

Beyond Particles Matter as Topology in an Electromagnetic Vacuum

Towards a Continuous Description of Matter and Gravitation

Abstract

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The history of modern physics can be interpreted as a gradual reduction of reality to ever smaller building blocks. Atoms became nuclei, nuclei became quarks, and quantum field theory ultimately replaced particles by point-like field excitations. Although extraordinarily successful, this framework leaves several conceptual questions unresolved. Why should nature be built upon mathematical singularities? Why should infinities arise that must later be removed through renormalization? Why should gravitation resist quantization while every other interaction is described through fields?

This essay explores a different possibility. Suppose the vacuum itself is the only fundamental entity. Matter, charge, inertia and gravitation are then not independent ingredients of reality but different manifestations of one continuous electromagnetic medium. In this picture an electron is not a point particle but a stable topological configuration of electromagnetic energy confined within a closed toroidal trajectory. Geometry replaces substance, and topology replaces particles.

The End of the Particle

The particle concept has always been an approximation. Every experimental observation of an elementary particle is ultimately an observation of electromagnetic interactions distributed over finite regions of space and time. The mathematical point is therefore never observed directly; it is an idealization.

Once matter is regarded as a localized field configuration rather than a point, many conceptual problems immediately change character. Infinite self-energy disappears because finite structures possess finite energy. Charge becomes a property of global geometry instead of an intrinsic label. Spin emerges from rotational topology rather than from an abstract internal degree of freedom.

Instead of asking what a particle is made of, the more fundamental question becomes: what stable geometries can exist within the vacuum itself?

The Vacuum as Physical Medium

Classical electrodynamics already suggests that empty space possesses measurable physical properties through the vacuum permittivity and permeability. Rather than treating these as immutable constants, one may regard them as constitutive properties of a dynamical medium.

The local propagation speed of electromagnetic disturbances is then

[$c(x)=.$]

Light speed is not interpreted as an independent universal constant but as the local response of the vacuum medium. Geometry and electrodynamics therefore become inseparable.

Toroidal Confinement

A propagating electromagnetic wave carries energy but normally disperses. The central hypothesis is that under special topological boundary conditions a wave may close upon itself and become self-consustaining.

The simplest stable geometry is not spherical but toroidal.

Within such a torus the electromagnetic field continuously circulates through two coupled rotations. If the phase requires two complete revolutions before returning to its initial state, the configuration naturally exhibits the familiar 720-degree symmetry associated with fermionic spin.

Spin therefore appears not as a mysterious intrinsic property but as a direct consequence of global topology.

Charge as Geometry

Gauss' law states that electric charge equals the flux of the electric field through a closed surface.

In conventional theory charge is introduced as an independent source term. Here the interpretation is reversed. The field exists first; charge is merely the topological consequence of its closed configuration.

The observed quantization of charge then reflects the existence of discrete topological classes rather than discrete material objects.

Matter becomes geometry.

Mass as Confined Energy

Einstein demonstrated that energy possesses inertia.

If electromagnetic energy becomes permanently confined inside a stable toroidal geometry, the total confined energy behaves as rest mass,

$$[E=mc^2.]$$

Mass therefore measures the amount of electromagnetic energy trapped within a stable topological structure.

The distinction between radiation and matter is reduced to one question: is the field free to propagate, or is it topologically confined?

Gravitation without Fundamental Gravity

General relativity describes gravitation as curvature of spacetime. Sakharov suggested that this curvature may itself be an emergent elastic response of the quantum vacuum.

Combining this idea with topological confinement leads to a remarkably economical picture.

Localized electromagnetic structures modify the vacuum. The modified vacuum changes its effective metric. The resulting metric governs the motion of all subsequent field configurations.

Matter curves the vacuum not because gravity is a separate interaction but because concentrated electromagnetic energy deforms the physical medium from which spacetime itself emerges.

Gravitation becomes elasticity rather than a fundamental force.

Singularities as Mathematical Artifacts

Point particles inevitably produce divergent energy densities. Black-hole singularities likewise indicate a breakdown of the continuum description.

If the vacuum changes its constitutive properties at extremely high energy densities, the local propagation velocity decreases, preventing unlimited energy concentration.

Instead of requiring renormalization after infinities appear, the theory prevents their formation altogether. Singularities are interpreted as artifacts of an incomplete mathematical idealization rather than physical entities.

A Different Ontology

The deepest implication is philosophical.

Modern particle physics begins with objects and derives fields.

The present framework begins with fields and derives objects.

The distinction is subtle but profound.

Reality consists not of particles moving through space, but of persistent patterns within a continuous medium. Matter resembles a vortex in a fluid: identifiable, stable and measurable, yet inseparable from the medium in which it exists.

In this sense an electron is no more an independent object than a whirlpool is independent of water.

Conclusion

Whether this programme ultimately succeeds depends not on its philosophical appeal but on its mathematical realization and experimental predictions. Nevertheless, it offers a coherent conceptual alternative to the particle ontology that has dominated twentieth-century physics.

If matter is topology, if gravitation is vacuum elasticity, and if the speed of light reflects the local state of the vacuum, then the apparent diversity of physical phenomena may arise from a single continuous substrate.

The goal is not to replace successful physics but to reinterpret it within a more economical ontology in which geometry, electromagnetism and gravitation become different expressions of the same underlying continuum.