "photon recoil"
- Wheeler's (rather opaque) shutter analogy makes a critical point:
  - MWs *coerce* all options into a single solution that stays invariant over time
  - A **photon** summarizes that consensus



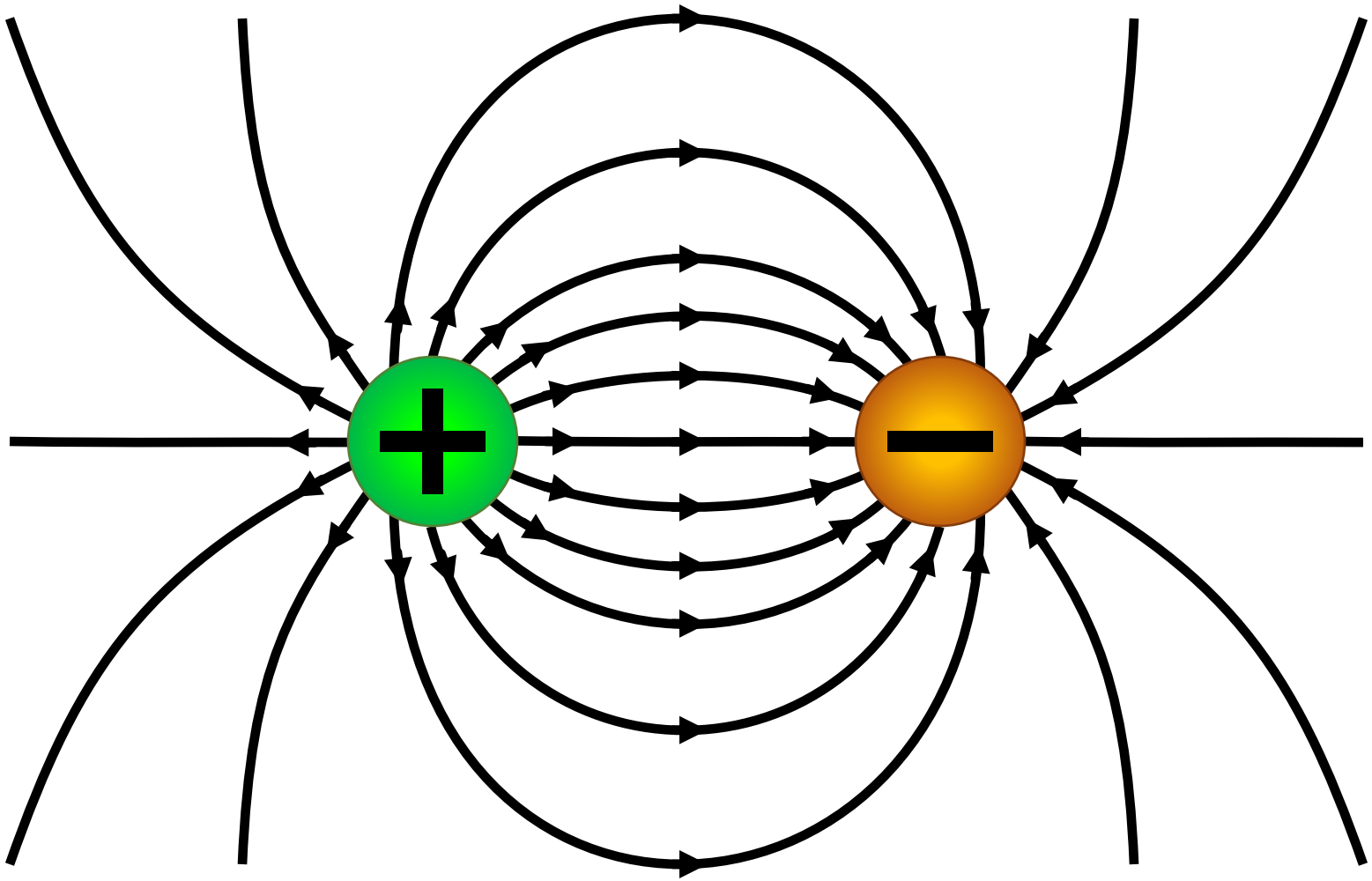
Part IV.
A Quick Introduction to Electrodynamics

A Different Take on Maxwell's Equations

- Practical use of Maxwell's equations requires training in:
  - The calculus
  - Differential equations and geometry
  - Knowledge of a wide range of physics constants and concepts
- On the other hand...
  - The critical features of the photon time paradox are puzzles of logic and causality, not calculus *per se*
  - The conceptual principles of electrodynamics are surprisingly compact (hence, only *four* unique Maxwell equations
  - I'll focus here on explaining the features that create the paradox

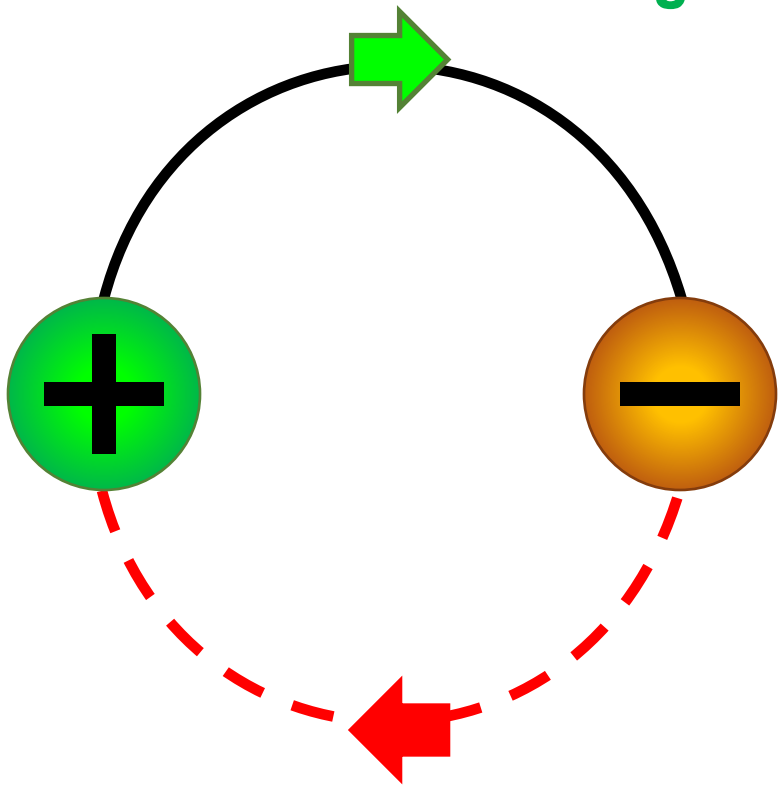
Particle Pair Creation as the Starting Point

The Standard Electric Field Line Interpretation



Maxwell's Flux Lines Interpretation (and Issues)

