Process Theology as a Lens for Bringing Quantum Physics into Focus

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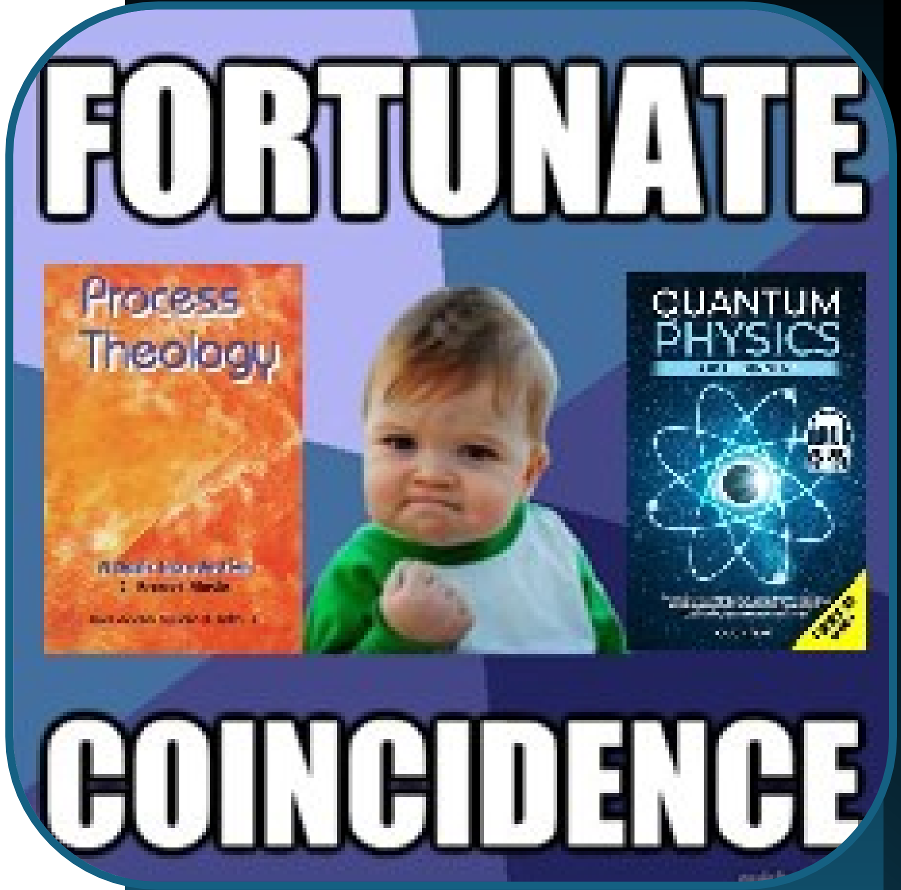
A Fortunate Coincidence

I want to begin with a personal story

As a graduate student in the late 1960s I took two courses at the same time:

- Process Theology
- Quantum Physics

I had no idea how important that coincidence would be



A Fortunate Coincidence

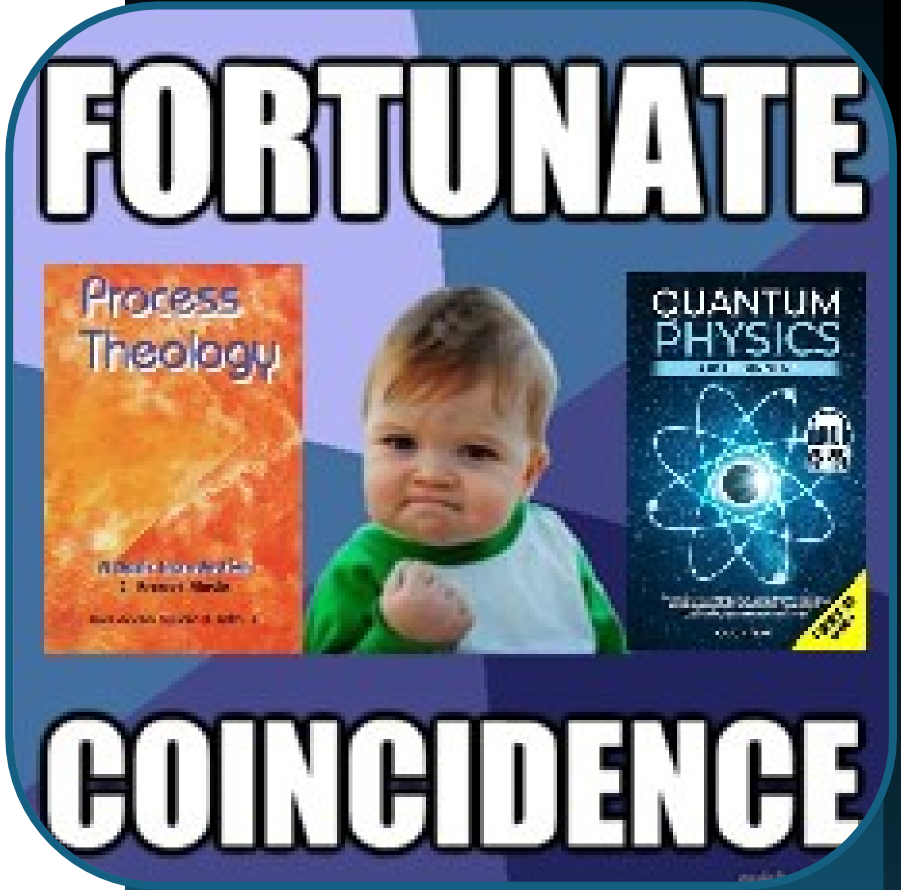
Something surprising happened

The Process Theology course made quantum physics feel:

- Natural
- Intuitive
- Even… straightforward

Not strange

Not mysterious



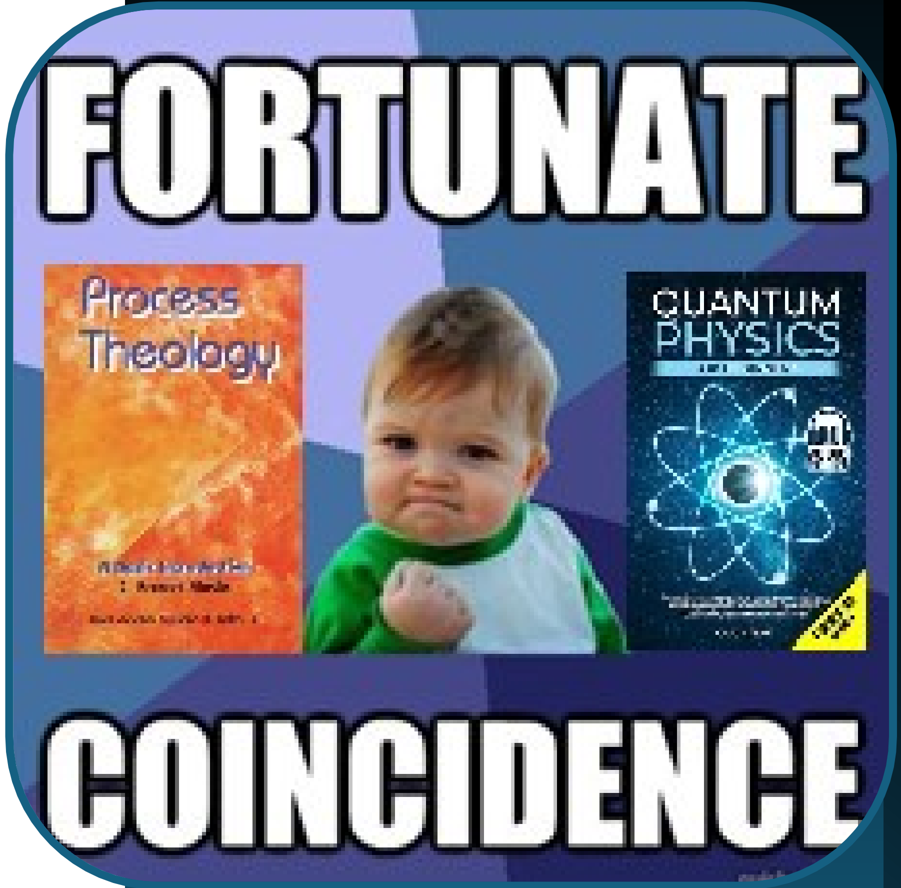
A Fortunate Coincidence

Most people experience quantum physics very differently:

- Confusing
- Counterintuitive
- "Weird"

That wasn't my experience

Question: Why?



What I Realized Later

Much later, I began to understand

- I had learned quantum physics with a very different *starting intuition*
- I didn’t have to “unlearn” anything first

