

# The Vortex Æther Model: A 3D, Non-Relativistic Vorticity Approach to Gravity, Electromagnetism, and Quantum Physics

Omar Iskandarani<sup>1</sup>

<sup>1</sup>*Independent Researcher, Groningen, The Netherlands\**

(Dated: March 5, 2025)

# Abstract

This paper introduces the Vortex Æther Model (VAM), a non-relativistic theoretical framework in which gravitational, electromagnetic, and quantum phenomena emerge from structured vorticity in a superfluid-like medium. Unlike general relativity, which relies on four-dimensional spacetime curvature, VAM posits that rotating vortex knots in a three-dimensional Euclidean Æther generate the forces and quantized states observed in nature. By combining classical fluid dynamics with topological vortex theory, VAM reproduces key features of modern physics—such as gravitational attraction, quantized charge, and wave-particle duality—without invoking higher dimensions or spacetime curvature. Central to this model is the absolute time paradigm, wherein local time variations reflect changes in vortex-induced energy distributions rather than relativistic effects. The model supports experimentally accessible predictions, including superfluid-based analogs of frame-dragging and vortex quantization analogous to phenomena observed in helium II. Moreover, it includes fundamental constants, such as the vortex-core tangential velocity  $C_e$  and the Coulomb barrier radius  $r_c$ , which establish the scale for core rotation speeds and interaction strengths. Taken together, these elements offer a cohesive re-interpretation of atomic structure and macroscopic forces, suggesting that a unified, inviscid Æther explains the emergence of both classical and quantum behavior.

## I. INTRODUCTION

The concept of an all-pervading Æther has a long and storied history in physics, dating back to the 19th century when luminaries such as James Clerk Maxwell proposed that electromagnetic waves could not exist without a medium to sustain them.[1] Early experiments by Michelson and Morley challenged the rigid notion of a stationary Æther, and Einstein’s special relativity largely supplanted the idea by making the speed of light invariant in all inertial frames.[2] Subsequently, general relativity replaced the idea of a physical transmission medium with curved spacetime geometry.[3]

Yet even as relativity thoroughly reorganized our view of gravitation, modern developments in quantum field theory suggest that the “vacuum” may itself exhibit nontrivial properties, including zero-point energy and structure reminiscent of a fluid.[4] Meanwhile,

---

\* ORCID: 0009-0006-1686-3961; info@omariskandarani.com

superfluid studies—particularly in helium II—show that vorticity can exist in quantized bundles, pointing to a connection between the macroscopic principles of fluid rotation and the discrete nature of quantum states.[5]

Building on these insights, the Vortex Æther Model (VAM) offers an alternative: it envisions an inviscid, superfluid-like medium in which stable vortex knots, rather than point particles, are the loci of energy and circulation. In VAM, gravity arises not from spacetime curvature but from vorticity-induced pressure gradients; electromagnetism follows from structured vortex interactions, eliminating the need for additional dimensions or separate force carriers. Notably, VAM introduces specific constants—such as  $C_e \approx 1.0938456 \times 10^6 \text{ m s}^{-1}$ , the vortex-core tangential velocity, and  $r_e \approx 1.40897017 \times 10^{-15} \text{ m}$ , the Coulomb barrier radius—both of which appear in the derived relations for stable vortex structures.

In so doing, the model ties together core principles of classical fluid mechanics, knot theory, and quantum mechanics, culminating in a picture where absolute time remains intact, and time dilation effects emerge from changes in vortex rotation rather than from relativistic four-velocity. By replacing geometric curvature with fluid-like circulation, VAM aims to bridge longstanding gaps between high-energy physics and classical descriptions of gravity, all within a three-dimensional Euclidean space. Subsequent sections will detail the mathematical formalism, including the reformulated field equations, derivation of quantum phenomena from vorticity quantization, and possible experimental avenues to probe or falsify this new Ætheric framework.

## PART I: FOUNDATIONAL CONSIDERATIONS

### II. SUPERFLUID-LIKE ÆTHER AND VORTICITY

At the heart of the Vortex Æther Model (VAM) lies the proposition that space is filled by an inviscid, superfluid-like medium—an Æther—whose key dynamical variable is vorticity. In classical fluid dynamics, vorticity  $\boldsymbol{\omega}$  is defined by

$$\boldsymbol{\omega} = \nabla \times \mathbf{v},$$

where  $\mathbf{v}$  is the local velocity field of the fluid. In an ordinary fluid, viscosity eventually diffuses vorticity. By contrast, the VAM Æther is assumed inviscid and potentially quantized, akin to superfluid helium where discrete vortex filaments can persist indefinitely without

dissipating. Building on ideas from Helmholtz and Kelvin—who proposed stable vortex rings in an inviscid fluid as analogs for atoms—this picture reinterprets fundamental particles and interactions in terms of persistent topological flow structures rather than pointlike entities. [6] [7]

### A. Fundamental Constants in the $\mathcal{A}$ ether

Within VAM, a small set of fundamental constants characterizes the structure and dynamics of this superfluid-like medium. Notable examples include the vortex-core tangential velocity,

$$C_e \approx 1.0938456 \times 10^6 \text{ m s}^{-1},$$

which sets the characteristic scale for rotational flow speeds, and the Coulomb barrier radius,

$$r_c \approx 1.40897017 \times 10^{-15} \text{ m},$$

which designates the minimal vortex-core size. These constants, together with a hypothesized “maximum force”  $F_{\text{max}}$  and an  $\mathcal{A}$ ether density  $\rho_{\mathcal{A}}$ , distinguish VAM from both standard quantum field theory and classical fluid approaches. Their precise numerical values derive from matching vortex-based formulations of charge and mass with empirically measured quantities—echoing how Planck’s constant arises from blackbody radiation yet underlies a host of quantum effects.[8]

### B. Gravitational Attraction via Vortex-Induced Pressure Gradients

A cornerstone of VAM is that what we typically describe as “gravitational force” is, in fact, a macroscopic manifestation of vortex-induced pressure gradients. Instead of invoking curvature in a four-dimensional spacetime, VAM treats mass concentrations as regions of heightened vorticity. By analogy with the Bernoulli principle, rotating fluids generate lower pressures at their cores, drawing other vortex structures toward them. In formula:

$$\nabla^2 \Phi_v = -\rho_{\mathcal{A}} |\boldsymbol{\omega}|^2,$$

where  $\Phi_v$  is a gravitational-like potential that emerges from the fluid’s vorticity. Regions of stronger vorticity lead to more pronounced pressure deficits, effectively producing an “attractive” force. Frame-dragging effects—classically modeled by relativistic metrics—become

natural consequences of fluid circulation, allowing rotating vortex knots to pull or twist nearby flows in ways that mimic general relativistic predictions.[9] This vorticity-based approach recasts gravitational phenomena in purely three-dimensional terms, aligning with the Euclidean spatial geometry central to VAM.

### C. Electromagnetism as Structured Vortex Interactions

Maxwell’s original insight into electromagnetic fields being states of stress in a medium inspires the VAM perspective that electric and magnetic fields correspond to stable vortex-flow configurations in the *Æther*. [10] Instead of positing separate force-carrying particles (photons) or curved four-dimensional fields, VAM defines “electromagnetic” effects in terms of circulation and linked vortex filaments. For instance, electric charges are understood as knotted vortex loops whose net winding number sets the charge magnitude. The Lorentz force law— $\mathbf{F} = q (\mathbf{E} + \mathbf{v} \times \mathbf{B})$ —arises from the exchange of vorticity and momentum between these loops, reproducing key electromagnetic phenomena without invoking extra dimensions.

### D. Quantum Features from Helicity and Knotted Vortices

Perhaps the most striking implication of VAM is its natural linkage between knotted vortex structures and quantum discreteness. In superfluid helium, quantized vortices have circulation in integer multiples of  $\kappa = h/m$ , suggesting that angular momentum and energy can only take discrete values in an inviscid, quantized flow.[11] VAM generalizes this principle by modeling electrons, protons, and other fundamental particles as stable vortex knots with conserved helicity:

$$H = \int \boldsymbol{\omega} \cdot \mathbf{v} \, dV.$$

Because helicity cannot continuously change without dissipating or reconnecting vortices, physical states become discretized, effectively mirroring the quantum energy levels observed in atomic systems. Wave-particle duality likewise emerges from the fluidic nature of vortex excitations, which can spread out as a wave yet remain localized by their topological core. Consequently, phenomena like electron orbitals, photon emission spectra, and spin angular momentum find a unified explanation in the dynamics of self-sustaining flow loops.

In this manner, VAM unifies gravitational, electromagnetic, and quantum behaviors under a single fluid-based framework. The superfluid-like  $\mathcal{A}$ ether, governed by vorticity and constrained by quantized circulation, serves as the substrate from which the familiar forces and quantum states of modern physics arise. The subsequent sections detail how these theoretical underpinnings translate into mathematical formulations, including explicit field equations and proposed experimental checks.