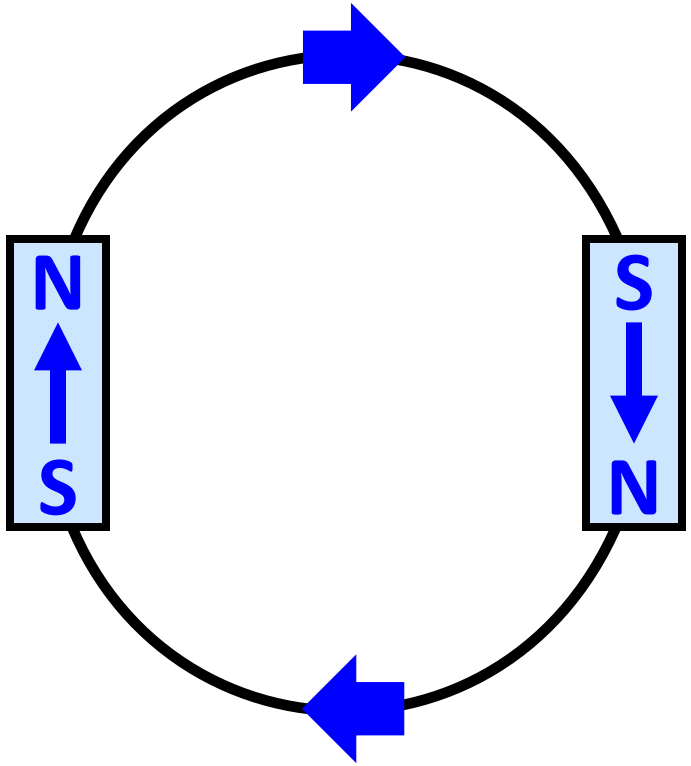
Maxwell visualized "flux lines" of fluid-like charges moving across XYZ space



His view implied a non-spatial "ground return" of charge flux (very strange!)

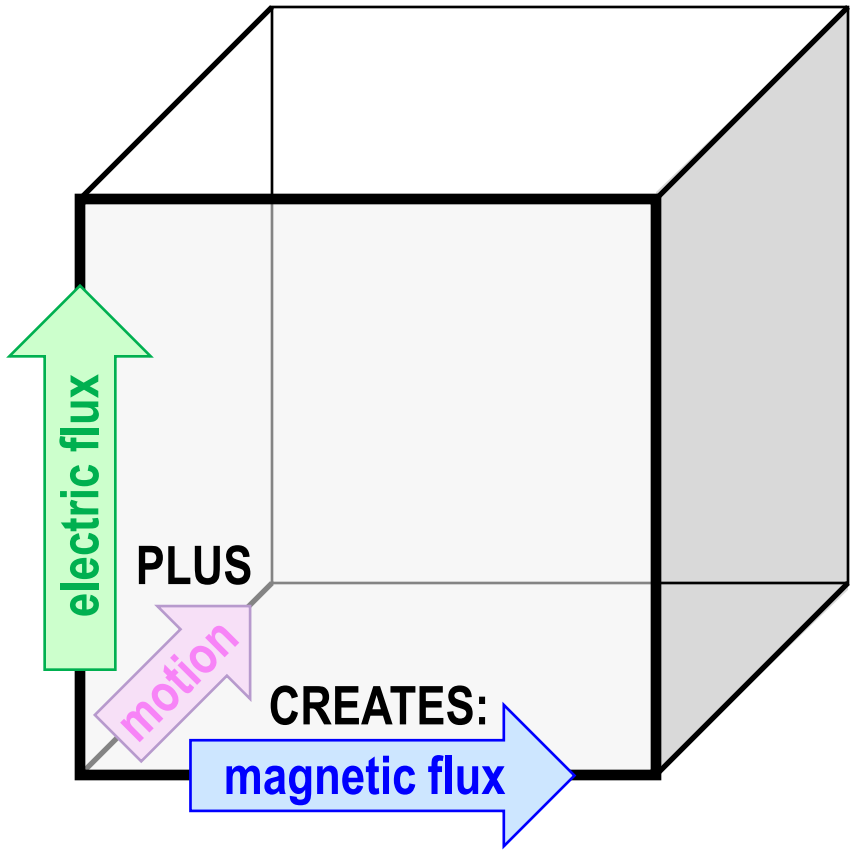
The Near-Symmetry of Electric and Magnetic Fields

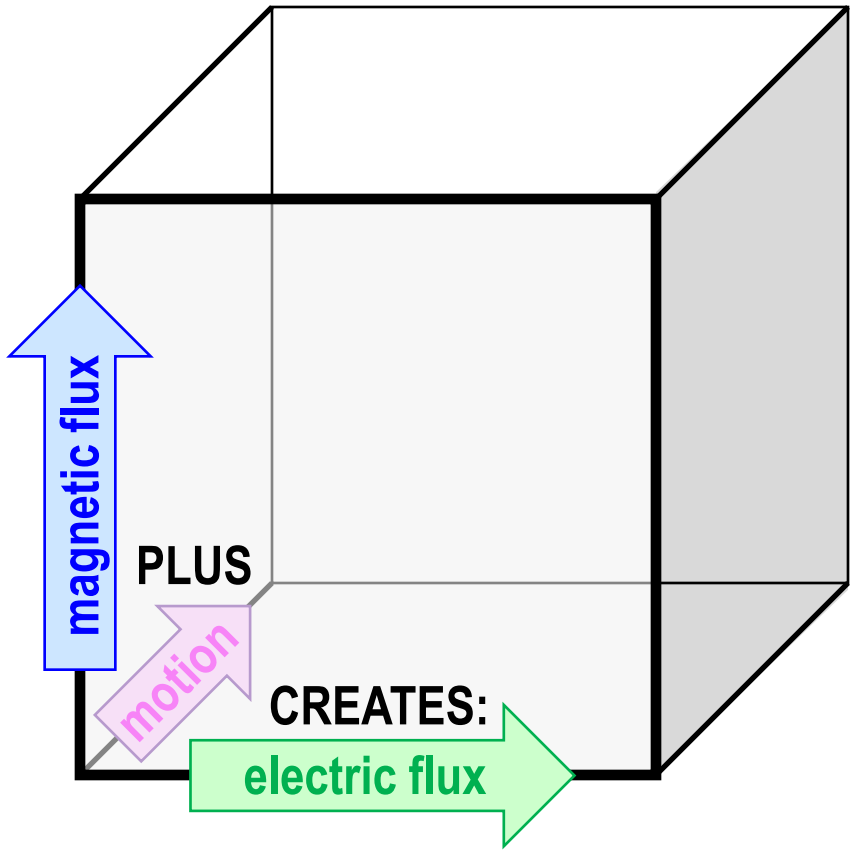
Magnetic "flux lines" are very similar to electric, but never leave XYZ space



Thus, there are no magnetic charges, only S-to-N magnetic flux directions

The Interplay of Electric and Magnetic Field Lines





Part V.
The Full Maxwell Equations

Maxwell's Equations (via Heaviside)

Gauss's Law: *Electric flux lines with persistent endpoints (charges) exist*

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\oiint_{\partial\Omega} \mathbf{E} \cdot \mathrm{d}\mathbf{S} = \frac{1}{\varepsilon_0} \iiint_{\Omega} \rho \, \mathrm{d}V$$

Gauss's Law of Magnetism: *Magnetic flux lines exist, but only as loops (no endpoints)*

$$\nabla \cdot \mathbf{B} = 0$$

$$\oiint_{\partial\Omega} \mathbf{B} \cdot \mathrm{d}\mathbf{S} = 0$$

Faraday's Induction Law: *Moving electric flux lines create magnetic flux lines*

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\oint_{\partial\Sigma} \mathbf{E} \cdot \mathrm{d}\boldsymbol{\ell} = -\frac{\mathrm{d}}{\mathrm{d}t} \iint_{\Sigma} \mathbf{B} \cdot \mathrm{d}\mathbf{S}$$