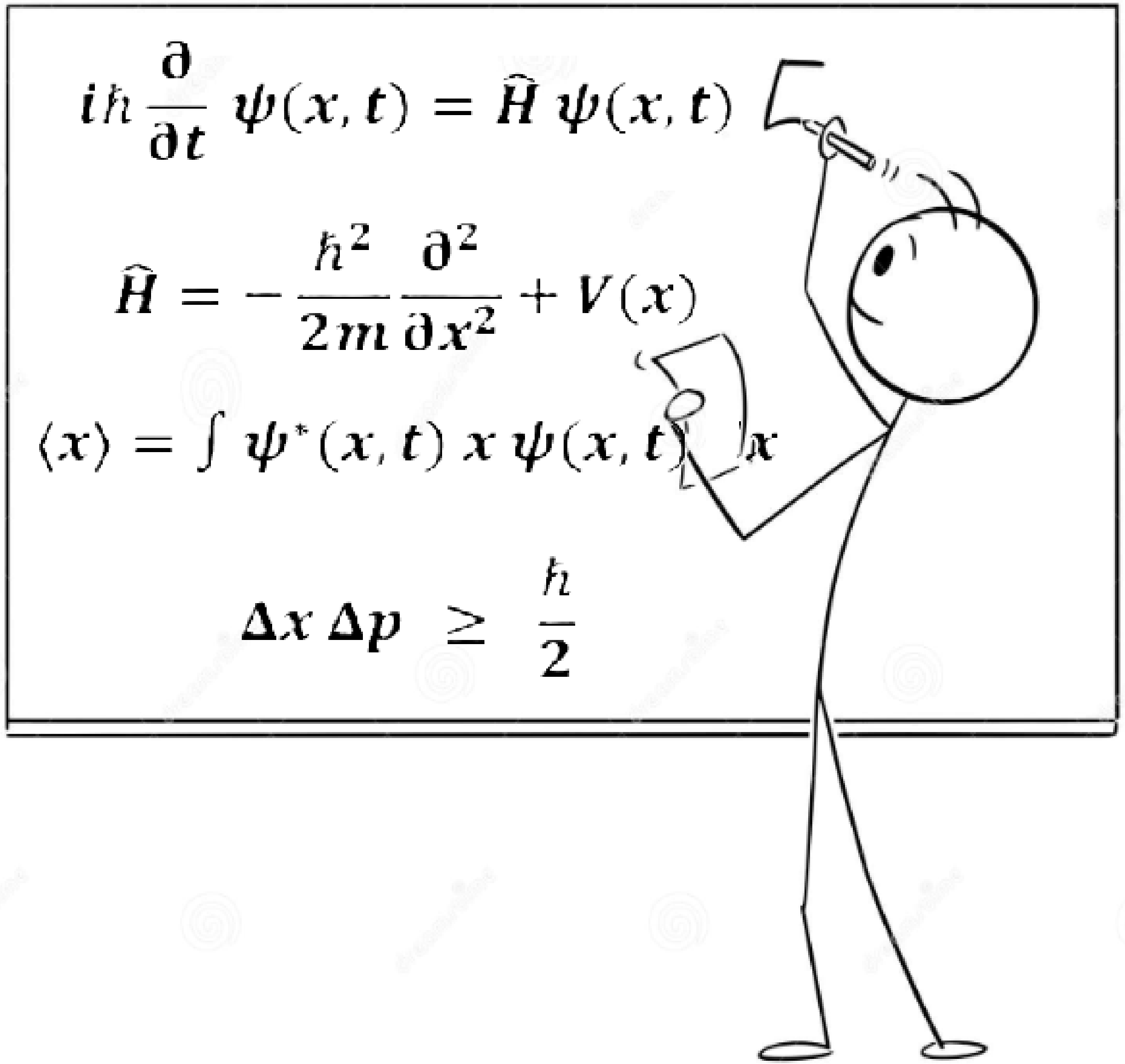
The Usual Approach

Most courses follow this path:

1. **Build classical physics**
2. **Develop intuition based on objects**
3. **Then introduce quantum physics**

Result:

→ Quantum physics feels like a break from reality because classical physics was mistaken for reality



The Usual Approach

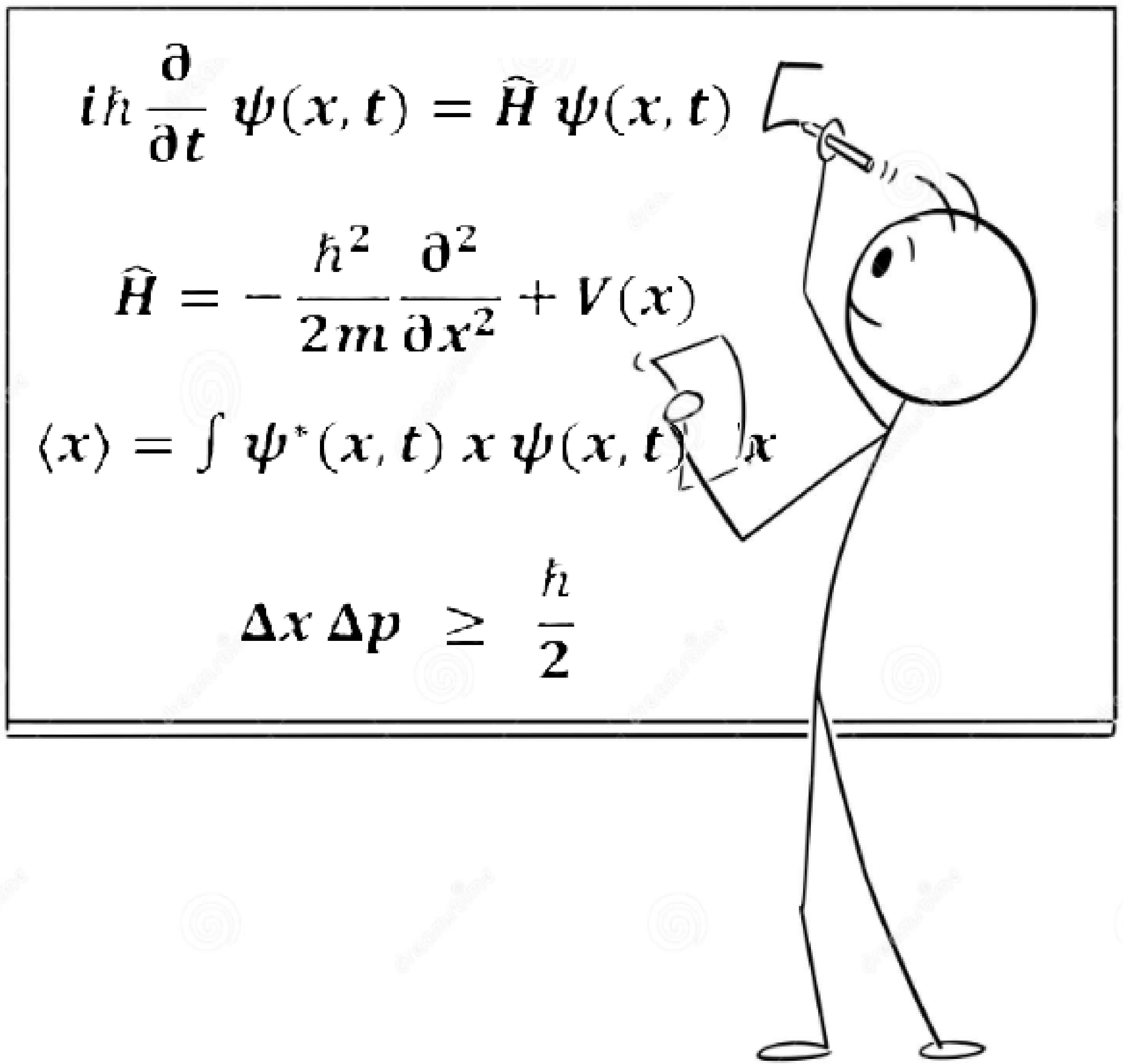
The Hidden Cost

Students are left thinking:

- Classical physics = normal
- Quantum physics = strange

And often:

You must *unlearn* your intuition to understand it



A Different Possibility

- What if the problem is not quantum physics...
- ...but the way we were taught to think?

A Different Possibility

The Alternative Approach

- Start with a different intuition
- Learn quantum physics first
- Use a framework where it feels natural

Then:

→ Classical physics emerges as a limiting case

A Different Possibility

What We Will Do in This Presentation

- We will:
  - Start with an event-based way of thinking
  - Learn quantum physics from that perspective
  - Let classical physics emerge naturally

The Role of Process Thought

Process thought (from Alfred North Whitehead)

Emphasizes:

- Events instead of things
- Becoming instead of static being

This way of thinking:

→ made quantum physics feel intuitive to me

Process Theology

Why Process *Theology*, Not Just Process Philosophy?

- So far we have introduced:
  - Events instead of things
  - Becoming instead of static being
- But this is not yet enough
  - The deeper intuition comes from certain conceptual structures used in Process Theology regarding possibility, actuality, and order

Process Theology

- What We Are NOT Doing
- We are NOT:
  - Explaining God
  - Arguing theology
  - Making religious claims
- We are NOT using this to:
  - Determine reality
- This is not a theology lesson

- What We ARE Doing
- We are using concepts from Process Theology as:
  - A way of thinking
  - A source of intuition
- Specifically:

  → To understand how the quantum physics model behaves

Process Theology

- Why Go This Far?
- Quantum physics describes:
  - Possibilities
  - Probabilities
  - Patterns

- But it does NOT provide:
  - An intuitive picture
- Process Theology provides a structured way to think about these ideas

Process Theology

Process Theology

- **Three Conceptual Roles (God from Process Theology)**
  - **Primordial Nature**
    → Structured realm of possibilities (Analogy: **Quantum States**)
  - **Consequent Nature**
    → Accumulation of actual events (Analogy: **Particle-like detections**)
  - **Superjective Nature**
    → Influence toward pattern and order (Analogy: **Probability distributions**)

Process Theology

Process Theology

How We Will Use These Concepts

- We are NOT using these to describe God
- We ARE using them as a model for thinking about quantum physics
- Treat them as:
  - Conceptual tools
  - Intuition builders

Process Theology

From Process Language → Quantum Intuition

- **Primordial Nature (Possibility)**
  → Quantum state: range of possible outcomes
- **Consequent Nature (Actuality)**
  → Measurement events: what actually occurs
- **Superjective Nature (Patterning Influence)**
  → Stable probability distributions

Process Theology

Process Theology

A New Way to Think About Quantum Physics

- Measurement outcomes are not classically deterministic
- Yet outcomes are not mere random chaos

But:

- Structured possibilities
  → actualized in events
  → forming stable patterns

Process Theology

What This Does NOT Mean

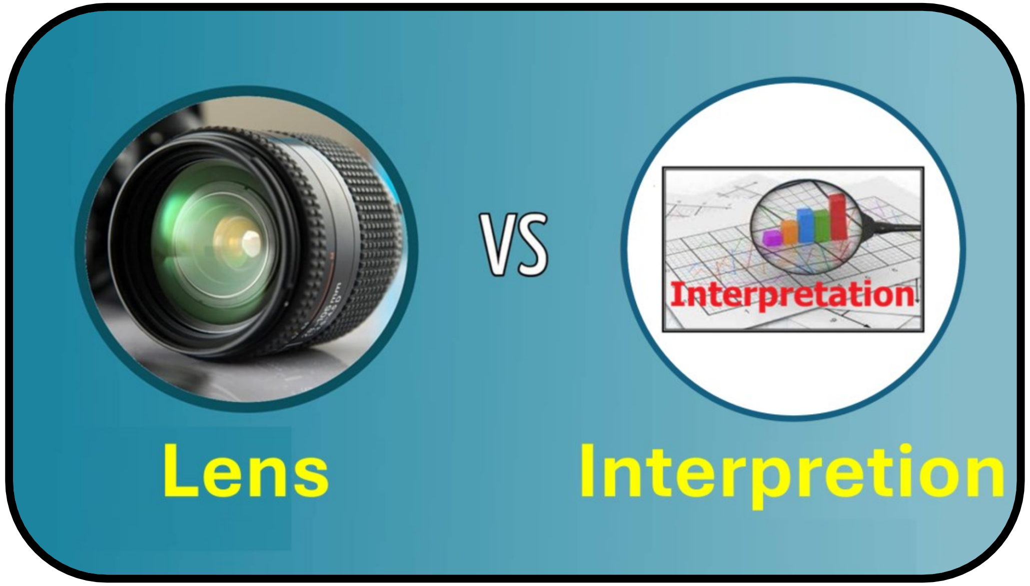
- We are NOT saying:
  - Particles are theological
  - Physics depends on God
  - This is what reality "is"
- This is a way to build intuition for a predictive model