[12] [13] [14] [15]

## PART II: MATHEMATICAL FORMALISM

### III. DERIVATION OF THE VAM FIELD EQUATIONS FOR VORTICITY-DRIVEN GRAVITY

In the Vortex  $\mathcal{A}$ ether Model (VAM), gravity is not a manifestation of curved spacetime but rather emerges from the rotational dynamics of an inviscid  $\mathcal{A}$ ether. This chapter outlines a self-consistent derivation of the “field equations” that govern the gravitational potential,  $\Phi_v$ , in a vorticity-based framework. By analogy with classical fluid dynamics—and guided by the principle that local pressure deficits correlate with increased vorticity—VAM provides a closed-form set of equations to replace the mass-driven potential of Newtonian gravity or the stress-energy tensor of general relativity.

#### A. Motivating Principles

##### 1. *Vorticity as the Source of Gravitational Attraction*

Instead of identifying “mass density” as the root source of gravitational fields, VAM posits that local concentrations of vorticity in the  $\mathcal{A}$ ether generate pressure gradients. A region containing a high magnitude of vorticity  $|\boldsymbol{\omega}|$  corresponds to a lower fluid pressure, which in turn exerts an attractive influence on surrounding vortex structures. The resultant force mimics gravitational attraction—bodies move toward regions of elevated vorticity because those regions exhibit a pressure deficit.

## 2. *Æther as an Inviscid Superfluid*

The medium’s assumed inviscidity and superfluid-like properties allow persistent, non-dissipative vortices. Unlike ordinary fluids, where frictional forces diffuse vorticity, VAM’s *Æther* supports stable vortex filaments, thus acting as a permanent “blueprint” for the flow structures that induce gravitational-like effects.

## 3. *Absolute Time and Three-Dimensional Space*

VAM retains a strictly three-dimensional, Euclidean view of space, supplemented by an absolute time parameter. Phenomena usually explained by spacetime curvature—such as gravitational time dilation—are here reinterpreted in terms of vortex-induced energy distributions, rather than relativistic geodesics.

### **B. Preliminaries: Governing Equations of Fluid Vorticity**

Let  $\mathbf{v}(\mathbf{r}, t)$  be the local velocity field of the *Æther*. The vorticity field is defined by

$$\boldsymbol{\omega} = \nabla \times \mathbf{v}.$$

#### 1. *Ideal Fluid Assumptions*

*a. Incompressibility:* Although VAM often treats the *Æther* as effectively incompressible at many scales, certain cosmological extensions may relax this. Where incompressibility is assumed, we have

$$\nabla \cdot \mathbf{v} = 0.$$

*b. Inviscid Flow:* The *Æther* is devoid of viscosity, so the Navier–Stokes equations reduce to the Euler equations for an inviscid fluid. Hence, the evolution of vorticity follows the Helmholtz laws of vortex motion, ensuring that vortex lines are either closed loops or extend to infinity without dissipating.

*c. Bernoulli’s Principle for Inviscid Flow:* The fluid pressure  $p$  is inversely related to the local flow speed  $|\mathbf{v}|$ ; in regions of high vorticity, the effective pressure is minimal.

### C. Defining the VAM Gravitational Potential

In Newtonian gravity, one introduces a scalar potential  $\Phi$  satisfying

$$\nabla^2 \Phi = 4\pi G \rho,$$

where  $\rho$  is mass density. VAM replaces  $\rho$  by a function of vorticity, positing that local vortex strength—rather than mass—sets the scale of “gravitational” attraction. Specifically, define  $\Phi_v(\mathbf{r}, t)$  as the *vorticity-induced* gravitational potential. The core equation is

$$\nabla^2 \Phi_v = -\alpha \rho_{\mathcal{A}} |\boldsymbol{\omega}|^2, \quad (1)$$

where:

- $\alpha$  is a dimensionless proportionality constant (or set of constants) that calibrates the strength of vorticity-induced gravity,
- $\rho_{\mathcal{A}}$  is the density of the  $\mathcal{A}$ ether, potentially a (nearly) uniform background parameter,
- $|\boldsymbol{\omega}|^2 = (\nabla \times \mathbf{v}) \cdot (\nabla \times \mathbf{v})$  is the local vorticity magnitude squared, acting as the source term.

#### 1. Physical Interpretation of Equation (1)

*a. Sign of the Source Term:* The negative sign indicates that high vorticity (strong circulation) lowers  $\Phi_v$ , analogous to how mass density lowers  $\Phi$  in Newtonian theory.

*b. Units and Dimensional Consistency:* If  $\Phi_v$  has units of  $(\text{length})^2/(\text{time})^2$ , then  $\alpha \rho_{\mathcal{A}} |\boldsymbol{\omega}|^2$  must match these units after applying  $\nabla^2$ . This consistency imposes constraints on  $\alpha$ ,  $\rho_{\mathcal{A}}$ , and the definitions of the velocity field scale.

## IV. FROM VORTICITY TO EFFECTIVE FORCE

### A. The Gravitational-Like Force

In analogy with Newton’s law  $\mathbf{F} = -m\nabla\Phi$ , we let

$$\mathbf{F}_{\text{grav}} = -m_{\text{vortex}} \nabla \Phi_v.$$



However, VAM identifies  $m_{\text{vortex}}$  not with inertial mass in the sense of a rest mass but rather with the effective vortex “mass” derived from fluid inertia. This synergy of fluid density and vortex circulation ensures that objects experience an attraction toward regions of high  $|\boldsymbol{\omega}|^2$ , replicating the gravitational pull from standard theories.

## B. Frame-Dragging as Circulation

In general relativity, frame-dragging appears when rotating masses “twist” spacetime. In VAM, rotating vortex filaments *literally* drag  $\mathcal{A}$ ether flow lines. The velocity field  $\mathbf{v}$  includes swirl components around rotating cores, giving rise to a circulation  $\Gamma$ :

$$\Gamma = \oint_C \mathbf{v} \cdot d\mathbf{l},$$

which modifies the local gradient of  $\Phi_v$ . Regions near fast-spinning vortex cores thus feel larger net “gravitational” influence, paralleling the relativistic Lense–Thirring effect.

# V. LINKING THE VAM POTENTIAL TO OBSERVABLES

## A. Connection to Newtonian Limit

To verify consistency in low-vorticity (i.e., weak-field) regimes, we compare  $\Phi_v$  in (1) with the usual Newtonian gravitational potential  $\Phi$ . Suppose we linearize by assuming  $|\boldsymbol{\omega}|^2$  is small. Then (1) takes a form not unlike

$$\nabla^2 \Phi_v \approx -4\pi G_{\text{swirl}} \rho_{\mathcal{A}},$$

where  $G_{\text{swirl}}$  is an effective gravitational constant in VAM. Matching asymptotic behavior at large distances can reproduce standard inverse-square gravitational forces, provided the distribution of vorticity correlates with classical mass distribution.

## B. Vorticity–Mass Equivalence Hypothesis

While VAM does not strictly require a mass–energy equivalence, it suggests that what we call “mass” in ordinary physics may be an emergent phenomenon linked to stable vortex

configurations. In some variants of VAM, one imposes

$$\rho_{\text{eff}}(\mathbf{r}) = \kappa |\boldsymbol{\omega}(\mathbf{r})|^2,$$

allowing direct reinterpretation of the Newtonian Poisson equation with an “effective mass density”  $\rho_{\text{eff}}$ . This further cements how vorticity takes the role of mass as the source of gravity.

## VI. VORTICITY TRANSPORT AND CONSERVATION

### A. Vorticity Evolution

Because the  $\mathcal{A}$ ether is assumed inviscid, the Helmholtz vorticity transport law holds:

$$\frac{D\boldsymbol{\omega}}{Dt} = (\boldsymbol{\omega} \cdot \nabla) \mathbf{v} - (\nabla \cdot \mathbf{v}) \boldsymbol{\omega}.$$

In incompressible flow ( $\nabla \cdot \mathbf{v} = 0$ ), this simplifies further,

$$\frac{D\boldsymbol{\omega}}{Dt} = (\boldsymbol{\omega} \cdot \nabla) \mathbf{v}.$$

Within the VAM framework, these evolution equations ensure that vortex lines remain “frozen” into the flow: they can stretch, tilt, or reconnect (if allowed topologically), but they do not disappear by dissipation. Vortex stretching or compression directly modifies the local potential  $\Phi_v$  via equation (1).

### B. Helicity as a Constant of Motion

To accommodate quantum-like phenomena, VAM also introduces helicity,

$$\mathcal{H} = \int_{\Omega} \boldsymbol{\omega} \cdot \mathbf{v} \, dV,$$

as an integral of motion in ideal flows. Helicity conservation fosters stable, knotted vortex filaments, linking topological invariants to discrete energy levels in the gravitational field. As helicity cannot continuously change in an inviscid flow, the quantization of  $\mathcal{H}$  parallels the quantized angular momentum in quantum mechanics, further illustrating how “particles” might remain permanently bound states of the  $\mathcal{A}$ ether’s vorticity.

## VII. SUMMARY OF THE VAM FIELD EQUATIONS

Bringing these threads together, the fundamental field equation for vorticity-driven gravity in VAM can be compactly stated:

### 1. Vorticity-Gravity Poisson Equation

$$\nabla^2 \Phi_v = -\alpha \rho_{\mathcal{A}} |\boldsymbol{\omega}|^2.$$

### 2. Inviscid Flow Equation (Euler or Bernoulli in steady state):

$$\frac{\partial \mathbf{v}}{\partial t} + (\mathbf{v} \cdot \nabla) \mathbf{v} = -\frac{1}{\rho_{\mathcal{A}}} \nabla p,$$

with  $p$  inversely related to  $|\boldsymbol{\omega}|$ .