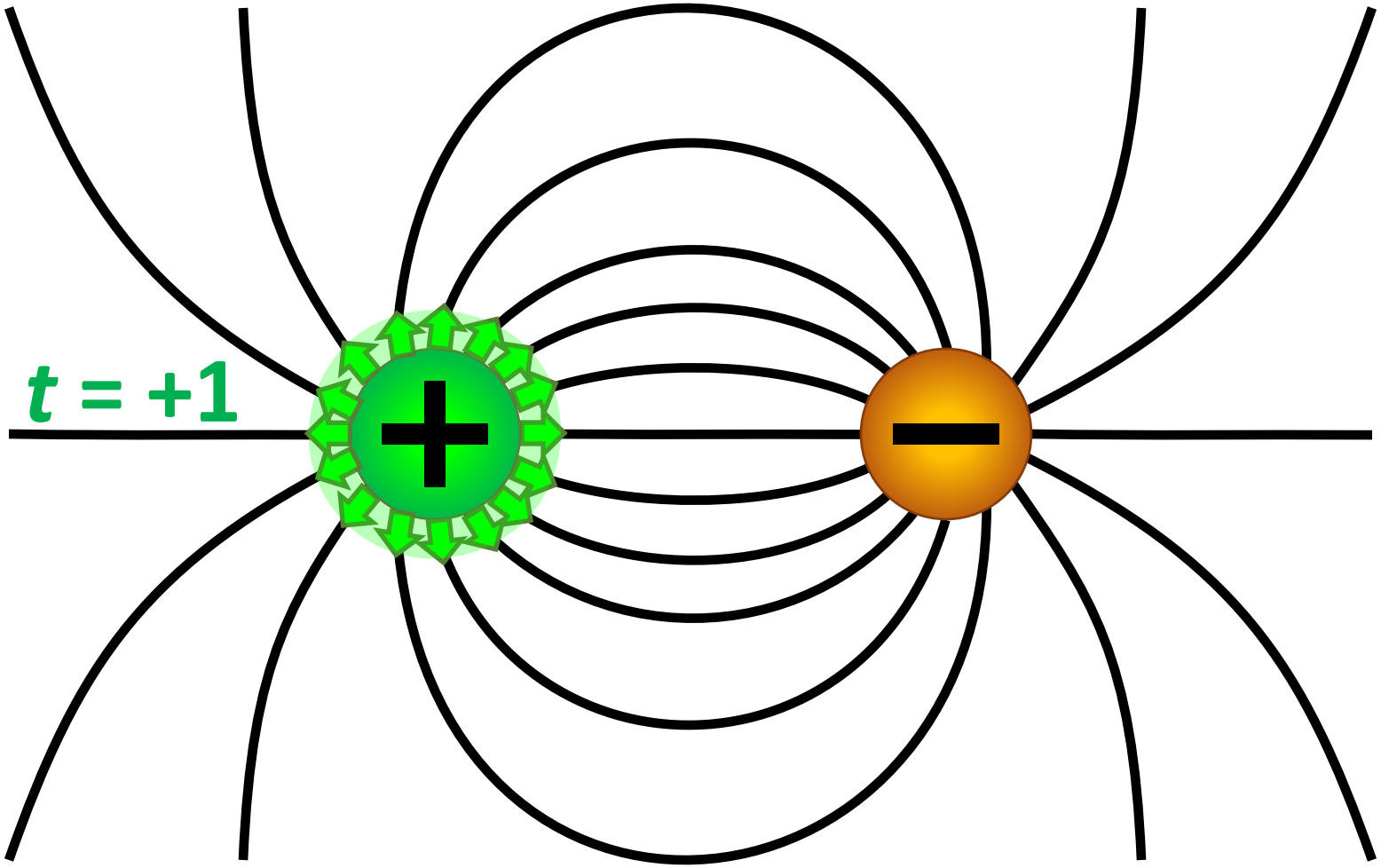
Ampere's Law: *Moving magnetic flux lines create electric flux lines*

$$\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

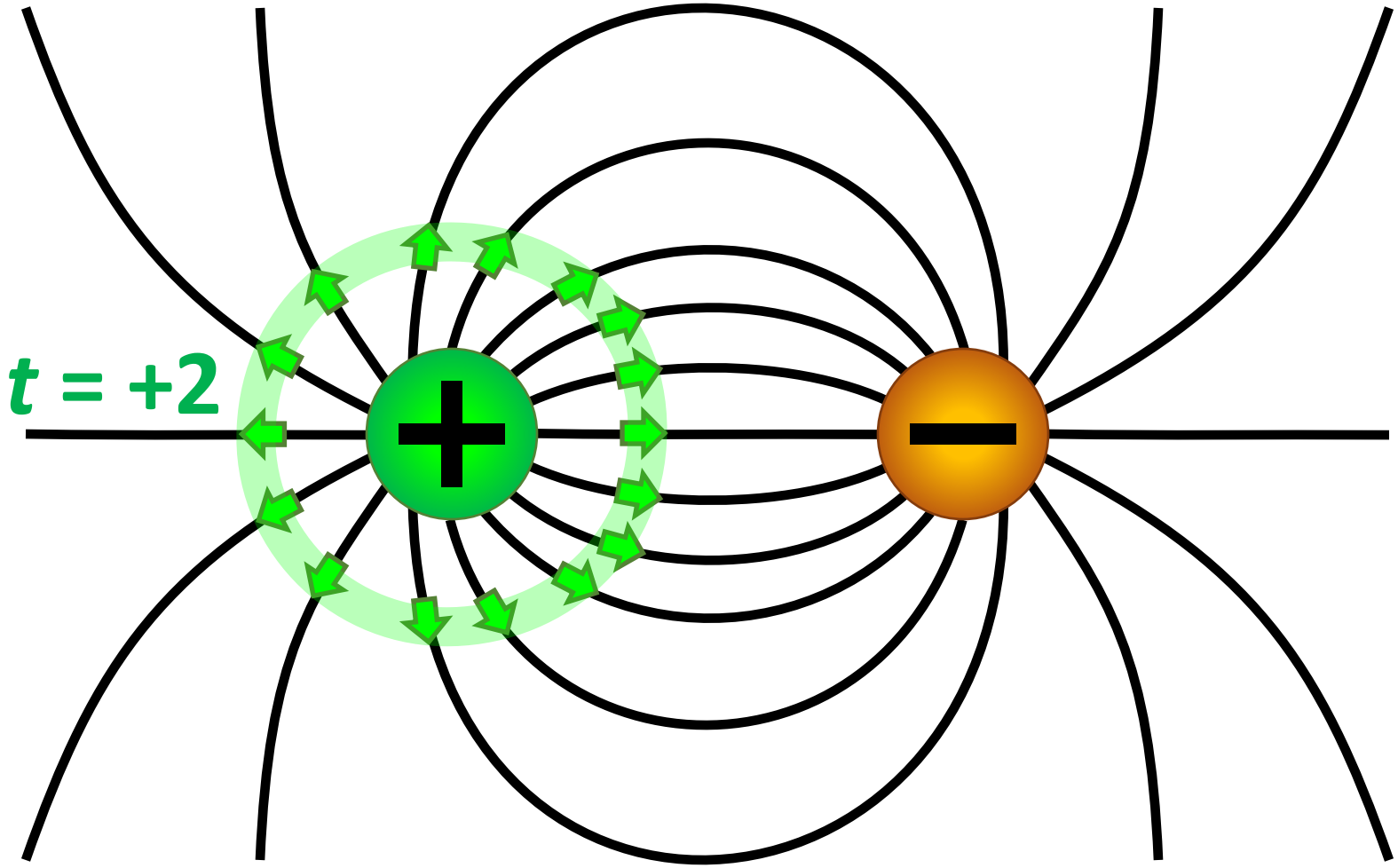
$$\oint_{\partial\Sigma} \mathbf{B} \cdot \mathrm{d}\boldsymbol{\ell} = \mu_0 \left(\iint_{\Sigma} \mathbf{J} \cdot \mathrm{d}\mathbf{S} + \varepsilon_0 \frac{\mathrm{d}}{\mathrm{d}t} \iint_{\Sigma} \mathbf{E} \cdot \mathrm{d}\mathbf{S} \right)$$