We are borrowing the structure of Process Theology to develop intuition for how the quantum physics model works

Where We Are Going

- We will build this step by step in Sessions 2 through 8:
- **Lecture 2:** The Standard Model → **Detected Events** *(Actual occasions)*
- **Lecture 3:** From Particles to Equations → **Structured Possibility** *(Primordial nature)*
- **Lecture 4:** Quantization: Building the Quantum State Machine → **Ordered Indeterminacy** *(Creativity under constraint)*
- **Lecture 5:** Running the Model: Time Evolution and Becoming → **Creative Advance** *(Ordered process becoming form)*
- **Lecture 6:** The Single Slit Experiment → **Tendency and Pattern** *(Lure / aim expressed probabilistically)*
- **Lecture 7:** Bound States: The Hydrogen Atom and Stable Matter → **Enduring Relations** *(Societies with inherited order)*
- **Lecture 8:** Summary and Conclusions → **Understanding Physics Through the Process Lens**

A Potential Confusion

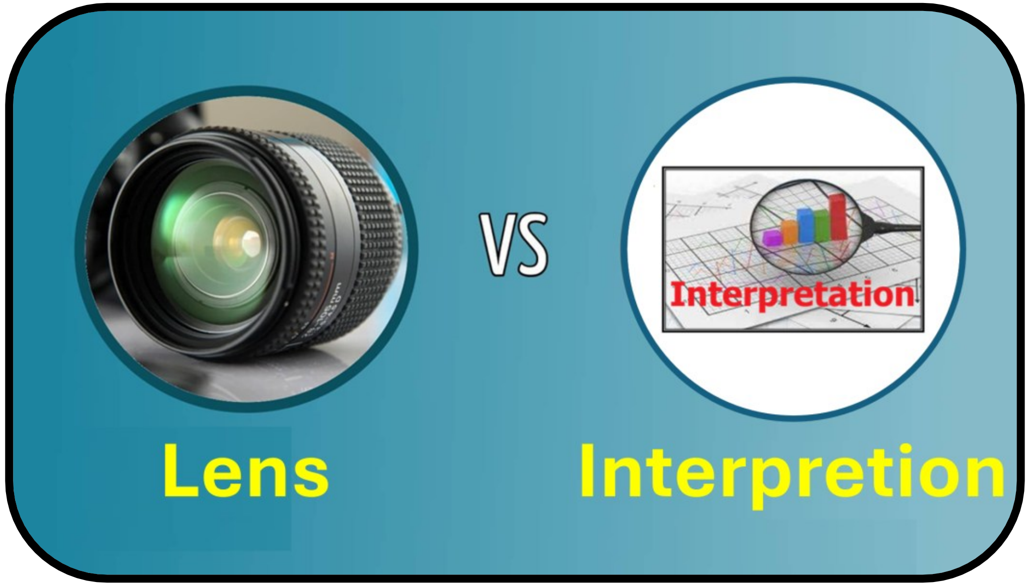


Lens vs Interpretation

- At this point, an important question arises:

Are we using Process Theology as an interpretation of quantum physics?

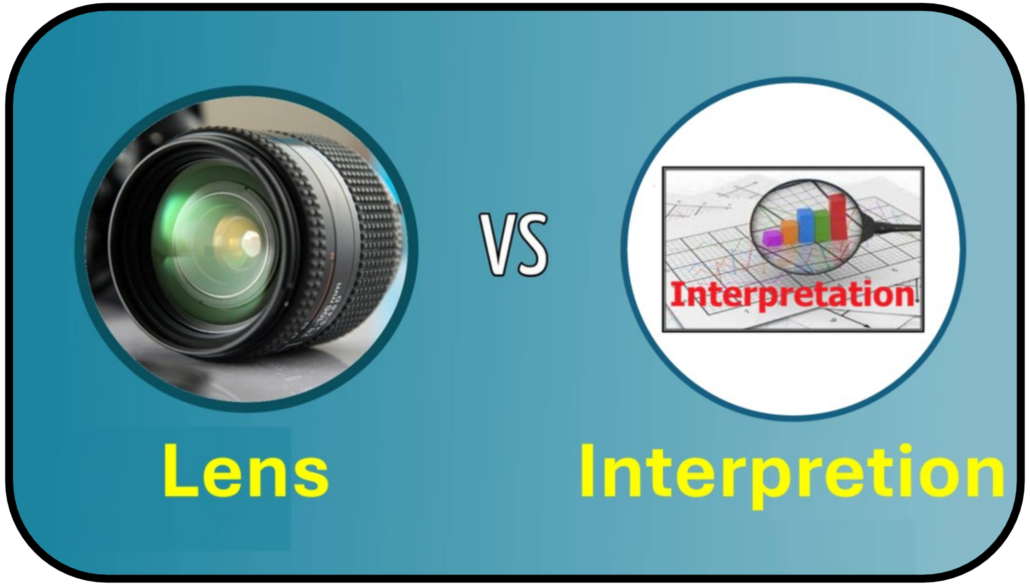
A Potential Confusion



No — This Is Not an Interpretation

- We are NOT:
  - Explaining what reality is
  - Filling in what physics leaves out
- We ARE:
  - Using a way of thinking
  - To better understand the model
- This is a lens for understanding, not an interpretation of reality

What is an Interpretation?



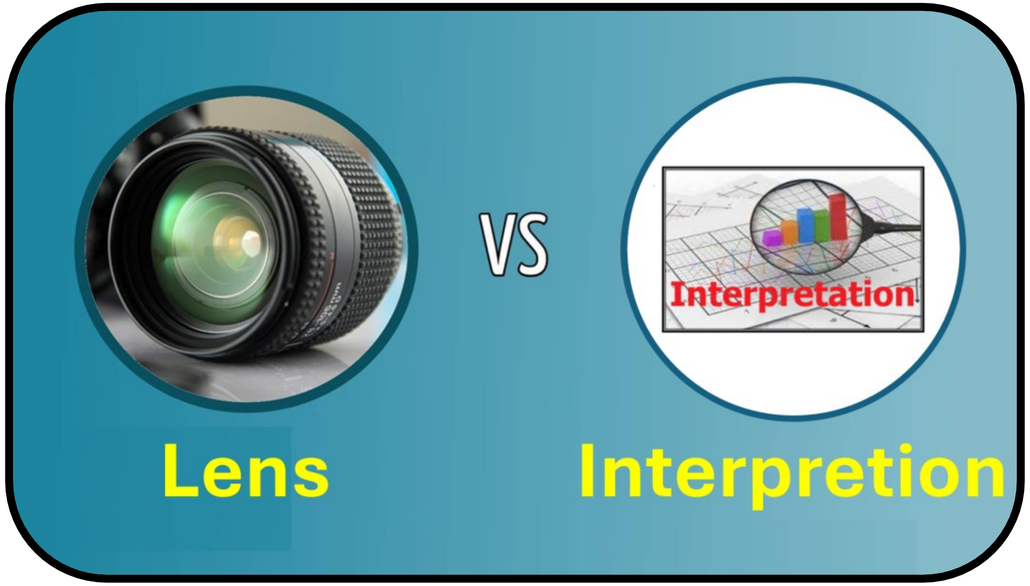
What Physics Can—and Cannot—Tell Us

- Quantum physics places limits on what can be known
- Example:

  Heisenberg Uncertainty Principle

  - We cannot simultaneously know:
  - Exact position
  - Exact momentum

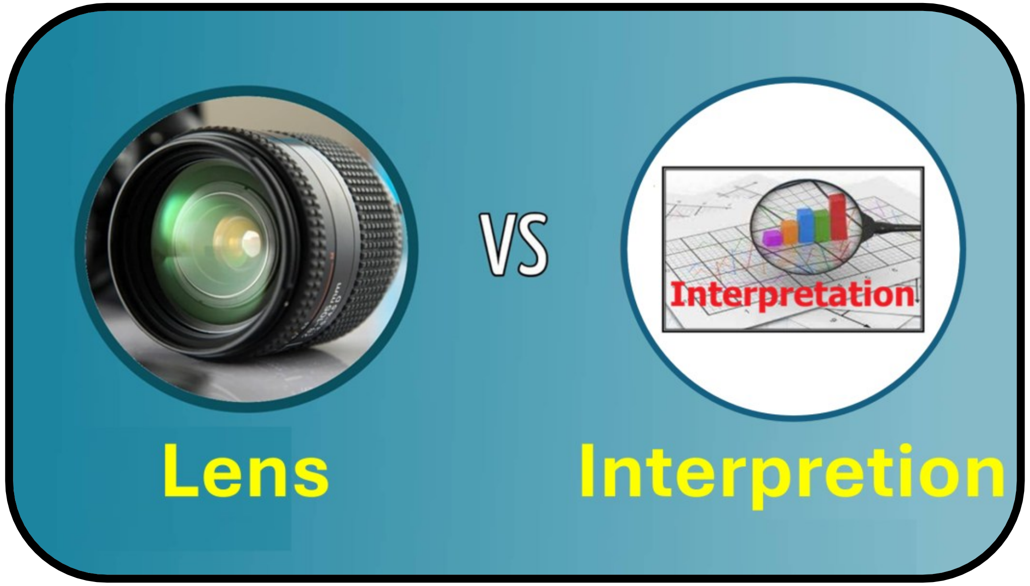
What is an Interpretation?