### 3. Vorticity Transport

$$\frac{D\boldsymbol{\omega}}{Dt} = (\boldsymbol{\omega} \cdot \nabla) \mathbf{v}.$$

For incompressible flow:  $\nabla \cdot \mathbf{v} = 0$ .

### 4. Helicity Conservation

$$\frac{d}{dt} \left( \int_{\Omega} \boldsymbol{\omega} \cdot \mathbf{v} dV \right) = 0 \quad (\text{ideal, inviscid flow}).$$

Together, these prescribe a self-consistent system that replaces mass-based gravity with vorticity-based “attraction.” In the weak-vorticity (or large-distance) limit, VAM reproduces familiar Newtonian forces; in more extreme regimes (fast vortex cores or large-scale circulations), it predicts novel behavior akin to frame-dragging and gravitational lensing, reinterpreted purely through fluid dynamics.

## VIII. CONCLUDING REMARKS

By deriving a vorticity-driven Poisson equation for the scalar potential  $\Phi_v$ , the Vortex  $\mathcal{A}$ ether Model provides a mathematical foundation for gravity that dispenses with four-dimensional spacetime curvature. Regions of concentrated vorticity function as “mass-like” sources, generating the lower-pressure zones that pull in other flow structures. This insight unifies gravitational phenomena with classical fluid principles, offering testable predictions—particularly in regimes of high rotational velocity or under conditions where superfluid

analogs can be studied experimentally. The next chapters will detail how these field equations integrate with electromagnetic-like interactions and yield quantized structures akin to the states of quantum mechanics, thus tying together three traditionally separate domains (gravity, electromagnetism, and quantum theory) into one coherent  $\mathcal{A}$ etheric picture.

## IX. ON THE EQUIVALENT OF MAXWELL’S EQUATIONS FROM VORTICITY

### A. Motivation and Conceptual Overview

In conventional electromagnetism, Maxwell’s equations describe how charges ( $\rho$ ) and currents ( $\mathbf{J}$ ) generate and respond to electric ( $\mathbf{E}$ ) and magnetic ( $\mathbf{B}$ ) fields. The Vortex  $\mathcal{A}$ ether Model (VAM) proposes a fluid-dynamic analogy: rather than postulating separate “electromagnetic” fields in vacuum, we interpret these as manifestations of circulation and topologically constrained vortex flows in an inviscid  $\mathcal{A}$ ether. Under this paradigm:

- **Electric field  $\mathbf{E}$**   $\longleftrightarrow$  A fluid “pressure-gradient” or potential-flow component in the  $\mathcal{A}$ ether, generally seen where vortex filaments originate or terminate.
- **Magnetic field  $\mathbf{B}$**   $\longleftrightarrow$  The rotational (solenoidal) component of the flow, i.e.  $\boldsymbol{\omega}$  or its vector-potential equivalent, generated by localized vortex tubes.
- **Charge density  $\rho$**   $\longleftrightarrow$  “Sources” or “sinks” of vortex flow, typically realized at the boundaries (or core) of knotted vortex structures.
- **Current density  $\mathbf{J}$**   $\longleftrightarrow$  Net transport of vortex fluid, reflecting how vortex filaments move or how vortex lines intersect a given surface.

By making these analogies, we can map the Maxwellian equations onto fluid equations in three-dimensional (3D) Euclidean space, thereby bypassing four-dimensional (4D) spacetime curvature or additional gauge dimensions.

### B. Formal Mapping

Consider a velocity field  $\mathbf{v}(\mathbf{r}, t)$  describing the  $\mathcal{A}$ ether’s motion. Its vorticity is

$$\boldsymbol{\omega} = \nabla \times \mathbf{v}.$$

In VAM, we introduce two vector fields,  $\mathbf{E}_v$  and  $\mathbf{B}_v$ , to serve as the effective analogs of electric and magnetic fields. Their definitions derive from decomposing  $\mathbf{v}$  into irrotational (“electric”) and solenoidal (“magnetic”) components:

1. **Irrotational component:**  $\mathbf{v}_{\text{irrot}} = -\nabla\Phi_v$ .

2. **Solenoidal component:**  $\mathbf{v}_{\text{sol}} = \nabla \times \mathbf{A}_v$ .

Hence, we can identify:

$$\mathbf{E}_v \equiv -\nabla\Phi_v, \quad \mathbf{B}_v \equiv \nabla \times \mathbf{A}_v,$$

where  $\Phi_v$  and  $\mathbf{A}_v$  play roles analogous to the usual electric potential  $\phi$  and magnetic vector potential  $\mathbf{A}$ . These “potentials” reflect vortex-flow potentials rather than electromagnetic fields in a vacuum.

### C. VAM Analogs of Maxwell’s Equations

#### 1. Gauss’s Law for Electricity

In electromagnetism,  $\nabla \cdot \mathbf{E} = \rho/\varepsilon_0$ . By analogy, if we treat local vortex “charge density”  $\rho_v$  as the source for  $\mathbf{E}_v$ , we obtain:

$$\nabla \cdot \mathbf{E}_v = \frac{\rho_v}{\varepsilon_v},$$

where  $\rho_v$  might represent the net “in/out flux” of vortex filaments in a given region, and  $\varepsilon_v$  is a VAM-defined permeability or coupling constant (analogous to  $\varepsilon_0$  in standard electromagnetism).

#### 2. Gauss’s Law for Magnetism

Maxwell’s  $\nabla \cdot \mathbf{B} = 0$  states that no magnetic monopoles exist. In VAM terms,  $\mathbf{B}_v = \nabla \times \mathbf{A}_v$  implies:

$$\nabla \cdot \mathbf{B}_v = \nabla \cdot (\nabla \times \mathbf{A}_v) = 0,$$

which expresses that vortex filaments form closed loops or extend to boundaries, never truly “originating” or “terminating” in the fluid interior.

### 3. Faraday’s Law of Induction

Conventionally,  $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ . In VAM, a changing  $\mathbf{B}_v$  (i.e., changing vorticity structure) manifests as circulation changes in the flow. Recast in fluid terms:

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

Physically, when local vortex lines move or reconnect, the irrotational flow  $\mathbf{E}_v$  must respond so as to maintain overall flow continuity.

### 4. Ampère–Maxwell Law

Maxwell’s corrected Ampère law is  $\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}$ . In VAM, introducing a “vortex current density”  $\mathbf{J}_v$  that describes net flux of vortex lines, the analogous relation becomes:

$$\nabla \times \mathbf{B}_v = \mu_v \mathbf{J}_v + \mu_v \varepsilon_v \frac{\partial \mathbf{E}_v}{\partial t},$$

where  $\mu_v$  and  $\varepsilon_v$  again play roles analogous to  $\mu_0$  and  $\varepsilon_0$ , respectively.

## D. Physical Interpretation: Charge, Current, and Waves

- **VAM “Charge”  $\rho_v$ .** In an inviscid fluid, the notion of vortex endpoints is largely topological: unless boundaries exist, vortex lines are closed loops. A net nonzero  $\rho_v$  implies that vortex lines effectively enter or exit a region (e.g., boundary surfaces or knotted cores), giving the impression of “charges.” When  $\rho_v \neq 0$ ,  $\mathbf{E}_v$  no longer remains purely divergence-free.
- **VAM “Current”  $\mathbf{J}_v$ .** Fluid flow carrying vorticity across a surface area is analogous to electric current in Maxwellian electromagnetism. For instance, a vortex line region translating at velocity  $\mathbf{u}$  through the  $\mathcal{A}$ ether can be assigned  $\mathbf{J}_v = \rho_v \mathbf{u}$ .
- **Electromagnetic-Like Waves.** One of Maxwell’s most profound insights was that coupled  $\mathbf{E}$ - $\mathbf{B}$  fields can propagate as waves at a characteristic speed  $c = 1/\sqrt{\mu_0 \varepsilon_0}$ . In VAM, coupling between  $\mathbf{E}_v$  and  $\mathbf{B}_v$  emerges from fluid continuity and vorticity conservation. Perturbations in the vortex flow can produce self-sustaining wave-like excitations, traveling at a speed  $v_{\text{wave}} = \frac{1}{\sqrt{\mu_v \varepsilon_v}}$ . The crucial difference: this wave is physically a fluid disturbance in the  $\mathcal{A}$ ether, not an abstract field in free space.

### E. Unified Picture: No Extra Dimensions Needed

Standard Kaluza–Klein or higher-dimensional theories embed electromagnetism in extra spatial dimensions to geometrize the coupling. By contrast, VAM retains a strictly 3D fluid framework:  $\mathbf{B}_v$  arises from vortex rotation,  $\mathbf{E}_v$  emerges from irrotational flow potential differences, and  $\rho_v$ ,  $\mathbf{J}_v$  capture effective “charges” and “currents.” All classical electromagnetic phenomena—from the Coulomb law to electromagnetic waves—have analogs in the fluid’s distribution of circulation.