Part VI.
A Shortcut to Understanding Light Waves

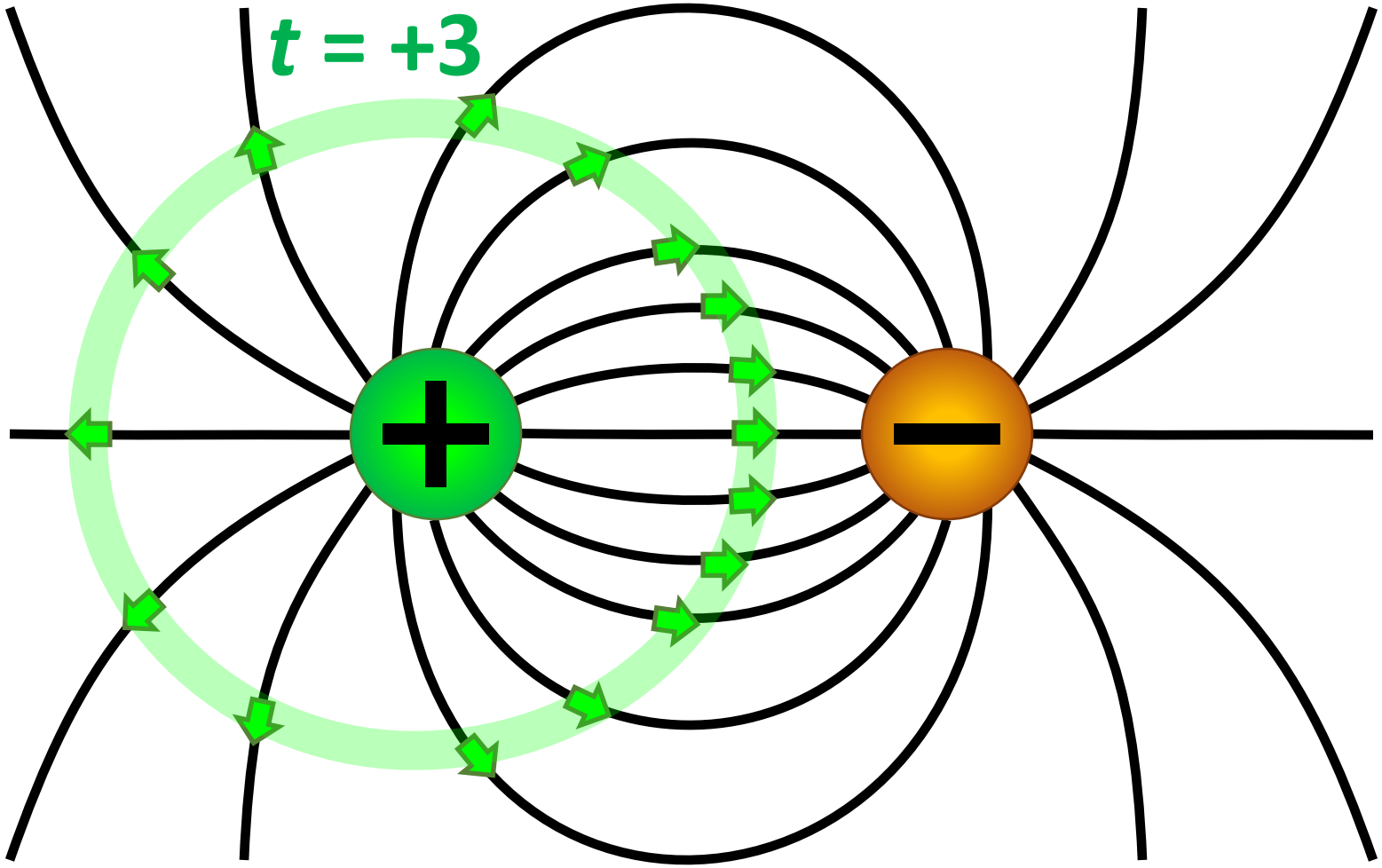
Maxwell's Flux as Lightspeed-Bound Micro Charges