Between Detection Events

- Quantum physics predicts:
  - What we will observe
  - With what probability
- Physics predicts observable outcomes and probabilities, but it does **NOT** tell us:
  - What a particle is doing between detection events

What is an Interpretation?



Einstein vs Bohr

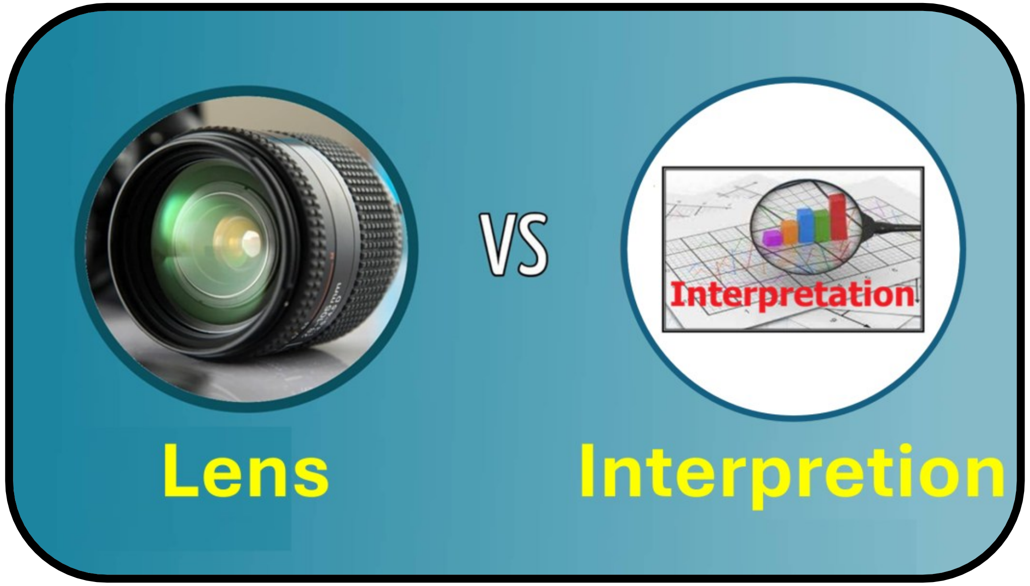
Albert Einstein

- → Thought quantum physics was incomplete
- → Wanted a deeper description

Niels Bohr

- → Argued that quantum physics is sufficient for describing observable phenomena
- → What happens between events is not accessible to science

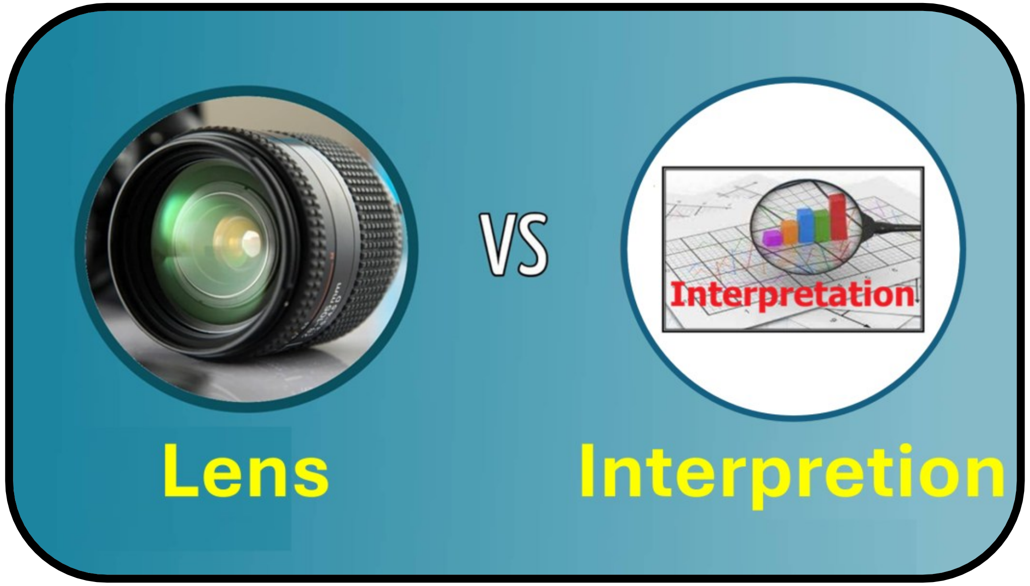
What is an Interpretation?



Interpretation is attempts to fill in the Gap

- Several interpretations attempt to clarify what the formalism means, and in some cases what underlying reality may be like:
  - Copenhagen interpretation
  - Bohmian mechanics
  - Many-worlds interpretation

My Approach



INSTRUMENTALISM

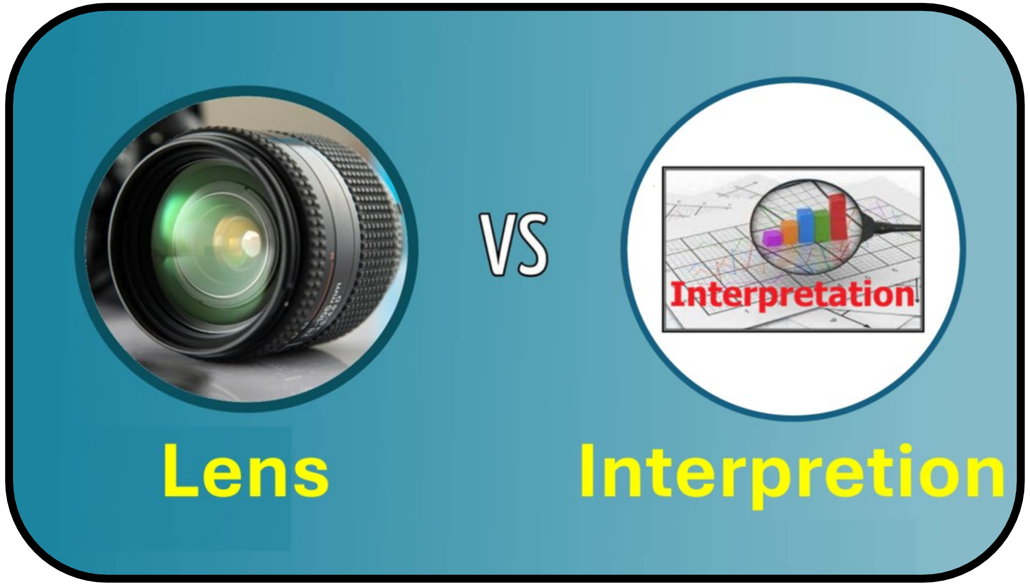
- Instrumentalism is:
  - Closely aligned with Copenhagen interpretation

But:

  - Even more disciplined

We focus only on prediction—not interpretation!

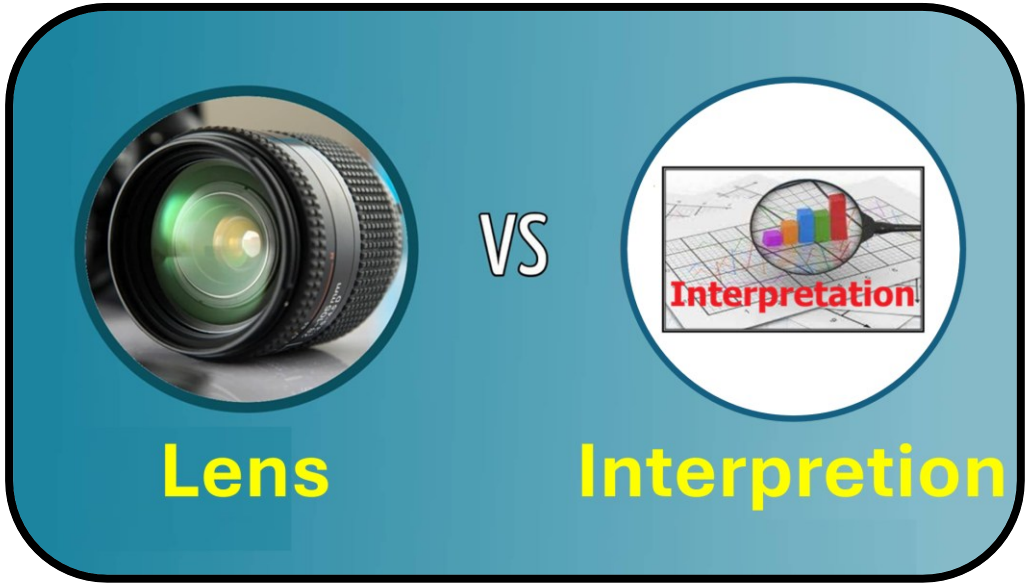
My Approach



What I Am—and Am Not—Doing

- I am NOT:
  - Using Process Theology to interpret quantum physics
  - Making claims about reality
- I AM:
  - Using Process Theology
  - → as a way to build intuition
  - → so the quantum model is easier to understand

Summary



Physics tells us what happens

Interpretations try to say what is real

We focuses only on what happens and use Process Theology to help us understand it