### F. Future Work and Testable Predictions

- **Experimentally Observing Vortex “Charge”:** In principle, tabletop superfluid systems might display analogs of  $\rho_v$  if specially prepared boundary conditions force vortex lines to appear to start or end at a surface, mimicking the existence of net “charge.”
- **Propagation Speed  $v_{\text{wave}}$ :** Detailed experiments in superfluid helium or rotating Bose–Einstein condensates could identify wave-like excitations with distinct speeds that match the  $\frac{1}{\sqrt{\mu_v \varepsilon_v}}$  dependence.
- **Vorticity Reconnection:** Real electromagnetic fields allow line reconnection events (magnetic reconnection). VAM predictions about vortex reconnection in an inviscid fluid might show parallels in topological changes that mimic reconnection flares or pulses, possibly tested with carefully designed vortex-bundle experiments.

### G. Conclusion

By drawing a deep analogy between the velocity–vorticity decomposition of an inviscid fluid and the electric–magnetic field structure of classical electromagnetism, VAM furnishes a purely three-dimensional, fluid-based explanation for Maxwell’s equations. It thereby unifies gravitational and electromagnetic principles in a single vorticity-driven model, eliminating the need for higher-dimensional frameworks or a separate continuum for “fields.” Rather than abandoning Maxwell’s formalism, VAM reframes it as a consequence of topological vortex

flows in a superfluid  $\mathcal{A}$ ether—shedding new light on the nature of “charge,” “current,” and the propagation of electromagnetic-like waves.

---

## X. SWIRL VELOCITY CONSTANT $C_e$

### A. Physical Rationale

The swirl velocity constant  $C_e$  sets a characteristic rotational speed within the vortex-core region of the  $\mathcal{A}$ ether. Conceptually, it parallels how the speed of light  $c$  is fundamental to electromagnetism, with  $C_e$  being fundamental to vortex-based phenomena. In early formulations of VAM,  $C_e$  emerges from equating quantized vortex circulation (inspired by superfluid helium analogies) to known particle parameters (e.g., electron radius or Coulomb barrier radius).

### B. Typical Derivation Sketch

#### 1. Vortex Circulation

Recall that for a quantum vortex, circulation  $\Gamma$  is often quantized in integer multiples of  $h/m$ . If we assume one quantum of circulation for the “electron vortex” core of radius  $r_c$ , then

$$\Gamma = 2\pi r_c C_e \approx \frac{h}{m_e}.$$

Solving for  $C_e$  yields

$$C_e = \frac{h}{2\pi m_e r_c}.$$

#### 2. Matching Empirical Data

Substituting known constants (Planck’s constant  $h$ , electron mass  $m_e$ , and a chosen vortex-core radius  $r_c \approx 1.4 \times 10^{-15}$  m) yields a numerical value on the order of  $10^6$  m/s.

This constant characterizes the swirl at the core boundary for stable vortex knots.

---



## XI. GRAVITATIONAL COUPLING $G_{\text{swirl}}$

### A. Motivation

In VAM, gravity emerges from vortex-induced pressure gradients, rather than from mass-energy curvature. To unify this approach with observed large-scale gravitational phenomena, one introduces an effective gravitational constant  $G_{\text{swirl}}$ . While it reduces to the familiar Newtonian  $G$  at large scales, it differs fundamentally in how it couples to vorticity distributions rather than mass-energy tensors.

### B. Outline of the Derivation

#### 1. Poisson-Like Equation

VAM posits

$$\nabla^2 \Phi_v = -\rho_{\mathcal{A}} |\boldsymbol{\omega}|^2 \alpha,$$

where  $\alpha$  is a dimensionless parameter,  $\rho_{\mathcal{A}}$  is the  $\mathcal{A}$ ether density, and  $\boldsymbol{\omega}$  is the local vorticity. In a weak-vorticity limit, if one identifies  $\rho_{\mathcal{A}} |\boldsymbol{\omega}|^2$  with “mass density,” a constant emerges that parallels  $G$ .

#### 2. Matching the Newtonian Limit

When specialized to a static, spherically symmetric distribution of effective mass (or vortex concentration),  $\Phi_v(r)$  resembles  $-G_{\text{swirl}} M_{\text{eff}}/r$ . This sets

$$G_{\text{swirl}} \approx \alpha \frac{\rho_{\mathcal{A}} C_e^2}{\mathcal{F}(r_c)},$$

where  $\mathcal{F}(r_c)$  is a factor capturing the vortex-core radius and boundary conditions.

—

## XII. MAXIMUM FORCE $F_{\text{max}}$

### A. Conceptual Role

$F_{\text{max}}$  is proposed as an upper bound on force—somewhat analogous to the Planck force in quantum gravity contexts. In VAM, it can emerge from constraints on how vortex lines can transmit momentum under near- $c$  speed tangential flows.

## B. Illustrative Relation

If  $\mathbf{v}$  saturates at or below  $C_e$  in vortex cores, and the cross-sectional scale is  $r_c$ , then the maximum momentum flux across that core area leads to

$$F_{\max} \approx \rho_E C_e^2 \pi r_c^2$$

(plus dimensionless factors that depend on topological boundary conditions). Empirically, VAM often picks  $F_{\max} \approx 29 \text{ N}$  to match certain nuclear or near-nuclear scale interactions.

—

## XIII. CORRECTIONS TO TIME FLOW: KEY EQUATIONS

### A. Local Time “Dilation” in VAM

Although VAM adheres to absolute time globally, local vortex-core effects can modulate the rate at which clocks tick when placed in regions of strong swirl or vorticity. Derivations parallel the gravitational time-dilation in General Relativity but replace mass-based potentials with vortex-induced metrics.

In a simplified scenario, one obtains the “adjusted time”:

$$t_{\text{adjusted}} = \Delta t \sqrt{1 - \frac{2 G_{\text{swirl}} M_{\text{effective}}(r)}{r c^2} - \frac{C_e^2}{c^2} e^{-r/r_c} - \frac{\Omega^2}{c^2} e^{-r/r_c}},$$

where

- $G_{\text{swirl}}$  couples the effective mass/vortex concentration to the potential,
- $C_e^2 e^{-r/r_c}$  is an exponential correction capturing swirl velocity at or near the core boundary,
- $\Omega^2 e^{-r/r_c}$  incorporates rotational or frame-dragging terms from any net angular velocity  $\Omega$ ,
- $\Delta t$  is the “global” or far-field time interval,
- $r_c$  is the characteristic vortex-core radius that ensures short-range saturation of swirl or rotating flows.

### 1. Physical Meaning

- As  $r \rightarrow \infty$ , the exponentials vanish, leaving the usual Newtonian-like  $\sqrt{1 - 2G_{\text{swirl}}M_{\text{eff}}/(rc^2)}$ .
- In the near-core region ( $r \approx r_c$ ), large swirl or frame rotation strongly reduces the local ticking rate.

### B. Simplified Differential Form

In certain configurations, if only the exponential swirl term is dominant (e.g. ignoring  $M_{\text{effective}}(r)$  and  $\Omega$ ), the rate of local time relative to global time can be written:

$$\frac{dt_{\text{adjusted}}}{dt} = \sqrt{1 - \frac{C_e^2}{c^2} e^{-r/r_c}}.$$

This relation is particularly relevant for analyzing how time is slowed in close proximity to a stable vortex filament—analogueous to a “time-warp” near a strong gravitational field in relativity.

## XIV. FINAL BOXED EQUATIONS

Summarizing these key results, we highlight two essential time-rate expressions:

$$t_{\text{adjusted}} = \Delta t \sqrt{1 - \frac{2G_{\text{swirl}}M_{\text{effective}}(r)}{rc^2} - \frac{C_e^2}{c^2} e^{-r/r_c} - \frac{\Omega^2}{c^2} e^{-r/r_c}}$$

$$\frac{dt_{\text{adjusted}}}{dt} = \sqrt{1 - \frac{C_e^2}{c^2} e^{-r/r_c}}$$

Here:

1.  $G_{\text{swirl}}$  is the vorticity-based gravitational coupling.
2.  $C_e$  sets the swirl velocity scale in vortex cores.
3.  $r_c$  is the vortex-core radius controlling short-range vortex structure.
4.  $\Omega$  is a global or local rotation parameter that can augment or diminish time-flow adjustments.

5.  $M_{\text{effective}}(r)$  identifies how vortex distributions effectively mimic mass at scale  $r$ .

—

## XV. CONCLUDING REMARKS

These derivations unify multiple hallmark features of the Vortex  $\mathcal{A}$ ether Model:

- $C_e$  and  $F_{\text{max}}$  anchor the short-distance or high-vorticity behavior.
- $G_{\text{swirl}}$  ensures Newton-like gravity emerges at large distances while acknowledging vortex dominance near the core.
- Time Adjustment Equations capture the essential notion that “local time slows” in high-vorticity zones, paralleling gravitational time dilation in general relativity but implemented purely through a fluid-dynamic swirl framework.

By offering explicit functional forms, this approach paves the way for numeric and conceptual exploration—ranging from near-atomic scales (where  $r_c$  becomes critical) to astrophysical phenomena in rotating systems (where  $\Omega$  and large-scale vortex flows might be relevant).

## XVI. PHOTON AS A VORTEX DIPOLE AND ITS IMPLICATIONS FOR EFFECTIVE GRAVITATIONAL COUPLING

### A. Photon as a Vortex Dipole

In VAM, photons are modeled not merely as electromagnetic waves in vacuum, but as localized dipole-like disturbances in the  $\mathcal{A}$ ether’s vortex structure. Conceptually, this dipole arises when two mutually opposite vortical flows propagate together as a self-contained packet. Each vortex ring has an opposite circulation, so the net “charge” in the fluid sense cancels, yet a finite momentum and energy remain.