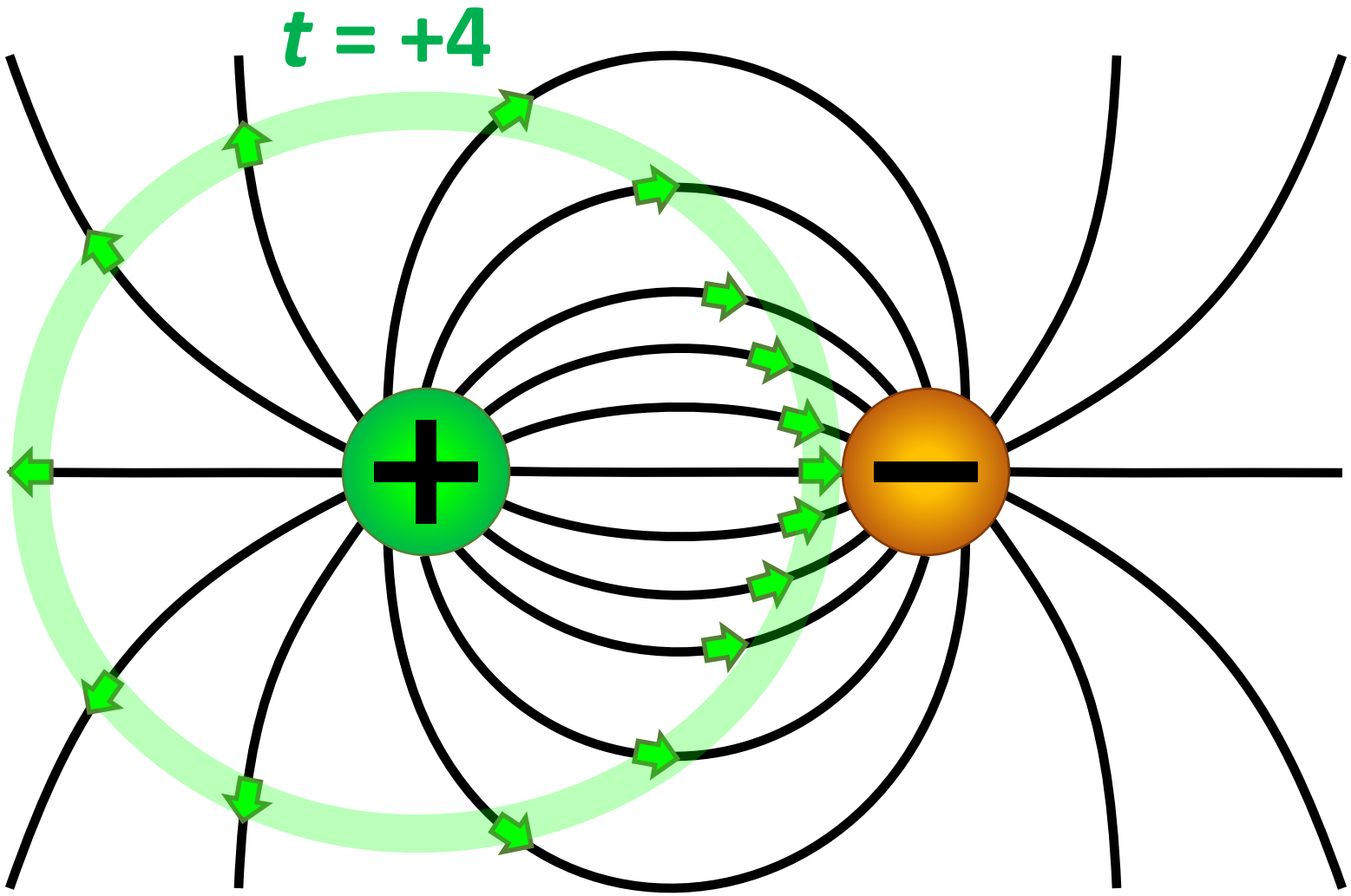
Geometry of Time = +2



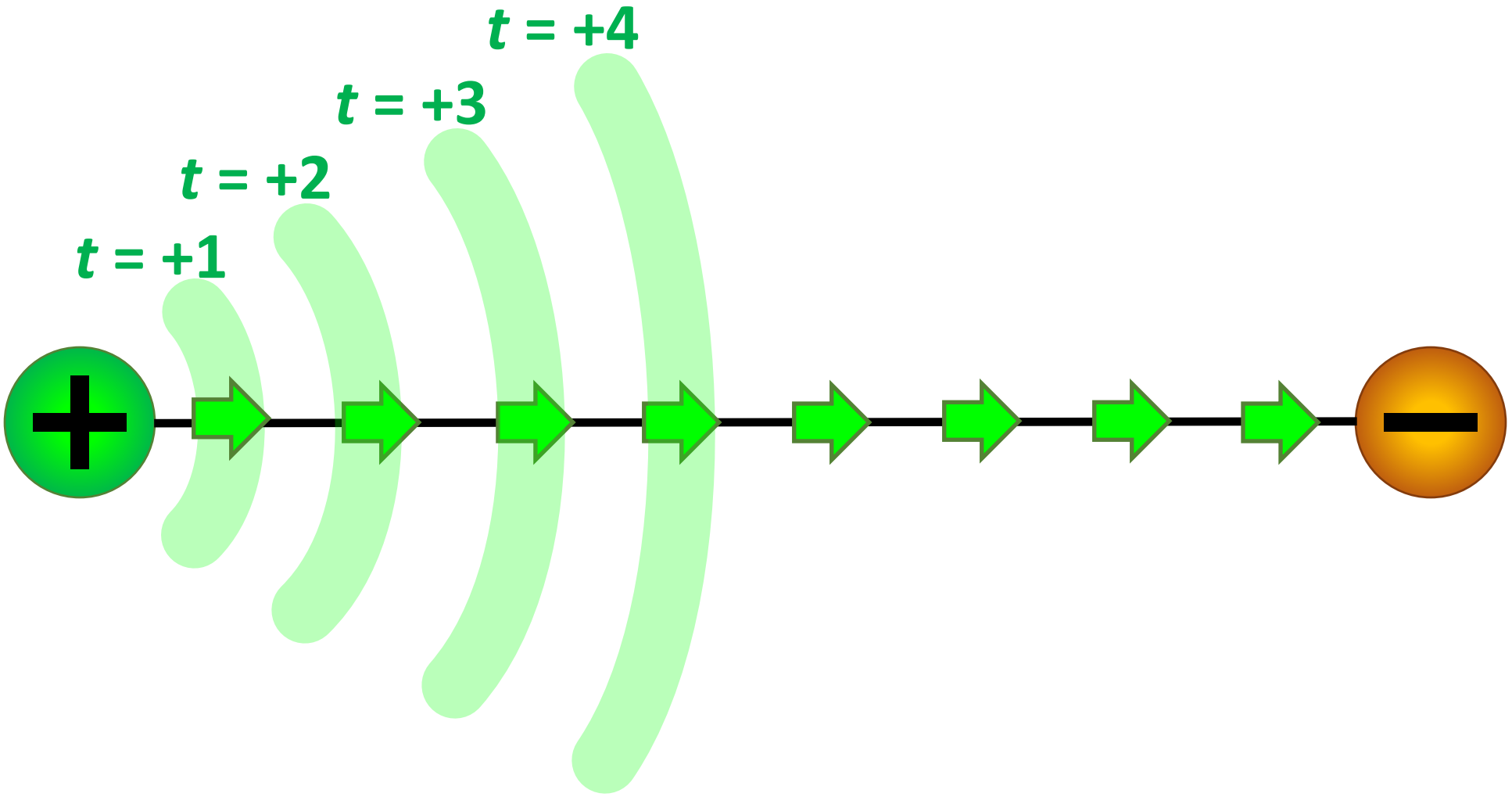
Geometry of Time = +3



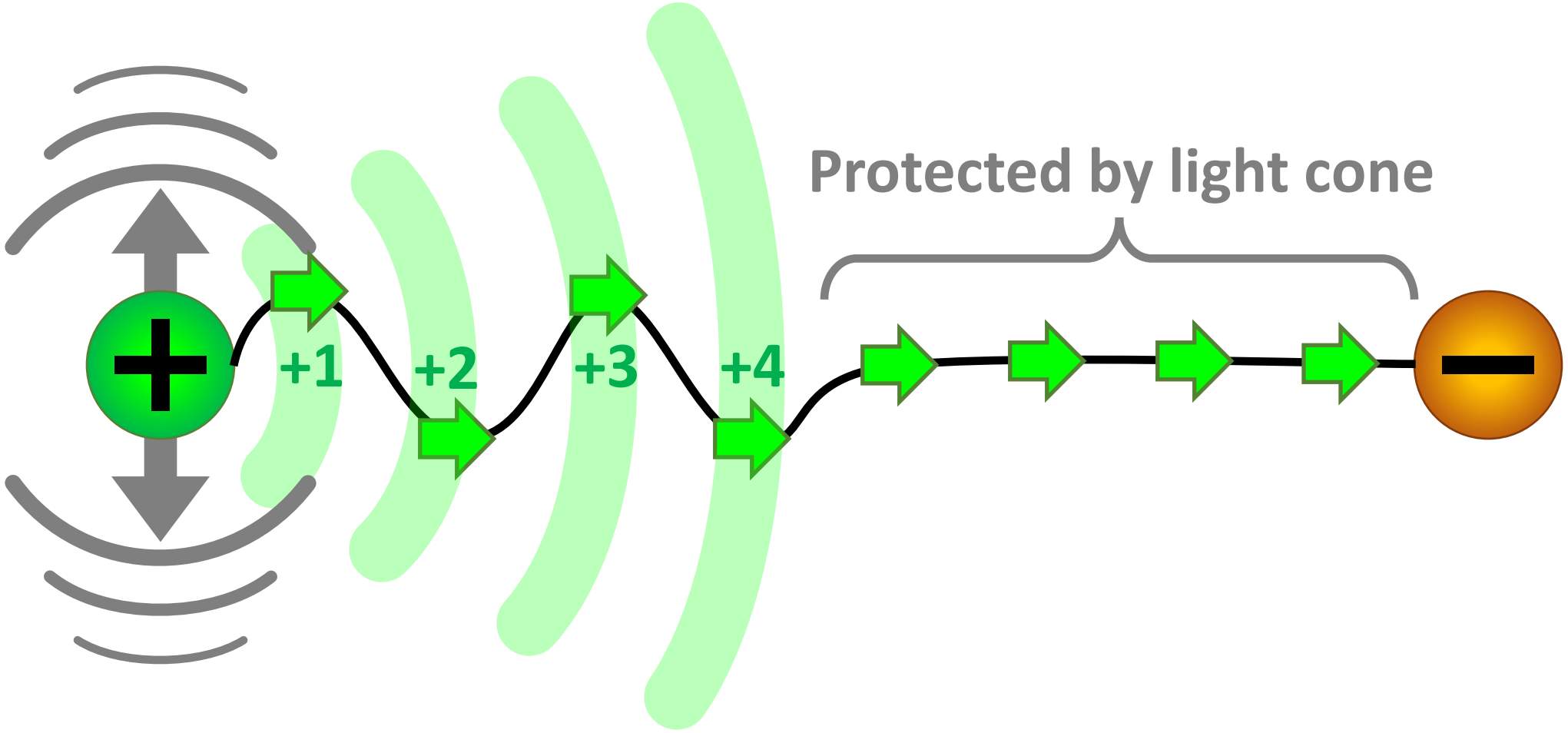