Today’s Focus

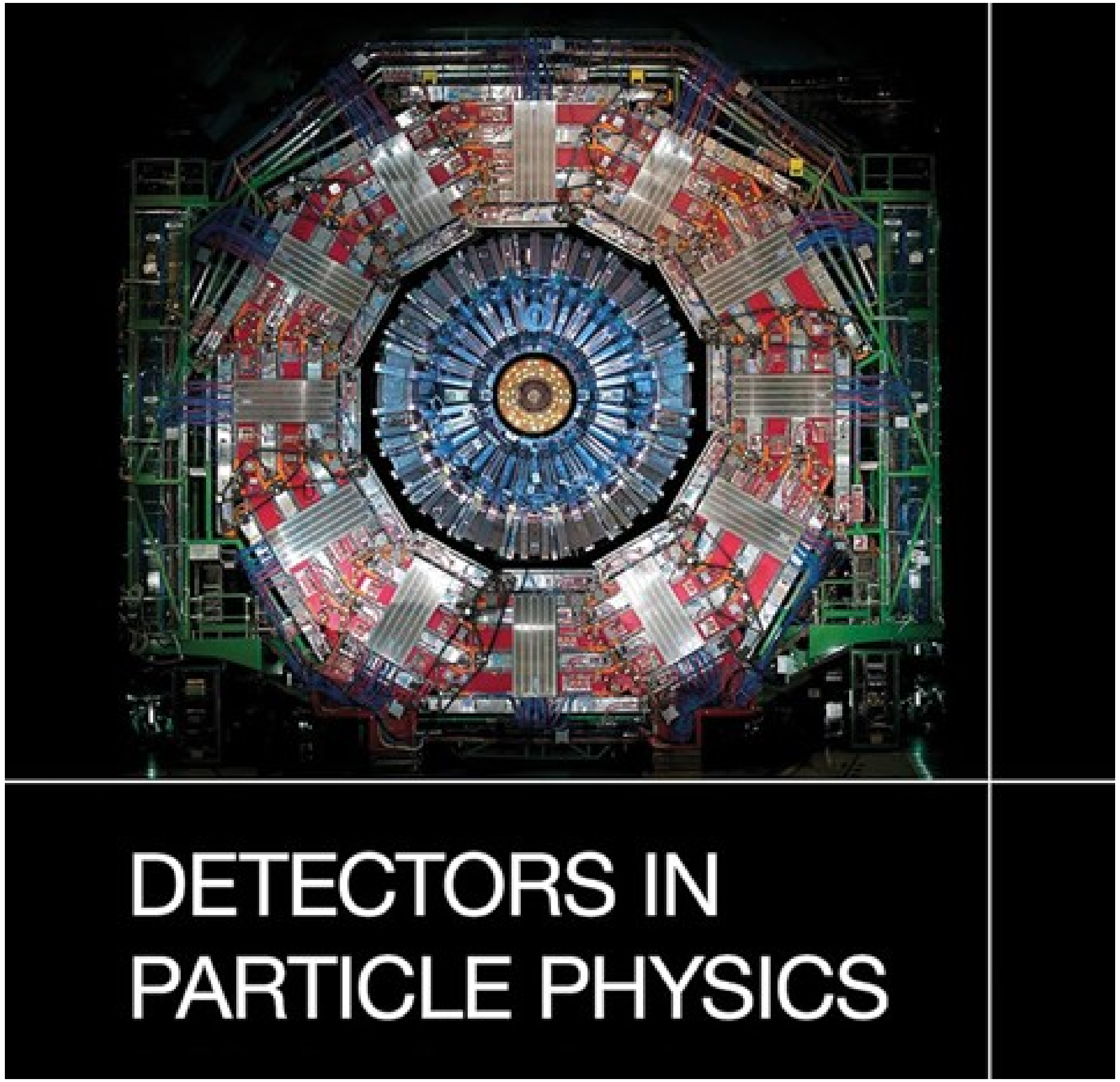
We begin with one example:

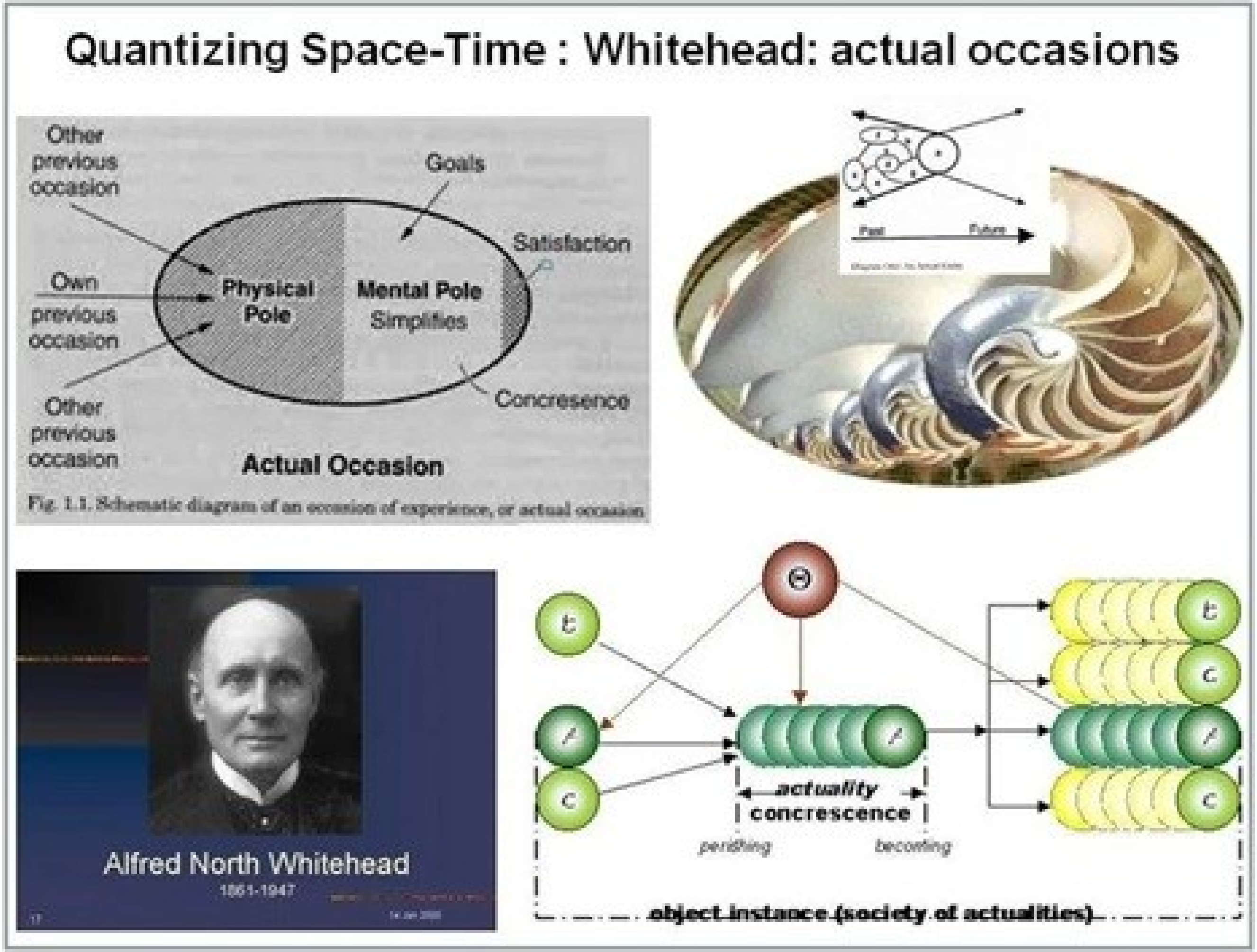
- A particle-like detection

This is:

- A physical event
- A measurable occurrence

→ Our first “actual occasion”





Actual Occasion

In Process Theology an "Actual Occasion" is:

- A concrete event
- Comes into being
- Not a thing
- Not persistent

→ A moment of realization

In physics:

- A detection event

- Same structure: a realized event

What We Observe in Physics

Particle-Like Detection In physics:

- A detector registers
- A discrete energy transfer
- At a specific place and time

→ What we observe is an event

Connecting the Two

- Detection event
- Actual occasion

→ Same structure: a realized event

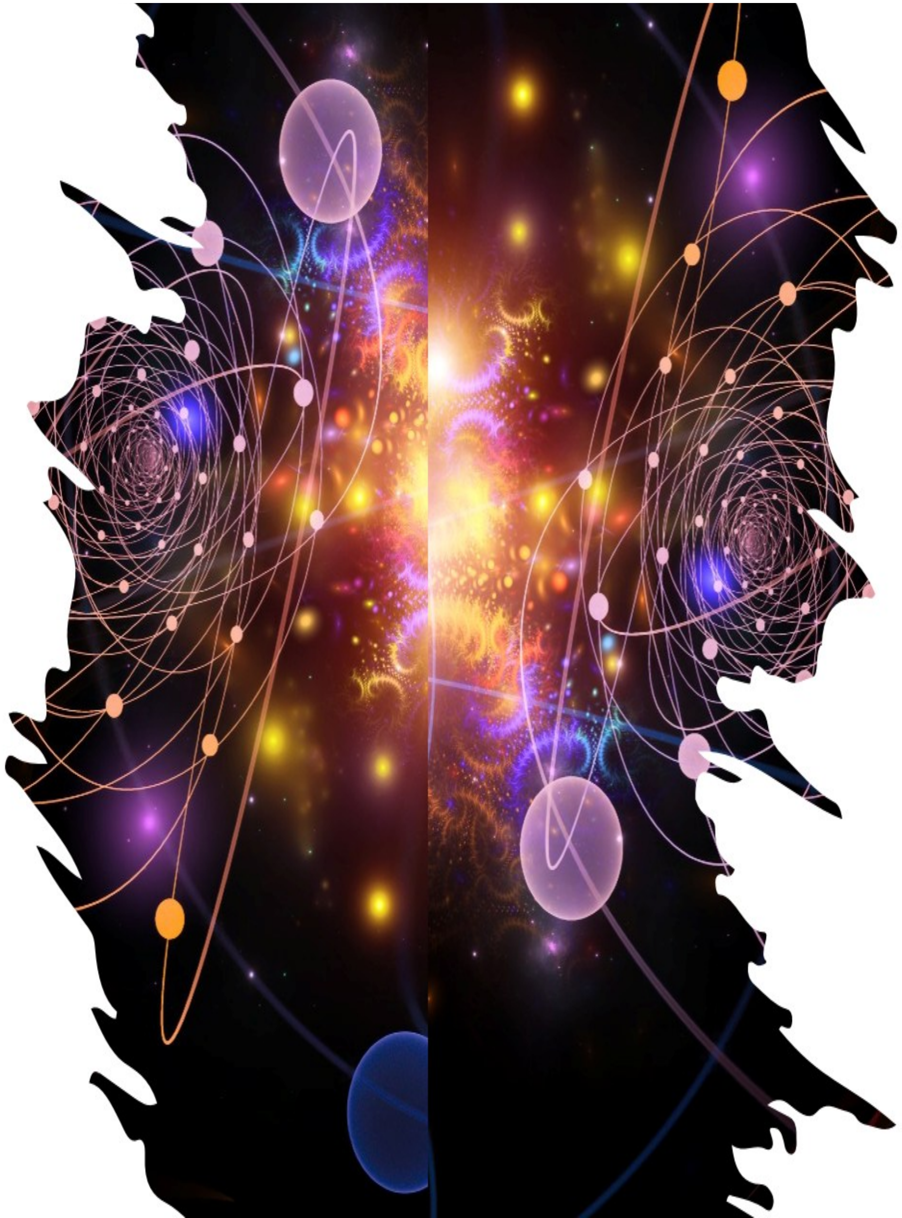
Note:

