# Beyond the One Electron Universe: Toward a Resonance-Based Foundation of Physics

## Introduction

Throughout the history of theoretical physics, the search for unity has repeatedly led to radical ideas. Maxwell unified electricity and magnetism. Einstein unified space and time. Quantum field theory replaced individual particles with underlying fields. Yet one of the most intriguing ideas ever proposed remains largely forgotten: the suggestion by John Archibald Wheeler, later popularized by Richard Feynman, that every electron in the universe might actually be the same electron traveling repeatedly through spacetime.

Although originally presented as an elegant speculation rather than a complete physical theory, the "One-Electron Universe" continues to raise a profound question:

*What if the enormous diversity of matter is merely different manifestations of a single underlying dynamical object?*

This essay reviews the original Wheeler-Feynman idea, examines how modern physics has developed related concepts, discusses the Williamson–van der Mark electromagnetic particle model, and argues that an unexplored research direction may exist: a resonance-based ontology in which all elementary particles emerge as stable eigenmodes of a single self-consistent dynamical structure.

## Wheeler and Feynman's One-Electron Universe

The observation that motivated Wheeler was deceptively simple.

Every electron possesses exactly the same intrinsic properties:

- identical mass,
- identical electric charge,
- identical spin,
- identical magnetic moment.

Unlike macroscopic objects, no electron has ever been observed to differ from another.

Wheeler therefore asked an extraordinary question:

Suppose there is only one electron.

In this picture the electron repeatedly travels forward and backward through time. Whenever it moves backward in time it appears to observers as a positron. The immense population of electrons observed throughout the universe would simply represent multiple intersections of a single continuous worldline with our spacetime.

Feynman found the idea intellectually attractive and later acknowledged that it influenced his own thinking about antiparticles and the formulation of quantum electrodynamics.

The hypothesis, however, was never developed into a predictive theory. The observed asymmetry between electrons and positrons, together with the success of quantum field theory, caused it to remain a fascinating historical curiosity.

# From Particles to Fields

Modern physics has already moved partway toward Wheeler's philosophical position.

Quantum field theory no longer regards electrons as independent objects. Instead, electrons are excitations of a single electron field extending throughout spacetime.

This represents a conceptual shift:

There are not many fundamental electrons.

There is one electron field.

Individual electrons correspond to localized excitations of that field.

Although mathematically different from Wheeler's proposal, both perspectives replace multiplicity with a deeper unity.

# Williamson and van der Mark

Among the few researchers who attempted to reinterpret elementary particles in terms of electromagnetic structure are John G. Williamson and Martin B. van der Mark.

Their proposal differs fundamentally from both Wheeler and conventional quantum field theory.

Instead of treating the electron as a point particle, they propose that it consists of a single photon trapped in a closed toroidal trajectory.

In this model:

- mass arises from confined electromagnetic energy,
- spin results from the topology of the circulating field,
- charge emerges from the electromagnetic configuration,
- stability results from self-consistent resonance.

Matter therefore becomes a special form of confined radiation.

This approach is remarkable because it attempts to derive particle properties from geometry and dynamics rather than introducing them as fundamental constants.

Although the model has not become part of mainstream particle physics, it remains one of the closest modern realizations of the idea that matter may be a self-organized electromagnetic resonance.

# Modern Relatives of the Idea

Several contemporary research programs pursue related forms of unification.

## Transactional Quantum Mechanics

John Cramer and Ruth Kastner extended Wheeler and Feynman's absorber theory into the Transactional Interpretation.

Physical interactions become standing-wave "transactions" between advanced and retarded waves propagating in opposite temporal directions.

Resonance plays a central role.

## Topological Models

Researchers such as Sundance Bilson-Thompson investigate particles as topological structures rather than point-like entities.

Particles become braids, knots or topological defects.

Identity is determined by topology rather than substance.

## Emergent Space

Work by Fotini Markopoulou and others proposes that spacetime itself emerges from networks of more fundamental relations.

Geometry becomes secondary.

Structure becomes primary.

## Wolfram Physics

Stephen Wolfram's hypergraph program similarly attempts to derive particles, spacetime and quantum mechanics from repeated applications of a single computational rule.

Again, multiplicity emerges from one underlying process.

## Geometric Quantum Field Theory

Nima Arkani-Hamed's work on scattering amplitudes replaces much of conventional spacetime description with purely geometric structures such as the amplituhedron.

Fundamental physics increasingly appears to arise from mathematical structure rather than microscopic particles.

## An Unexplored Possibility

Despite these developments, one striking possibility remains surprisingly underdeveloped.

Suppose there exists only one fundamental dynamical object.

Not one electron.

Not one field.

Not one string.

But one self-consistent resonant structure.

Every elementary particle would then represent a stable eigenmode of this single object.

The differences between electrons, muons, quarks and photons would correspond to different resonance patterns rather than different fundamental entities.

The ontology changes completely.

Instead of asking

"What particle is this?"

we ask

"Which resonant mode is presently excited?"

## Resonance as the Fundamental Principle

Physics already relies heavily on eigenvalue problems.

Atoms possess discrete energy levels because only certain standing waves are stable.

Optical cavities support discrete resonant modes.

Musical instruments generate harmonics.

Crystalline solids possess phonon modes.

Quantum mechanics itself is fundamentally spectral.

It is therefore natural to ask whether elementary particles may likewise represent stable resonances of a deeper dynamical system.

Such a framework would naturally incorporate:

- Fourier analysis,
- nonlinear dynamics,
- topological stability,
- closed geodesics,
- Floquet theory,
- self-interference,
- spectral geometry.

The universe would resemble a cosmic resonator rather than a collection of independent particles.

## Philosophical Consequences

If all particles arise from one resonant object, individuality becomes emergent rather than fundamental.

Matter, radiation and perhaps even spacetime become different organizational states of the same underlying dynamics.

This picture echoes ideas from:

- Wheeler's One-Electron Universe,
- Bohm's Implicate Order,
- Williamson and van der Mark's electromagnetic particle model,
- modern topological physics,
- emergent spacetime,
- and information-based approaches to fundamental physics.

Yet it is distinct from all of them.

Its central postulate is resonance.

Reality would not consist of things.

Reality would consist of stable patterns.

## Why This Matters

The history of physics repeatedly demonstrates that apparent complexity often conceals profound simplicity.

Electricity and magnetism became electromagnetism.

Space and time became spacetime.

Matter and energy became equivalent.

The next unification may not involve discovering a smaller particle.

Instead, it may involve recognizing that particles themselves are not fundamental.

They may be the observable eigenmodes of one underlying self-resonant dynamical system.

Whether this vision ultimately proves correct remains unknown.

Nevertheless, it represents a coherent research direction connecting ideas that have traditionally been treated separately: Wheeler's single electron, Feynman's spacetime picture, Williamson and van der Mark's confined photon, topological particle models, emergent spacetime, and the increasingly geometric language of modern theoretical physics.

Perhaps the deepest question is no longer:

"*What is the fundamental particle?*"

Instead, it may be:

"*What is the simplest dynamical system capable of producing every stable resonance that we call reality?*"