Geometry of Time = +4



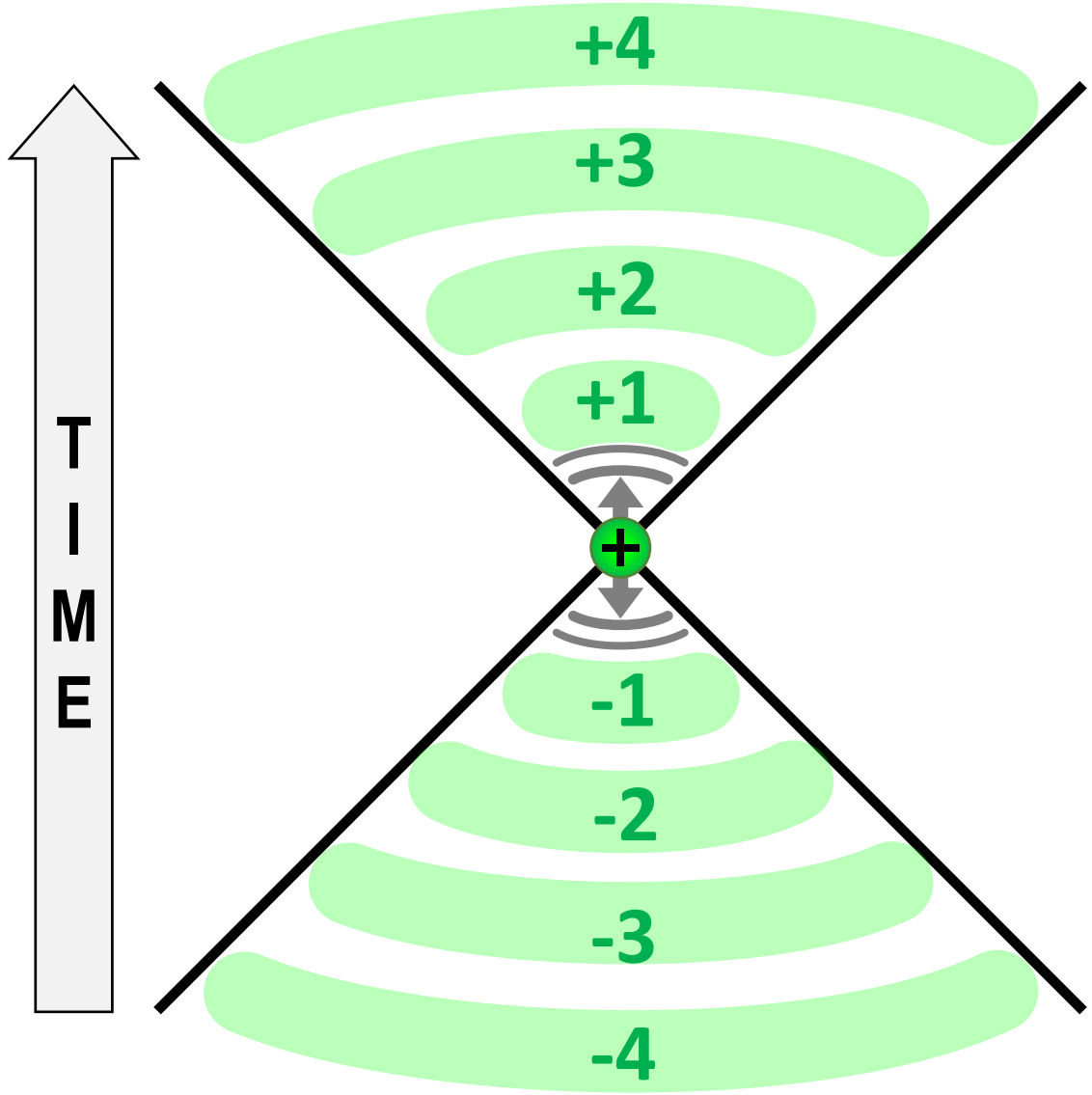
One Line of Lightspeed-Bound Flux Units



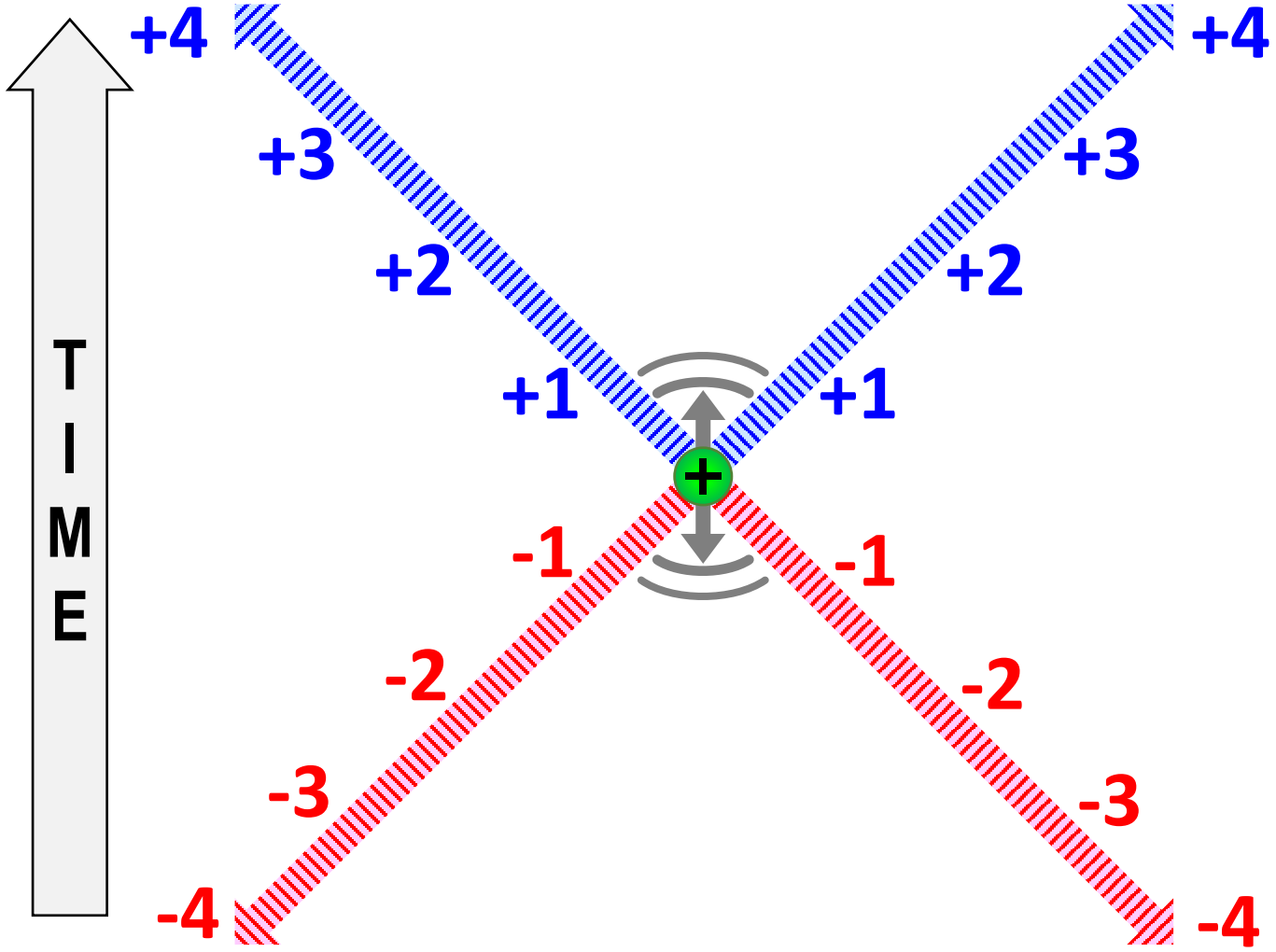