- This is an analogy
- Physics stands on its own

Three Roles: Possibility, Event, Pattern

Process Theology (Used as Intuition)

- **Primordial Nature**
  → Structured realm of possibilities
- **Consequent Nature**
  → Actualized events
- **Superjective Nature**
  → Emergence of pattern and order



Quantum Physics Model

- **Quantum State**
  → Defines possible outcomes
- **Detection Event**
  → Realized outcome
- **Probability Pattern**
  → Stable statistical distribution

Three Roles: Possibility, Event, Pattern

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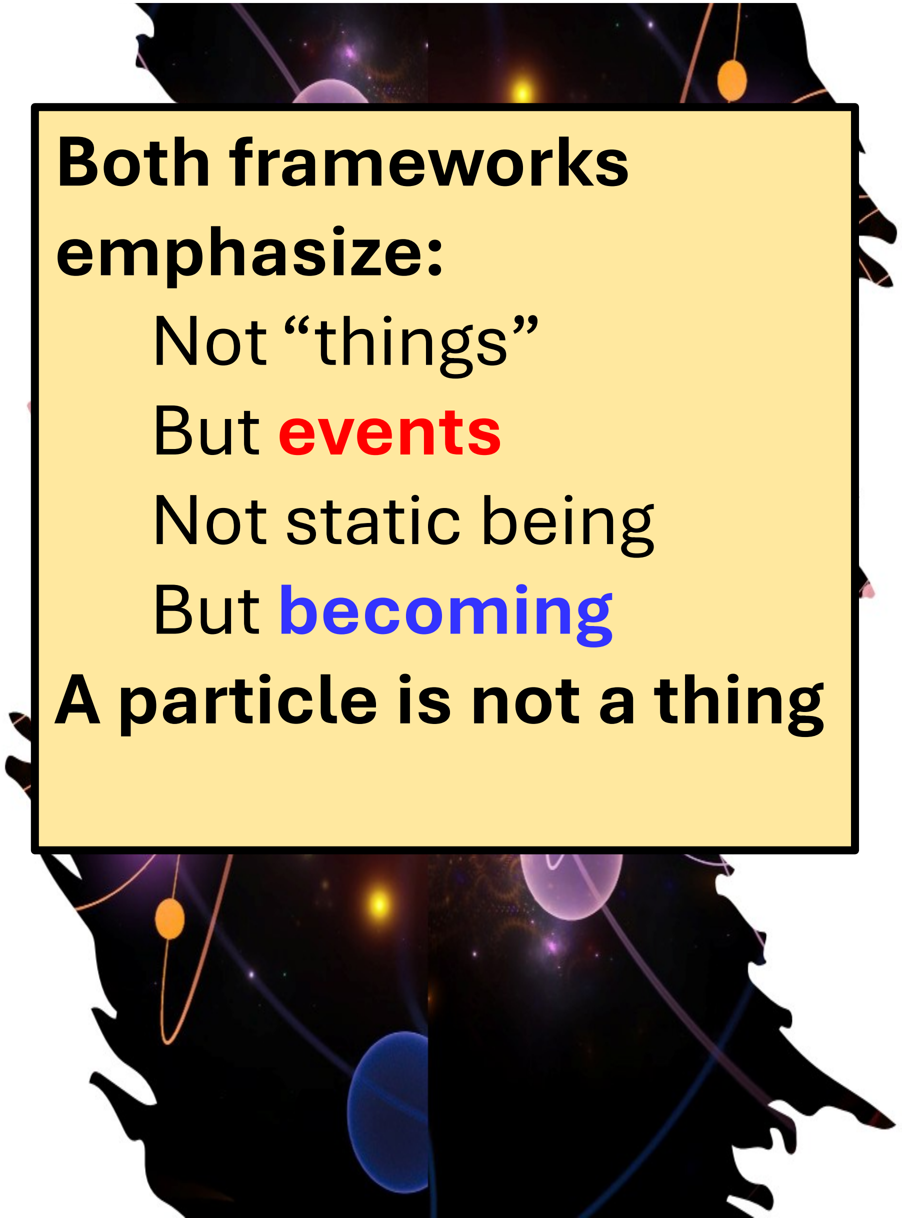

Both frameworks emphasize:

Not “things”

But **events**

Not static being

But **becoming**

A particle is not a thing

Quantum Physics Model

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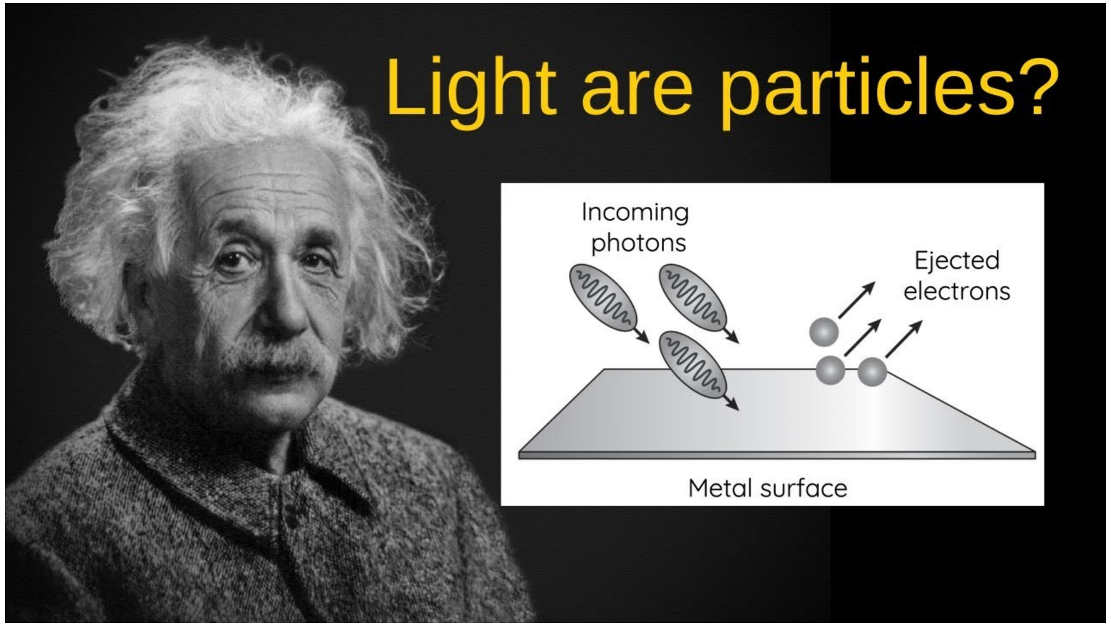
What Is a Particle?



What We Call a Particle

- Not something we see directly
- Not an object traveling
- A name we assign to a particle-like detection event
- A localized quantized energy packet recognized in detection

Based on:

- Mass
- Charge
- Spin

→ A particle is the identified type of a quantized energy-packet detection event

What Happens in Detection

What happens in a particle detector:

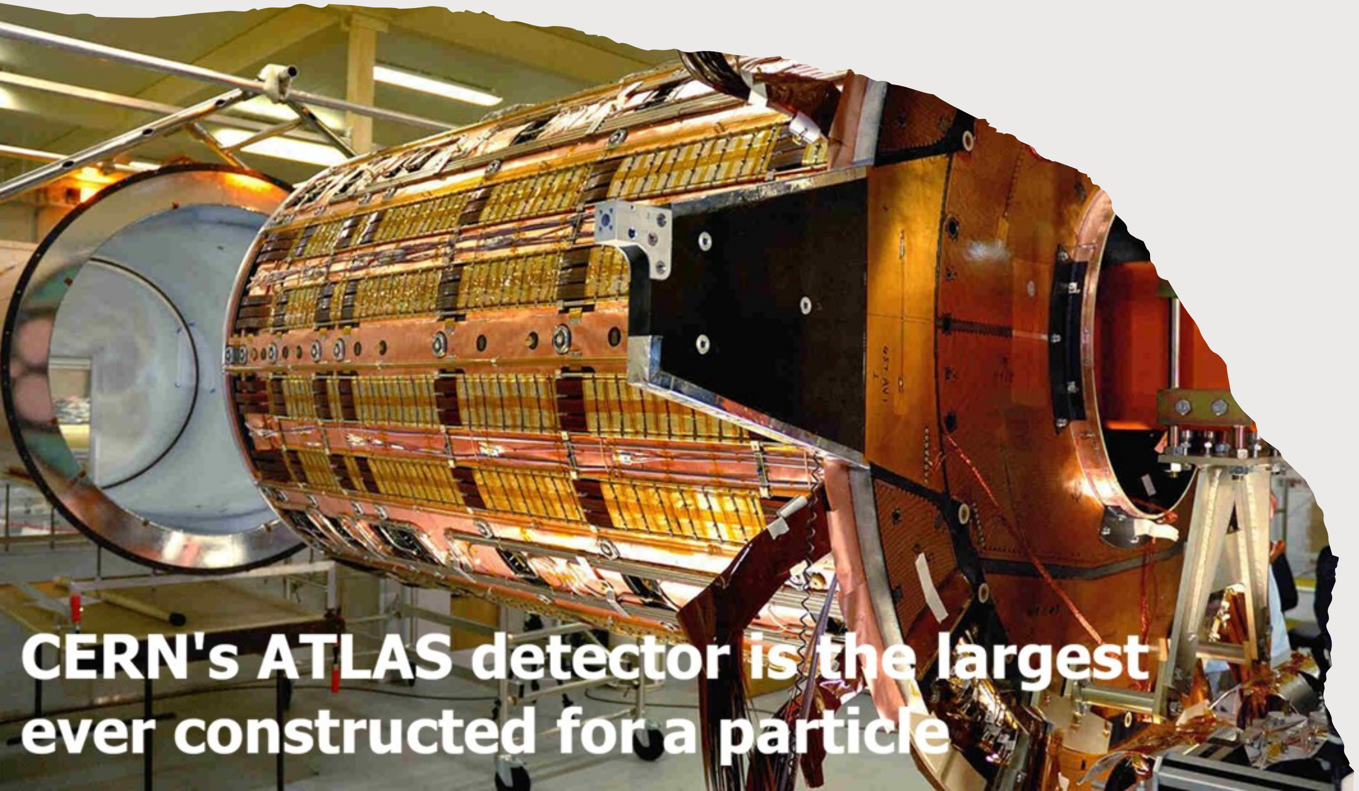
- Energy is transferred
- In a discrete amount
- Into the detector