## B. Implications for Gravitational Coupling

Because photons in VAM carry quantized circulation, they contribute—albeit minimally—to the local vorticity distribution. Thus, the gravitational coupling an electromagnetic wave experiences or produces can be understood as a second-order effect of the fluid motion. In regimes where standard physics would assign photons zero rest mass, VAM still allows them to curve around strong vortex cores, giving an effective gravitational interaction consistent with lensing phenomena. This preserves the observational successes of light bending around massive bodies, while offering a fluid-based explanation of how “massless” quanta can be deflected.

## C. Summary

By replacing the abstract field concept with a vortex dipole structure, VAM naturally explains the localization and propagation of photons and their slight gravitational coupling—maintaining consistency with lensing experiments, Doppler shifts, and wave–particle duality. The detailed mathematics can be left to an appendix or integrated into the main electromagnetic formalism sections if space permits.

# XVII. VORTEX QUANTIZATION AND ELECTROMAGNETIC WAVE PROPAGATION IN VAM

## A. Vortex Quantization

Just as superfluid vortices in helium display quantized circulation, VAM stipulates a discrete circulation quantum in the  $\mathcal{A}$ ether. This quantization underlies both particle-like phenomena (localized vortex knots) and wave-like excitations (collective oscillations). Circulation in integer multiples of  $\kappa = h/m$  ensures certain modes or frequencies remain stable or resonant.

## B. Electromagnetic Wave Propagation

In the continuum limit, small-amplitude disturbances of the  $\mathcal{A}$ ether’s velocity potential (analogous to  $\mathbf{E}_v$  and  $\mathbf{B}_v$ ) propagate at a characteristic speed  $v_{\text{wave}} = 1/\sqrt{\mu_v \varepsilon_v}$ . Because the  $\mathcal{A}$ ether is treated as inviscid, these wave modes can travel long distances without dissipating, offering a direct analog to Maxwell’s electromagnetic waves—yet here interpreted entirely within a fluidic vorticity framework.

## C. Reconciliation with Observed Light Speed

Matching  $v_{\text{wave}}$  to  $c \approx 3 \times 10^8$  m/s constrains the VAM coupling constants  $\mu_v$  and  $\varepsilon_v$ . Consequently, typical experiments measuring the speed of light would detect the wave speed within the superfluidic  $\mathcal{A}$ ether, thus reaffirming observed invariants of light in a new conceptual guise.

# XVIII. CONNECTING ATOMIC ORBITALS IN VAM WITH VORTEX GRAVITY AND SPACETIME INTERPRETATION

## A. Atomic Orbitals in VAM

Traditional quantum mechanics depicts atomic orbitals as solutions to the Schrödinger or Dirac equations with Coulombic potentials. Within VAM, these potentials arise from vortex-driven pressure distributions in the  $\mathcal{A}$ ether. The electron orbits a nucleus not by classical revolution, but by forming a stable, quantized vortex ring around a central vortex core (the nucleus). This re-interpretation preserves the predicted energy levels while attributing them to topological constraints in fluid helicity.

## B. Vortex Gravity Near Atomic Cores

At short distances, vortex gravity (parametrized by  $G_{\text{swirl}}$ ) supplements electromagnetic-like interactions with additional “pressure deficits” near nucleons. Although minute, these effects may subtly alter high-precision spectroscopic measurements or contribute to phenomena typically explained by nuclear or QED corrections. In practice, the large ratio  $C_e/c$  and

small vortex-core scale  $r_c$  keep these gravitational-like contributions small but conceptually unifying.

### C. VAM Spacetime Interpretation

While relativity sees atomic clocks as subject to time dilation from mass or velocity, VAM redefines local time shifts in terms of vortex swirl, local circulation energy, and boundary constraints. In principle, one might interpret the nucleus (protons and neutrons as stable vortex knots) generating a local swirl field that modifies electron orbit times. Hence, “relativistic corrections” to orbital shapes—e.g. the fine structure—can be attributed to fluidic swirl velocities and the presence of near-core vortex drag.

### D. Conclusion

By embedding atomic orbitals within a vortex-gravity framework, VAM offers a single, overarching fluid interpretation that covers large-scale gravitational phenomena and microscopic quantum structures. This synergy strengthens the claim that the same fundamental vorticity principles underlie both atoms and astronomical bodies, without requiring separate sets of postulates for gravitational vs. quantum realms.

## PART III: APPLICATIONS AND IMPLICATIONS

### 1. The Electron as a Toroidal Vortex

#### 1.1 Conceptual Basis

Historically, Helmholtz and Lord Kelvin explored the idea that atoms might be stable knots in an inviscid fluid. In VAM, this idea is adapted to fundamental particles such as electrons. Instead of a pointlike charge, the electron is conceived as a toroidal vortex—a closed loop of rotating *Æther*—whose core flow and topology define quantized properties (charge, spin, rest mass).

#### 1. Toroidal Geometry

A torus can be described by two characteristic radii: the *major radius*  $R$  (distance

from the torus center to the core center) and the *minor radius*  $r$  (cross-sectional radius of the vortex tube). In many simplified VAM treatments, these radii are comparable (e.g., a “horn torus,”  $R \approx r$ ), ensuring localized, self-sustaining vorticity.

## 2. Quantization via Circulation

In superfluids, circulation around a vortex core is quantized in multiples of  $\kappa = h/m$ . Applying the same logic, an electron is identified with exactly one quantum of circulation in the  $\mathcal{A}$ ether. Matching observational data (e.g., Compton wavelengths, classical electron radius) allows one to solve for the swirl velocity constant  $C_e$  and the minor radius  $r_c$ .

## 3. Charge and Helicity

VAM posits that electric charge is a manifestation of boundary conditions on the vortex. In mathematical terms, a net winding number or linking of the vortex tube with itself (knottedness) plays the role of “charge.” Helicity (the integral  $\int \boldsymbol{\omega} \cdot \mathbf{v} dV$ ) remains conserved for inviscid, closed loops, explaining both stability and quantization.

### 1.2 Phenomenological Consequences

- **Wave-Particle Duality:** The toroidal vortex is localized in space yet can exhibit wave-like excitations in the surrounding  $\mathcal{A}$ ether field—paralleling electron wavefunctions in quantum mechanics.
- **Spin:** The intrinsic angular momentum of a knotted vortex is topologically pinned, explaining spin- $\frac{1}{2}$  as a stable, non-dissipative rotational state.
- **Self-Energy:** The electron’s rest mass can be attributed to vortex rotational energy. Within VAM, inertial mass emerges from the fluid’s resistance to changes in vortex circulation.



## 2. Black Hole Horizons as Extreme Vortex Interiors

### 2.1 Replacing Singularity with “Vortex Collapse”

In general relativity, black holes are defined by event horizons and central singularities. VAM interprets these regions as zones of ultra-strong vorticity where the fluid pressure becomes extremely low. Instead of a singularity in curved spacetime, one encounters an extreme vortex interior, possibly saturating velocity at or near the speed of light.

#### 1. Core Vorticity and “Schwarzschild-Like” Radius

By analogy with Schwarzschild black holes, one introduces a radius  $r_s$  where the swirl-induced potential approaches a critical threshold. VAM would say  $r_s$  is the boundary where the fluid velocity can no longer increase without structural breakdown.

#### 2. Horizons as Fluid Boundaries

Just as black holes have horizons inside which light cannot escape, a VAM-based horizon emerges where outward fluid flow is overwhelmed by inward swirl. Beyond this “horizon,” vortex filaments loop indefinitely, preventing external signals from escaping.

### 2.2 Frame-Dragging and Rotating “Black Holes”

When the vortex core itself rotates (an analog to a Kerr black hole), frame-dragging arises naturally from the fluid swirl. VAM reinterprets ergospheres and ring singularities as topological constraints in rotating vortex cores—no separate “spacetime metric” is needed. Instead, the rotational velocity at the boundary sets how severe the horizon is.

### 2.3 Possible Observable Signatures

- **Critical Vortex Speed:** Near the horizon, local swirl velocity might approach  $c$ . This could produce distinctive gravitational lensing or photon capture phenomena if the vortex geometry couples to electromagnetic waves.
- **Ringdown Patterns:** In a real rotating fluid, small perturbations cause wave excitations (“ringdown modes”) that could mimic black hole gravitational waves but be

interpreted purely through vortex fluid oscillations.

### 3. Vorticity-Based Explanation for Dark Matter

#### 3.1 The “Missing Mass” Problem

Astrophysical observations—spiral galaxy rotation curves, galaxy cluster dynamics, gravitational lensing—suggest more gravitational pull than accounted for by luminous matter. Dark matter is typically invoked to reconcile this discrepancy. VAM offers an alternative perspective: large-scale, low-density vortex flows in galactic halos may produce additional gravitational-like attraction without requiring new, non-luminous matter.

#### 3.2 Galactic Halos as Coherent Vortex Structures

##### 1. Extended Vorticity in Galaxy Disks

Many spiral galaxies display rotation curves that flatten at large radii. In VAM, if the interstellar medium and the halo form a gently rotating superfluid-like region, persistent large-scale vorticity could yield an effective gravitational potential well.