Jiggling the Source Creates Finite-Speed Waves



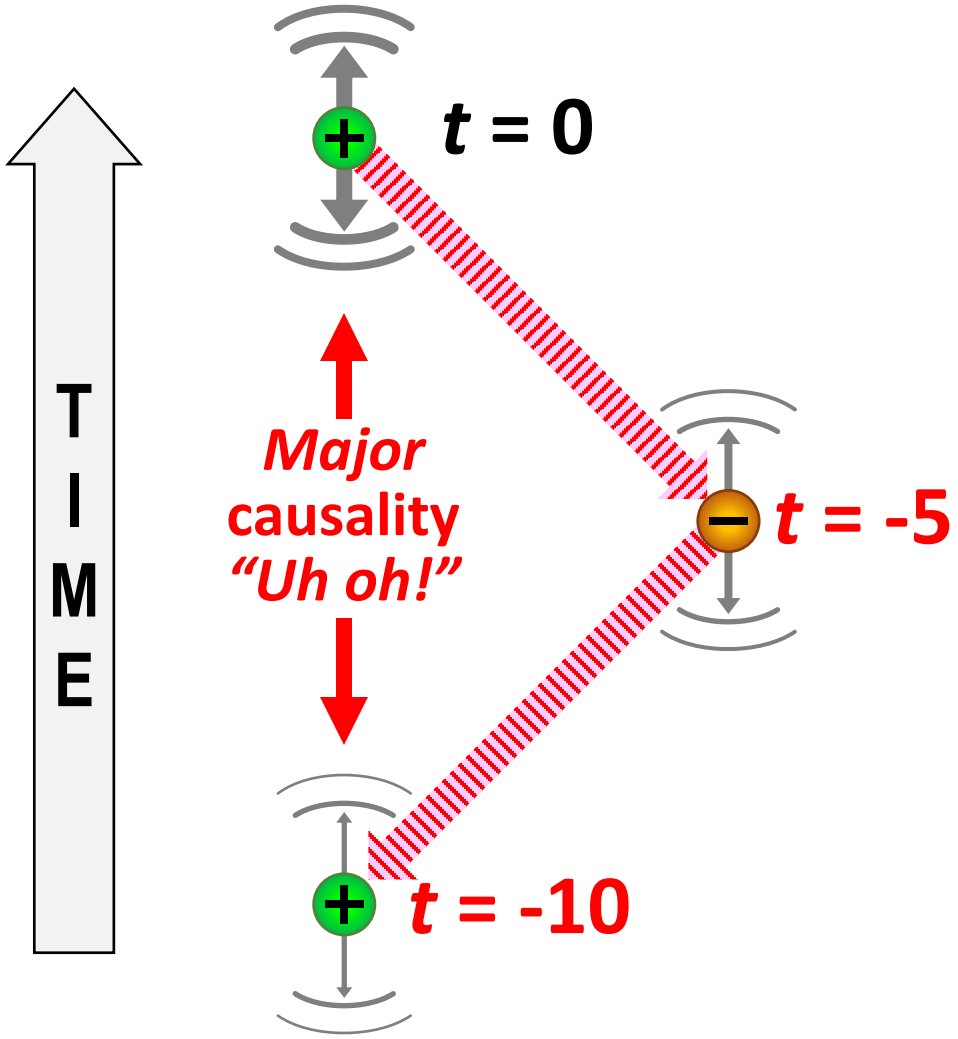
The Simple Scary Part: The Wave Goes Both Ways