→ Detection = quantized energy transfer

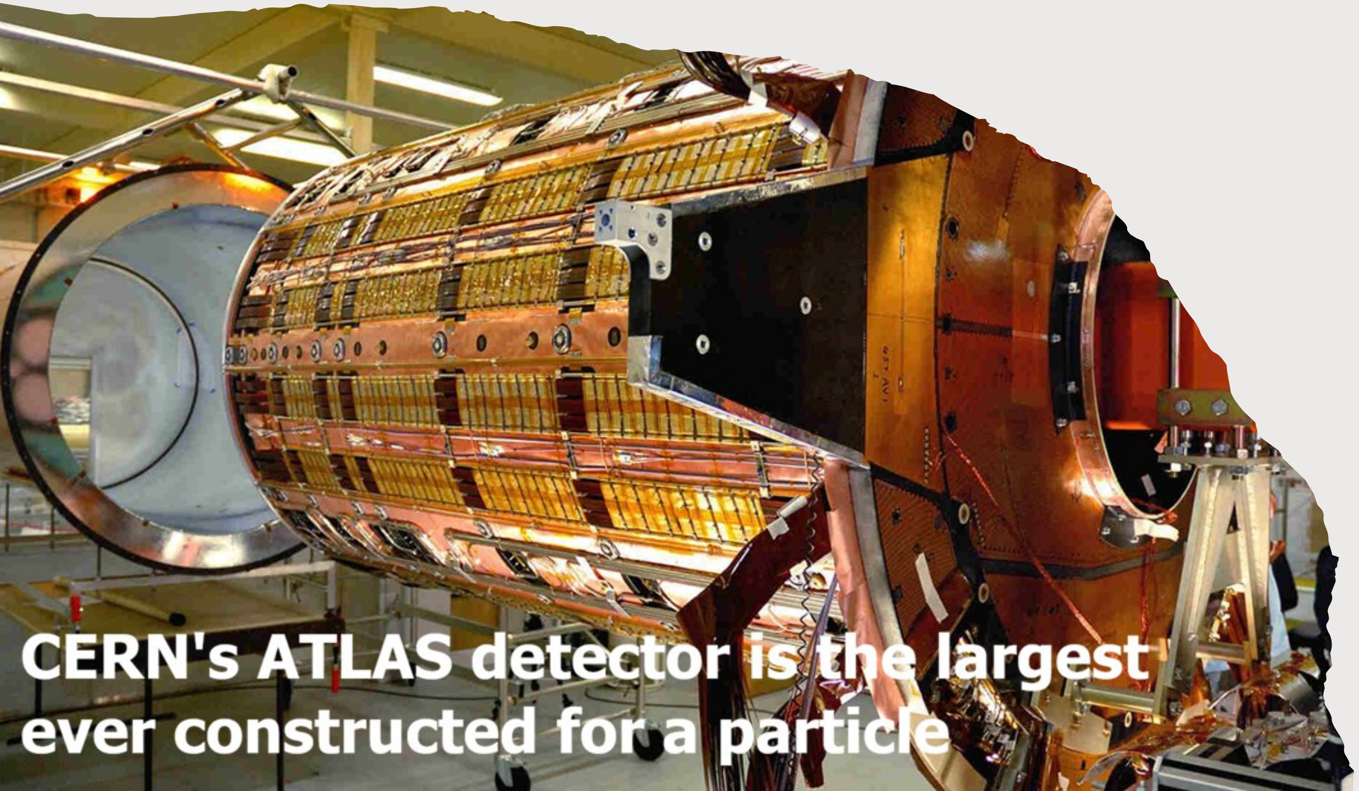
Elementary particle types are identified by characteristic properties such as:

- Mass
- Charge
- Spin

→ These properties identify the type of event observed



What Happens in Detection



A particle-detection event Is not:

- Detection of a tiny object arriving

But:

- A localized energy-transfer event occurring
- A quantized detector response being registered

The quantum model tells us:

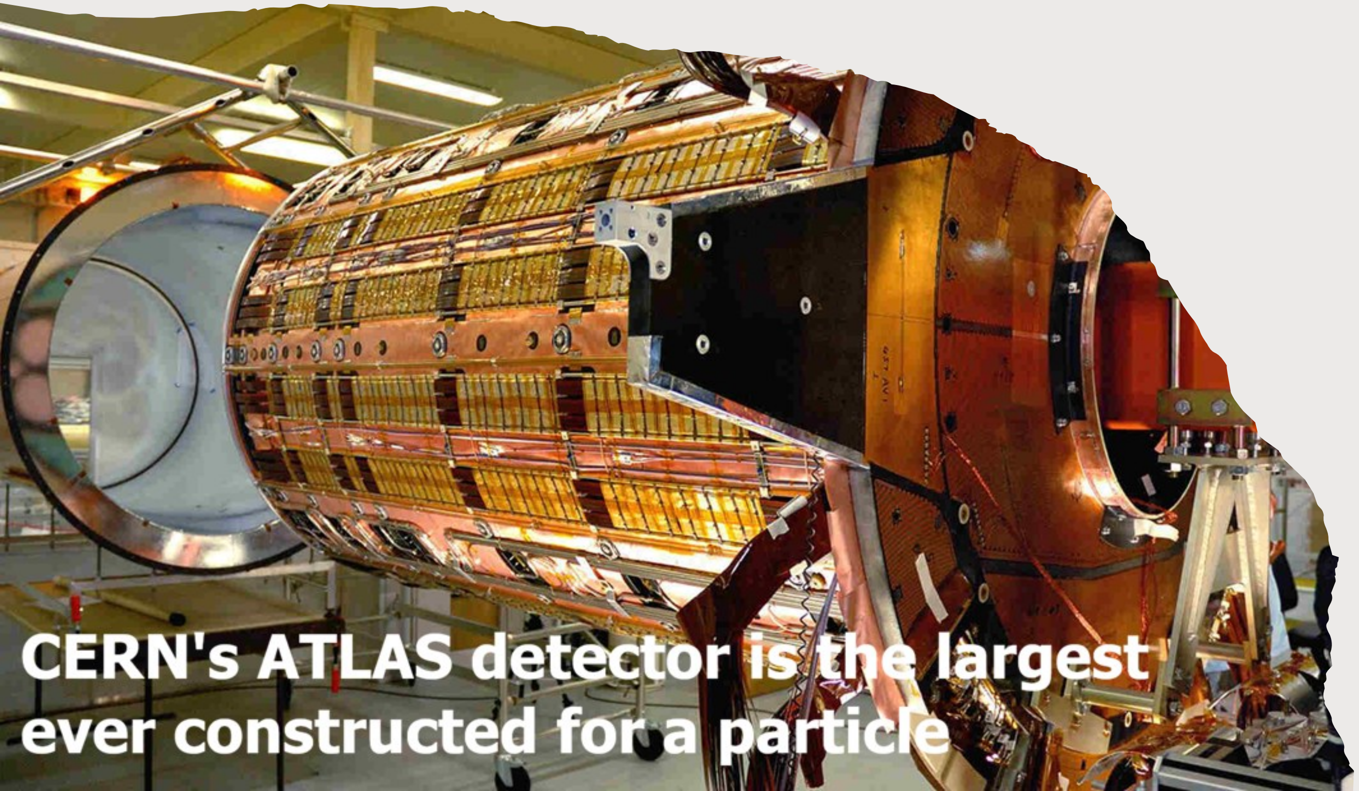
- How much energy, momentum, charge, and spin were transferred
- The statistical laws governing such events

The quantum model does not tell us:

- What underlying "thing" caused the event in transit

The "particle" is the label we assign to a detected quantized energy-transfer event

What Happens in Detection



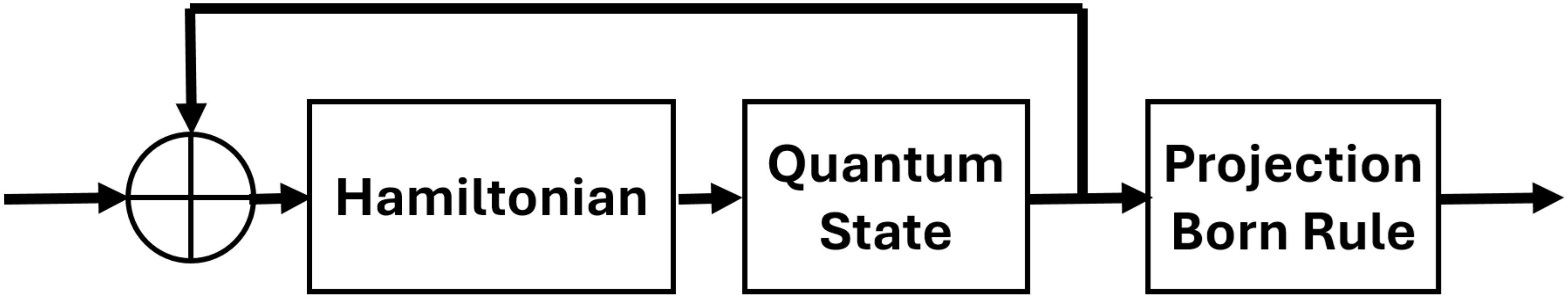
Types of Detection Events

Physics identifies recurring detection-event categories associated with elementary particles:

- **Six Leptons**
  - Electron, muon, tau, neutrinos (3 types)
- **Six Quarks**
  - Up/down, charm/strange, top/bottom
- **Six Bosons**
  - Photon, W/Z, Higgs, gluons and graviton (still has not been detected)