##### 2. Pressure Deficit

Just as in the local solar system, rotating fluids produce inward radial forces. The “dark matter halo” might simply be an extensive swirl region, its boundaries set by the galactic environment and the coherence length of the superfluidic  $\mathcal{A}$ ether.

#### 3.3 Predictions and Testable Consequences

- **No Additional Particle:** VAM eliminates the need for WIMPs or axions as an invisible matter component. Instead, it predicts that if one could measure the large-scale distribution of vorticity, it would track the “dark matter” gravitational potential.
- **Galaxy Clusters:** Vorticity filaments connecting galaxies in clusters might replicate the large-scale gravitational bridging effects typically attributed to dark matter, possibly visible in X-ray or gravitational-lensing signatures if the vortex flows compress hot gas.

- **Potential Offsets:** In phenomena like the Bullet Cluster (where dark matter distribution appears offset from baryonic mass after collisions), VAM might require specialized vortex-boundary conditions or shock effects. This can provide observational tests to either confirm or refine the vortex-halo idea.

#### 4. Concluding Remarks on Toy Models

Each of these toy models—the electron torus, black hole horizons, and dark matter halos—serves as an illustrative application of the VAM’s core principle: stable vortex flow in an inviscid  $\mathcal{A}$ ether can account for what we normally attribute to point-particle quantum mechanics, spacetime singularities, and large-scale invisible mass. While these ideas remain unconventional, they showcase how a single, fluid-based framework can unify diverse physical phenomena without resorting to extra dimensions or purely geometric curvature of spacetime. Future research must deepen these toy models—especially via numerical simulations of multi-scale vortex dynamics and further comparisons with astrophysical data.

## XIX. DISCUSSION / OUTLOOK

### Discussion and Outlook

#### 1. *Summary of VAM’s Core Innovations*

The Vortex  $\mathcal{A}$ ether Model proposes a three-dimensional, inviscid superfluidic medium in which gravity, electromagnetism, and quantum effects all emerge from vorticity interactions. By ascribing mass-like properties to stable vortex concentrations, VAM replaces the notion of “curved spacetime” or gauge-theoretical fields with topologically constrained fluid flow. This viewpoint unifies multiple branches of physics—classical fluid dynamics, quantum mechanics, and gravity—under a single set of governing principles based on vortex helicity and quantization.

#### 2. *Possible Experimental and Observational Tests*

##### 1. Superfluid Helium or Bose–Einstein Condensates (BECs)

- **Vorticity Quantization:** Experiments that generate knotted vortices or vortex rings in superfluid helium might reveal stable topological structures with discrete circulation—analogous to VAM’s discrete particle states.
- **Frame-Dragging Analogs:** Rotating superfluid containers (or rotating BEC traps) can be monitored to detect “dragging” effects on embedded vortex lines, mirroring gravitational frame-dragging in VAM.

## 2. Precision Spectroscopy

- **Shifts in Energy Levels:** Since VAM proposes subtle modifications to near-nuclear regions (e.g., vortex-boundary conditions), high-precision spectroscopy of atomic transitions might reveal anomalies in line shapes or Lamb shifts if vortex-induced pressure gradients differ slightly from standard QED.

## 3. Optical / Electromagnetic Tests

- **Propagation Speed and Refractive-Like Effects:** If the *Æther* is quantized, one could look for minuscule variations in the “speed of light” under extreme vorticity conditions, possibly detectable in advanced interferometry setups.
- **Polarization Dependencies:** VAM’s vortex “dipole” model of photons suggests certain polarization or phase-shift effects in strong background flows.

## 4. Astrophysical and Cosmological Observations

- **Galaxy Rotation Curves:** If large-scale cosmic vorticity can mimic the gravitational effects attributed to dark matter, observations of galactic halos or clusters (e.g., lensing data) could reveal signatures consistent with vortex swirl rather than discrete dark matter distributions.
- **Pulsar Frame-Dragging:** Precise timing of pulsars orbiting rotating compact objects (e.g., near black-hole candidates) could, in principle, distinguish between standard general-relativistic dragging and fluidic swirl-based predictions if they deviate in specific parametric regimes.

### *3. Open Theoretical Questions*

#### **1. Cosmology and Large-Scale Structure**

VAM’s premise that cosmic voids and filaments might be manifestations of large-scale vortex flows raises fundamental questions about cosmic inflation, the cosmic microwave background, and structure formation. Could early-universe turbulence (or vortex seeding) serve as an alternative to inflationary perturbations?

#### **2. Dark Matter and Dark Energy**

While VAM offers a swirl-based explanation for flat galaxy rotation curves, the broader dark energy puzzle remains. How do accelerating universal scales interplay with a vorticity-driven *Æther*? Might large-scale flows or expansions of vortex webs mimic cosmological-constant behavior?

#### **3. The Strong Nuclear Force**

VAM explains inertia and possibly electromagnetic phenomena through vortex circulation. However, the strong force exhibits complex confinement and asymptotic freedom, typically described via non-Abelian gauge theories. Could these behaviors emerge from multi-filament, knotted vortex states in a higher “density” zone of the *Æther*? Formulating a consistent fluidic analog for color confinement is challenging but remains an intriguing possibility.

#### **4. Unification with the Standard Model**

VAM reinterprets fundamental particles as stable vortex knots, but the Standard Model’s extensive success includes renormalization, gauge symmetries, and chiral anomalies. Any successful VAM-based unification must replicate these properties in a topologically rigorous manner. How non-Abelian gauge fields or spontaneous symmetry breaking would appear in purely fluidic terms is an open question.

### *4. Comparisons to Existing Fluid-Based Analog Gravity*

Several analog-gravity programs use condensed-matter or fluid systems (like Bose–Einstein condensates or shallow-water waves) to simulate aspects of spacetime curvature, horizons, or Hawking radiation. VAM shares this ethos of “geometry from fluid flows,” but pushes

the analogy to a literal reformulation of fundamental interactions:

- **Difference in Scope:** While most analog-gravity models treat the fluid system as an analogy that reproduces partial behaviors (e.g., horizon physics), VAM posits a full replacement for both electromagnetism and gravity.
- **Common Ground:** Both approaches rely on emergent phenomena in low-temperature or highly controlled fluid systems. Observations in analog systems that replicate black-hole metrics, event horizons, and wave excitations (Hawking-like radiation) can serve as indirect support for VAM’s core claims about fluid-based emergent gravity.

## 5. *Potential Pitfalls and Challenges*

### 1. **Compatibility with Precision Tests**

- **Gravitational Waves:** General relativity’s predictions for gravitational-wave speed and polarization have been tested to high precision. VAM would need to match these results or provide testable divergences that future detectors could confirm or refute.
- **Local Lorentz Invariance Tests:** High-precision experiments detect no significant anisotropy in the speed of light. Though VAM can replicate an “effective” constant wave speed, any minute anisotropy or fluid reference-frame effect must be shown to remain below current experimental thresholds.

### 2. **Quantum Field Theory Embedding**

The Standard Model’s success (especially in collider experiments) implies that any departure from standard quantum field theory must remain so subtle that it evaded detection thus far. Explaining the entire zoo of fermions and bosons purely by vortex knots remains an incomplete but tantalizing path.

### 3. **Vacuum Zero-Point Energy**

Quantum fluctuations, Casimir effects, and vacuum polarization have well-verified experimental signatures. VAM must show how fluid-based vorticity or the *Æther*’s density can produce the same measurable effects, including negative or positive vacuum energies observed in boundary-dependent phenomena.

#### 4. Complex Boundary Conditions

In both astrophysical and microscopic contexts, boundaries and topological constraints can be intricate (e.g., black-hole horizons, event horizon structures, or cosmic boundary conditions at large scales). Simplified vortex solutions may not carry over seamlessly to real astrophysical environments.

#### 6. Final Thoughts

The Vortex Æther Model sketches a bold alternative to the standard frameworks of relativistic gravity and quantum field theory, positing that fundamental forces and quantum phenomena emerge from the rotational flows of a superfluid-like medium. While its ambition is to unify gravity and quantum mechanics without the overhead of spacetime curvature or extra-dimensional gauge fields, VAM faces critical tests in both high-precision experiments and large-scale cosmological observations. Its possible successes—explaining wave-particle duality, clarifying dark matter phenomena, and merging with topological notions of particle physics—suggest it warrants continued theoretical development and cautious but creative experimental pursuit. The next steps include refining the model’s boundary conditions, comparing its predictions to advanced gravitational-wave and cosmological data, and exploring high-fidelity laboratory analogs that might mimic the exotic vorticity regimes invoked by VAM.

- 
- [1] Maxwell, James Clerk. *A Dynamical Theory of the Electromagnetic Field*. *Philosophical Transactions of the Royal Society of London*, vol. 155, 1865, pp. 459–512, doi:10.1098/rstl.1865.0008.
  - [2] Michelson, Albert A., and Edward W. Morley. “On the Relative Motion of the Earth and the Luminiferous Æther.” *American Journal of Science*, vol. 34, no. 203, 1887, pp. 333–345.
  - [3] Einstein, Albert. “The Foundation of the General Theory of Relativity.” *Annalen der Physik*, vol. 49, 1916, pp. 769–822, doi:10.1002/andp.19163540702.
  - [4] Wilczek, Frank. “Quantum Field Theory.” *Reviews of Modern Physics*, vol. 71, 1999, pp. S85–S95, doi:10.1103/RevModPhys.71.S85.
  - [5] Donnelly, Russell J. *Quantized Vortices in Helium II*. Cambridge University Press, 1991.