Vacuum Waves "Hug" the Lightcone Walls

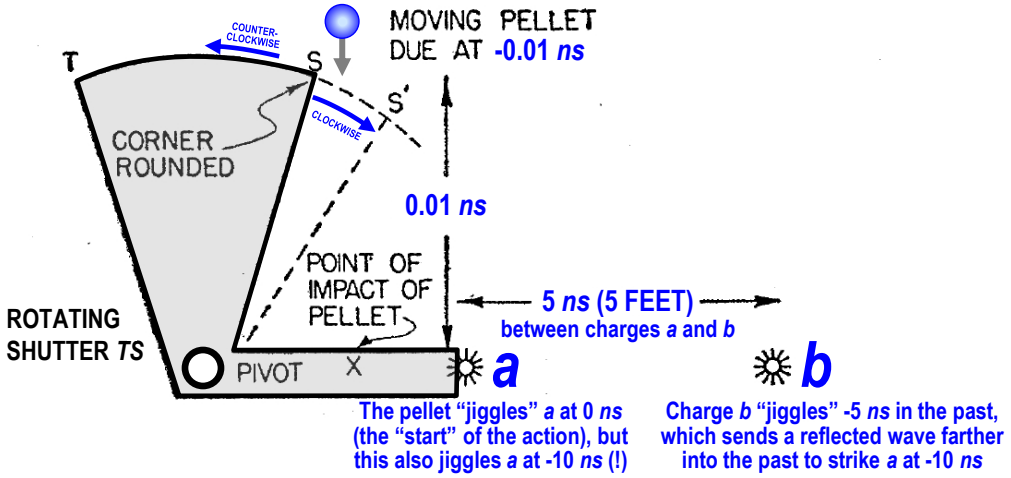


The Problem: You Now Can Impact Your Past



Part VII.
The Wheeler-Feynman Advanced Photon Conundrum

The Wheeler-Feynman Advanced Effects Paradox



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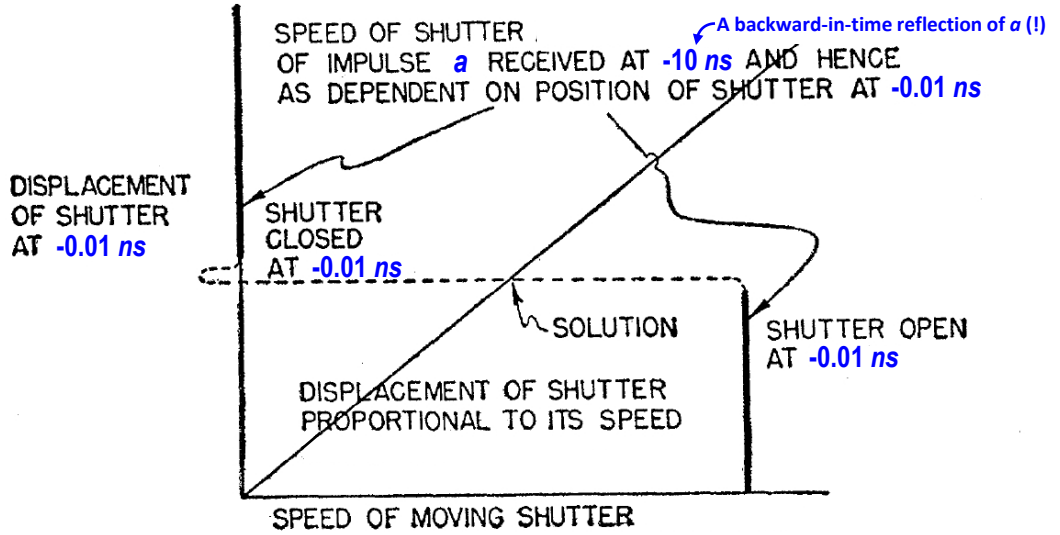

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Wheeler's Intent

- Wheeler and Feynman's conclusions:
  - The impacts of advanced waves on the past **are real**
  - *However*…
  - Attenuation and continuity of action combine to keep these real impacts from splitting the outcome into multiple histories
  - The result is more like a "negotiation" of how much the wave from the future is permitted to impact the past
- These joint papers inspired Feynman's later work
  - Feynman's Lagrangian (variational) method — his "integral of all histories" — captured the negotiation process more precisely

The Strange Issue of Recoil

- Contrary to what you likely have heard…
  - Maxwell's equations cannot explain all electromagnetic phenomena if they are interpreted *only* in the future direction
  - The missing behavior: Recoil after charge acceleration
  - The only fully conserving momentum-energy source of local recoil is the particle that absorbs the photon in the future
    - That particle could be billions of years in the future
- An experiment: Shine a laser into the darkest part of space
  - With sufficiently good instruments, you can detect a recoil effect
    - That recoil is a testable example of the future affecting you now

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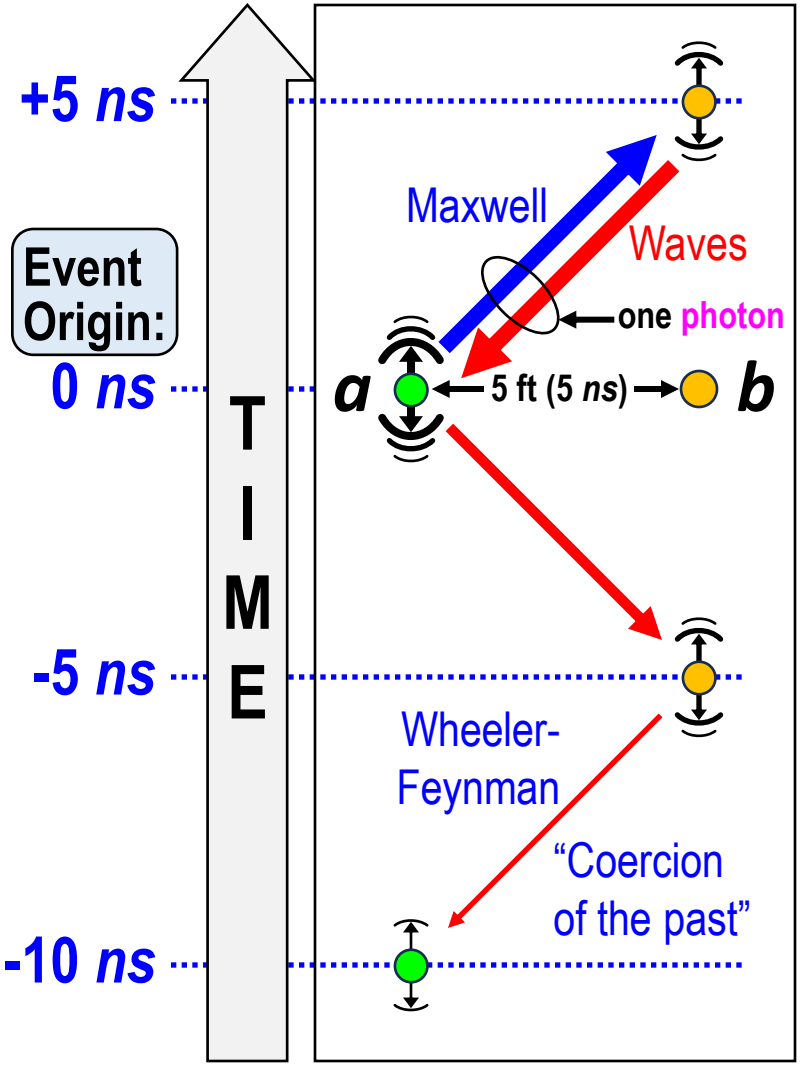

Part VIII.
Summary: Where to Next?

A New Interpretation of Quantum Collapse

- Maxwell waves from the future cause quantization and collapse
- As long as no specific and quantized advanced wave is selected, a quantum system remains quantum
- As in Wheeler's example, the two-way wave structures become unstable "houses of cards" when pushed close to a causal paradox
- "Paradox proximity" destabilizes quantum states into collapsing
- The impact of advanced waves from the future on "now" is vast and multi-level, with the future likely helping to set physics properties
- Multi-scale futures give a better quantum computing model