18 different kinds of detectable events

The Quantum State Machine Model Allows Us to Extremely Accurately Predict the Outcome of Physics Experiments



The Quantum Model is a standard state machine model

- The model has **three parts only**:
  - A space of possible states (**Hilbert Space**)
  - Rules for evolving the states (**Hamiltonian**)
  - Measurement rule (**Born rule**)
- **Nothing else is required for prediction**

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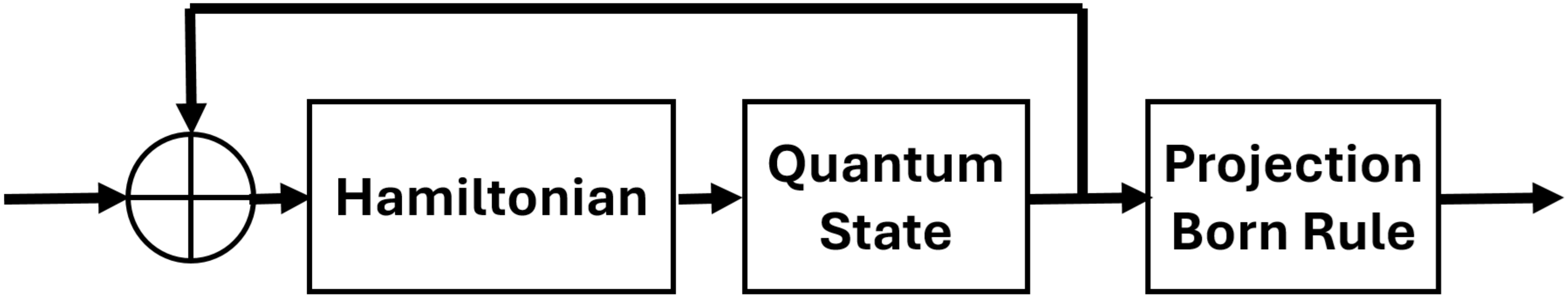

How the Quantum State Machine Model Is Typically Built

- We do not start directly with the quantum model
- We begin with:
- → A **classical Lagrangian**

The Lagrangian contains:

The fields (as variables)

Their interactions

The structure of the system

It is the starting blueprint of the theory

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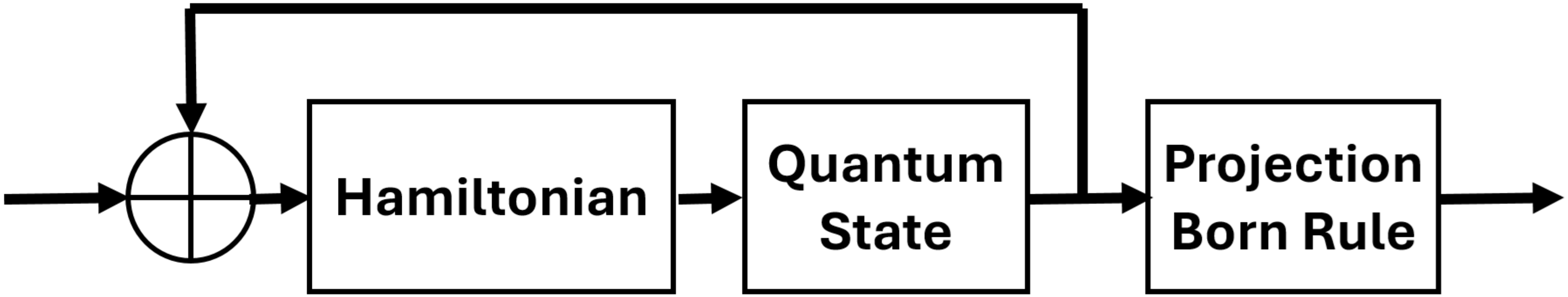


What Are "Fields" at This Stage?

- In the Lagrangian:
- Fields are **classical variables**

They describe:

- What can exist
- How it can change

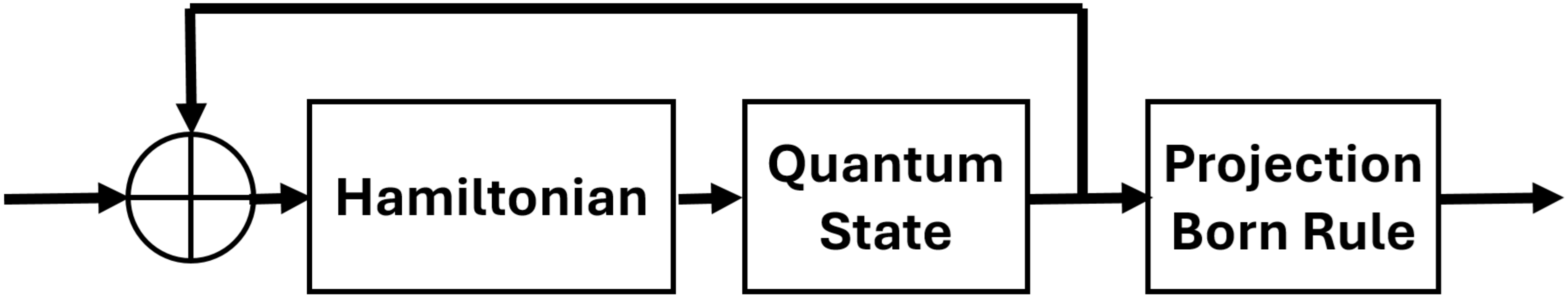
Examples:

- **Electron field**
- **Electromagnetic field**

These are not yet quantum objects

They are part of the starting description

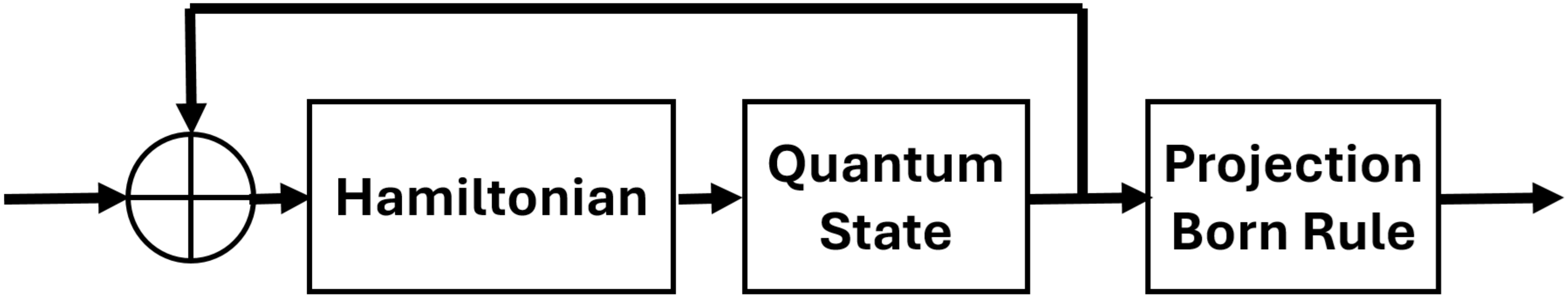
The Quantum State Machine Model Allows Us to Extremely Accurately Predict the Outcome of Physics Experiments



From Classical to Quantum

- Quantization is the mathematical process that turns the classical description into a quantum model
- From this process we obtain:
  - **Quantum states**
  - **A Hamiltonian (energy operator)**
- **This is where the classical framework is converted into a quantum theory**

The Quantum State Machine Model Allows Us to Extremely Accurately Predict the Outcome of Physics Experiments



The Final Structure of the Model

- Quantum fields are:
  - **Mathematical operators**
  - Acting on quantum states
- Their effects are already built into:
  - The **quantum states** (Hilbert Space)
  - The **quantum mathematical operators** (Hamiltonian)

So the final model consists of:

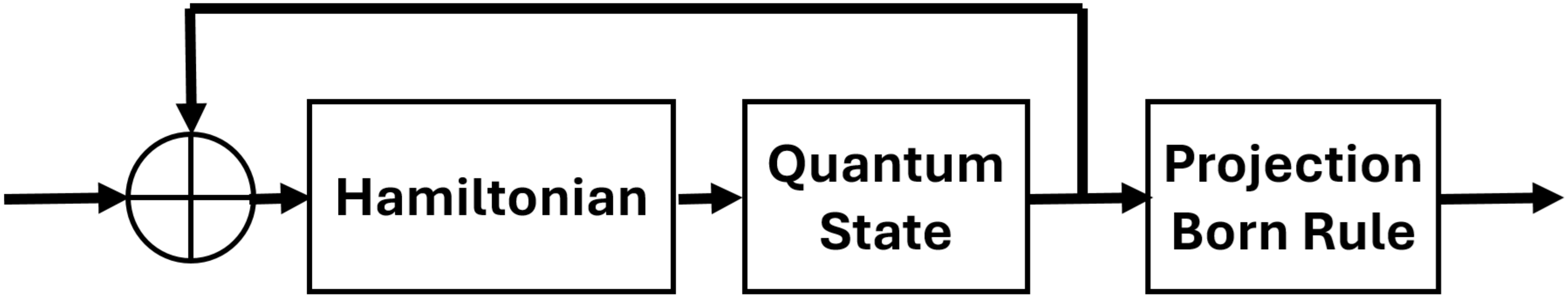
Quantum states

Hamiltonian

Born Rule

Fields are not a separate part because they are already encoded in the model

The Quantum State Machine Model Allows Us to Extremely Accurately Predict the Outcome of Physics Experiments



Quantum Physics Model

- Predicts **probabilities of detection events**
- Consists of three parts:
  - **Quantum states**
  - **Hamiltonian**
  - **Born Rule**

Predicts with extraordinary precision

- **Explains atoms, chemistry, and the stability of matter**
- **Powers semiconductors, lasers, microchips, MRI, and modern electronics**
- **Correctly models particle interactions and quantum phenomena**
- **Has never failed in its tested domain when properly applied**

The most successful predictive frameworks in human history

From Possibility to Event to Pattern

Conceptual Lens (Process Theology)

- Primordial Nature → Possibility
- Consequent Nature → Actual events
- Superjective Nature → Pattern

Possibility → Event → Pattern

- Next Session
  - → *What is a quantum state?*
  - → Understanding possibility
  - → Primordial Nature


"That's all Folks!"
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