- [6] Helmholtz, Hermann. “On Integrals of the Hydrodynamical Equations which Express Vortex-Motions.” *Philosophical Magazine*, vol. 33, 1867, pp. 485–512.
- [7] Thomson (Lord Kelvin), William. “On Vortex Atoms.” *Proceedings of the Royal Society of Edinburgh*, vol. 6, 1867, pp. 94–105.
- [8] Wilczek, Frank. “Quantum Field Theory.” *Reviews of Modern Physics*, vol. 71, 1999, pp. S85–S95, doi:10.1103/RevModPhys.71.S85.
- [9] Donnelly, Russell J. *Quantized Vortices in Helium II*. Cambridge University Press, 1991.
- [10] Maxwell, James Clerk. “A Dynamical Theory of the Electromagnetic Field.” *Philosophical Transactions of the Royal Society of London*, vol. 155, 1865, pp. 459–512, doi:10.1098/rstl.1865.0008.
- [11] Barenghi, Carlo F., and Ladislav Skrbek. “Introduction to Quantum Turbulence.” *Proceedings of the National Academy of Sciences*, vol. 111, suppl. 1, 2014, pp. 4647–4652, doi:10.1073/pnas.1312549111.
- [12] Wilczek, Frank. “Quantum Field Theory.” *Reviews of Modern Physics*, vol. 71, 1999, pp. S85–S95, doi:10.1103/RevModPhys.71.S85.
- [13] Donnelly, Russell J. *Quantized Vortices in Helium II*. Cambridge University Press, 1991.
- [14] Maxwell, James Clerk. “A Dynamical Theory of the Electromagnetic Field.” *Philosophical Transactions of the Royal Society of London*, vol. 155, 1865, pp. 459–512, doi:10.1098/rstl.1865.0008.
- [15] Barenghi, Carlo F., and Ladislav Skrbek. “Introduction to Quantum Turbulence.” *Proceedings of the National Academy of Sciences*, vol. 111, suppl. 1, 2014, pp. 4647–4652, doi:10.1073/pnas.1312549111.

## APPENDIX 1. DETAILED DERIVATION OF THE SWIRL VELOCITY CONSTANT $C_e$

### 1. Quantum of Circulation: The Starting Point

In quantum fluids such as superfluid helium, vortex circulation is quantized in integer multiples of

$$\kappa = \frac{h}{m},$$



where  $h$  is Planck's constant and  $m$  is the mass of the fluid's constituent particle (e.g., the helium atom in superfluids). By analogy, VAM postulates that any stable vortex representing a fundamental particle (like an electron) must have circulation locked to a discrete value, typically  $\kappa$ .

### *1.1 Physical Interpretation in VAM*

- **Electron as a Torus**

VAM envisions the electron not as a point, but as a knotted or looped vortex in the  $\mathcal{A}$ ether, whose core radius is  $r_c$ .

- **Single Quantum of Circulation**

For the simplest (trefoil-like or single-loop) topology, one quantum  $\kappa$  is assigned—mirroring how an electron carries a single “charge.”

Hence, for the fundamental vortex representing the electron, the total circulation  $\Gamma$  around the loop is presumed to be

$$\Gamma = \frac{h}{m_e}.$$

Here  $m_e$  is the electron mass, playing the role analogous to the helium-4 atom mass in superfluids.

## **2. Geometry of the Vortex Loop**

### *2.1 Definition of Circulation $\Gamma$*

For a circular vortex ring of radius  $r_c$ , we assume that the tangential velocity at the ring is constant and labeled  $C_e$ . Circulation  $\Gamma$  is thus:

$$\Gamma = \oint_{\text{ring}} \mathbf{v} \cdot d\mathbf{l} = C_e \cdot 2\pi r_c,$$

since  $\mathbf{v} \cdot d\mathbf{l} = C_e dl$  around a circle of circumference  $2\pi r_c$ .

## 2.2 Matching Quantized Circulation

From the quantum condition above,

$$2\pi r_c C_e = \frac{h}{m_e}.$$

Solving for  $C_e$  yields:

$$C_e = \frac{h}{2\pi r_c m_e}.$$

This identifies  $C_e$  as the swirl (tangential) velocity at the vortex ring radius  $r_c$ , determined purely by fundamental constants ( $h$  and  $m_e$ ) and the chosen length scale  $r_c$ .

## 3. Connecting $r_c$ to Empirical Data

### 3.1 Choice of $r_c$

In VAM, one typically relates  $r_c$  to the “vortex-core radius,” which may be on the order of

$$r_c \approx 10^{-15} \text{ m},$$

often compared to nuclear or sub-nuclear scales (the proton or electron Compton radius). Different versions of the model might use:

- **Classical Electron Radius:**  $r_e \approx 2.8179 \times 10^{-15} \text{ m}$ , or
- **Coulomb Barrier Radius:**  $r_c \approx 1.4 \times 10^{-15} \text{ m}$ , or
- **Some fraction of the proton’s scale** based on high-energy scattering data.

Plugging in a chosen  $r_c$  leads to a numerical value for  $C_e$ . For instance:

$$r_c \approx 1.4 \times 10^{-15} \text{ m}, \quad m_e \approx 9.109 \times 10^{-31} \text{ kg}, \quad h \approx 6.626 \times 10^{-34} \text{ J s},$$

yields

$$C_e \approx 1.0 \times 10^6 \text{ m/s}.$$

### 3.2 Dimension Check

- Left side:  $[\text{Velocity}] = \text{m s}^{-1}$ .
- Right side:  $[h/(r_c m_e)]$ . Since  $[h] = (\text{J s}) = (\text{kg m}^2/\text{s}) \times \text{s}$ , dividing by  $(\text{kg}) \times \text{m}$  leaves  $\text{m/s}$ , matching the velocity dimension exactly.

## 4. Physical Interpretation and Implications

### 1. Bound on Tangential Velocity

The swirl velocity  $C_e$  effectively caps how fast the  $\mathcal{A}$ ether can rotate within the electron-like vortex core. This parallels how the speed of light  $c$  defines a universal limit for ordinary relativistic motion.

### 2. Link to Electron Charge and Mass

The link between  $\Gamma = h/m_e$  and the vortex geometry suggests that electron mass, charge, and spin might all be reinterpreted as emergent properties of stable vortex flow in the  $\mathcal{A}$ ether. VAM often couples this expression with others connecting, e.g.,  $\alpha \approx e^2/(4\pi\epsilon_0\hbar c)$  to show the synergy between electromagnetic constants and fluidic swirl.

### 3. Universality

While  $C_e$  is derived in the context of the electron, the same approach can define swirl velocities for other stable vortex knots (e.g., protons, neutrinos) by substituting the appropriate mass and length scale. Each yields its own characteristic swirl speed, potentially offering a topological reason for differing particle masses or quantum states.

## 5. Conclusion

This derivation of  $C_e$  reveals how a single quantum of circulation  $\Gamma = h/m_e$ , wrapped around a vortex core of radius  $r_c$ , leads to a characteristic tangential velocity scale:

$$C_e = \frac{h}{2\pi r_c m_e}.$$

When supplemented with a suitable choice for  $r_c$  based on nuclear or sub-nuclear measurements, it yields the  $\sim 10^6$  m/s swirl speed commonly cited in VAM literature. Consequently,

$C_e$  serves as a fundamental velocity constant for vortex-based models of the electron and, by extension, any elementary particle’s stable vortex structure—reinforcing VAM’s viewpoint that basic quantum parameters can be derived from fluid mechanical constraints in a superfluidic  $\mathcal{A}$ ether.

## APPENDIX 2. FULL POISSON-LIKE EQUATION FOR VORTICITY-BASED GRAVITY

### 1. Setting the Stage: Inviscid Fluid and Vortex Flow

#### 1.1 Euler’s Equation for an Inviscid Fluid

In VAM, the  $\mathcal{A}$ ether is assumed inviscid and (often) incompressible. Neglecting time dependence for simplicity or considering a near-steady flow, the Euler equation takes the form

$$\rho_{\mathcal{A}} (\mathbf{v} \cdot \nabla) \mathbf{v} = -\nabla p,$$

where:

- $\rho_{\mathcal{A}}$  is the density of the  $\mathcal{A}$ ether,
- $\mathbf{v}$  is the flow (velocity) field,
- $p$  is the fluid pressure,
- $(\mathbf{v} \cdot \nabla)\mathbf{v}$  denotes the convective acceleration.

#### 1.2 Local Pressure and the Emergent “Potential”

Unlike a conventional fluid, VAM postulates that *large* vorticity  $\boldsymbol{\omega} = \nabla \times \mathbf{v}$  lowers the local pressure. This pressure deficit acts similarly to how mass density generates gravitational pull. Define a scalar function  $\Phi_v(\mathbf{r})$  such that:

$$p(\mathbf{r}) = p_0 - \alpha \rho_{\mathcal{A}} \Phi_v(\mathbf{r}),$$

where  $p_0$  is a reference (far-field) pressure, and  $\alpha$  is a dimensionless coupling constant. Then

$$\nabla p = -\alpha \rho_{\mathcal{A}} \nabla \Phi_v.$$

Thus, Euler's equation becomes

$$\rho_{\mathcal{E}} (\mathbf{v} \cdot \nabla) \mathbf{v} = \alpha \rho_{\mathcal{E}} \nabla \Phi_v.$$

Canceling  $\rho_{\mathcal{E}}$  on both sides:

$$(\mathbf{v} \cdot \nabla) \mathbf{v} = \alpha \nabla \Phi_v. \quad (1)$$

## 2. Relating Convective Acceleration to Vorticity

### 2.1 Convective Acceleration Identity

A well-known fluid-mechanics vector identity states:

$$(\mathbf{v} \cdot \nabla) \mathbf{v} = \nabla \left( \frac{1}{2} |\mathbf{v}|^2 \right) - \mathbf{v} \times (\nabla \times \mathbf{v}) = \nabla \left( \frac{1}{2} |\mathbf{v}|^2 \right) - \mathbf{v} \times \boldsymbol{\omega}.$$

Hence equation (1) can be written as:

$$\nabla \left( \frac{1}{2} |\mathbf{v}|^2 \right) - \mathbf{v} \times \boldsymbol{\omega} = \alpha \nabla \Phi_v. \quad (2)$$

Rearrange it to:

$$\nabla \left( \frac{1}{2} |\mathbf{v}|^2 - \alpha \Phi_v \right) = \mathbf{v} \times \boldsymbol{\omega}. \quad (3)$$

Taking the curl of both sides yields

$$\nabla \times \left[ \nabla \left( \frac{1}{2} |\mathbf{v}|^2 - \alpha \Phi_v \right) \right] = \nabla \times (\mathbf{v} \times \boldsymbol{\omega}).$$

But the curl of a gradient  $\nabla \chi$  is zero, so the left side vanishes:

$$0 = \nabla \times (\mathbf{v} \times \boldsymbol{\omega}). \quad (4)$$

### 2.2 Expand $\nabla \times (\mathbf{v} \times \boldsymbol{\omega})$

Using the triple-vector identity,

$$\nabla \times (\mathbf{A} \times \mathbf{B}) = (\mathbf{B} \cdot \nabla) \mathbf{A} - (\mathbf{A} \cdot \nabla) \mathbf{B} + \mathbf{A} (\nabla \cdot \mathbf{B}) - \mathbf{B} (\nabla \cdot \mathbf{A}),$$

we set  $\mathbf{A} = \mathbf{v}$  and  $\mathbf{B} = \boldsymbol{\omega}$ . Thus

$$\nabla \times (\mathbf{v} \times \boldsymbol{\omega}) = (\boldsymbol{\omega} \cdot \nabla) \mathbf{v} - (\mathbf{v} \cdot \nabla) \boldsymbol{\omega} + \mathbf{v} (\nabla \cdot \boldsymbol{\omega}) - \boldsymbol{\omega} (\nabla \cdot \mathbf{v}).$$

Equation (4) demands this be zero:

$$(\boldsymbol{\omega} \cdot \nabla) \mathbf{v} - (\mathbf{v} \cdot \nabla) \boldsymbol{\omega} + \mathbf{v} (\nabla \cdot \boldsymbol{\omega}) - \boldsymbol{\omega} (\nabla \cdot \mathbf{v}) = 0. \quad (5)$$

In many VAM treatments,  $\nabla \cdot \mathbf{v} = 0$  (incompressibility) and  $\nabla \cdot \boldsymbol{\omega} = 0$  (the divergence of a curl is always zero). Then

$$(\boldsymbol{\omega} \cdot \nabla) \mathbf{v} = (\mathbf{v} \cdot \nabla) \boldsymbol{\omega}. \quad (6)$$

This condition underlies vortex conservation: if  $\boldsymbol{\omega}$  is large in one region, it must remain stable unless boundary interactions (or reconnection) intervene.

## Appendix A: Identifying a Poisson-Like Equation for $\Phi_v$

### 1. Bernoulli-like Relation and Pressure

From equation (3), we see that

$$\frac{1}{2} |\mathbf{v}|^2 - \alpha \Phi_v = \text{constant} \quad (\text{along streamlines}),$$

akin to the Bernoulli principle. Where vorticity is strong,  $\mathbf{v}$  is large, driving  $\Phi_v$  up or down accordingly.

### 2. Defining $\nabla^2 \Phi_v$

To find a connection between  $\Phi_v$  and  $|\boldsymbol{\omega}|^2$ , VAM posits a near-equilibrium relation where the local pressure deficit is proportional to  $|\boldsymbol{\omega}|^2$ . Equivalently, we let

$$p(\mathbf{r}) = p_0 - \alpha \rho_E \Phi_v(\mathbf{r}),$$

and we demand

$$\Phi_v \propto \int |\boldsymbol{\omega}|^2 dV \quad (\text{locally}),$$

so that if  $\boldsymbol{\omega}$  is large,  $\Phi_v$  is negative or “deep.” Making this local and differential, we propose an ansatz:

$$\nabla^2 \Phi_v = -\alpha \rho_E |\boldsymbol{\omega}|^2. \quad (7)$$

Here:

- The negative sign ensures that higher vorticity corresponds to a more negative  $\Phi_v$ , analogous to how higher mass density  $\rho$  in Newton’s law leads to  $\nabla^2\Phi = -4\pi G\rho$ .
- $\rho_{\mathcal{A}}$  sets the scale of the fluid’s inertia (i.e., how strongly it responds to rotation).
- $\alpha$  calibrates the coupling strength between vorticity magnitude and “gravitational potential.”

### 3. Physical Justification

#### 1. Analogy with Newtonian Poisson Equation

In Newtonian gravity,  $\nabla^2\Phi = -4\pi G\rho$ . By analogy,  $\rho_{\mathcal{A}}|\boldsymbol{\omega}|^2$  plays the role of an “effective mass density,” producing a negative potential.

#### 2. Stationary Flow Requirement

In regions of near-steady vortex flow, the net swirl remains approximately constant, so the potential  $\Phi_v$  must solve the above Poisson-like equation with appropriate boundary conditions ( $\Phi_v \rightarrow 0$  at large  $r$ , for instance).

#### 3. Empirical Matching

Parameter  $\alpha$  can be fitted to recover standard gravitational results at large distance (where vorticity correlates with mass distribution). In high-swirl regions (like near a black-hole analog or near nuclear-scale vortex knots), this potential saturates or modifies the local “gravitational” field.

### Appendix B: Final Boxed Equation

Thus, the fundamental field equation for vorticity-driven gravity in VAM takes the form:

$$\boxed{\nabla^2\Phi_v(\mathbf{r}) = -\alpha \rho_{\mathcal{A}} |\boldsymbol{\omega}(\mathbf{r})|^2},$$

where  $\boldsymbol{\omega} = \nabla \times \mathbf{v}$ ,  $\rho_{\mathcal{A}}$  is the  $\mathcal{A}$ ether density, and  $\alpha$  is a dimensionless coupling parameter. In analogy to standard Newtonian gravity,  $\Phi_v$  becomes more negative in regions of strong vortex flow, reproducing an “attractive” effect that draws other vortex structures inward.

## Appendix C: Concluding Remarks

### 1. Conceptual Shift

Rather than treating mass-energy as the source of gravitational potential, VAM places vorticity squarely in the driver’s seat. Regions with intense rotation (high  $|\boldsymbol{\omega}|$ ) generate deeper potentials and hence stronger “gravitational” pull.

### 2. Boundary Conditions and Extensions

Real systems may require boundary conditions that handle compressibility (in astrophysical or high-energy domains) or vortex reconnection events. These nuances can alter the strict Poisson form but keep the same core insight: *vorticity begets gravity-like forces*.

### 3. Next Steps

Using equation (7), one can solve for  $\Phi_v$  in specified geometries (e.g., rotating spheres, vortex filaments, or topological knots). Matching these solutions to observed gravitational phenomena (e.g., orbital velocities or lensing effects) offers a novel test of VAM’s validity and predictive power.

## Appendix D: Appendix 3. Extended Maxwell–VAM Equations in Index Form

### 1. Preliminaries and Notation

1. **Indices:** We use  $i, j, k \in \{1, 2, 3\}$  to refer to spatial coordinates  $x^1, x^2, x^3$ . Time is denoted as  $t$  or  $x^0$  in four-dimensional notation if needed, but VAM preserves a strict three-dimensional geometry with absolute time as an external parameter.

### 2. Fields:

- **VAM-Electric Field:**  $E_v^i(\mathbf{r}, t)$
- **VAM-Magnetic Field:**  $B_v^i(\mathbf{r}, t)$

These are derived from the underlying fluid velocity  $\mathbf{v}$  and its decomposition into irrotational ( $\nabla\Phi_v$ ) and solenoidal ( $\nabla \times \mathbf{A}_v$ ) parts. In many treatments:

$$E_v^i \equiv -\partial^i\Phi_v, \quad B_v^i \equiv \epsilon^{ijk}\partial_j A_{v,k},$$



where  $\Phi_v$  and  $\mathbf{A}_v$  play roles analogous to the scalar and vector potentials in standard electromagnetism.

### 3. VAM Charge and Current:

- **VAM-Charge Density:**  $\rho_v(\mathbf{r}, t)$
- **VAM-Current Density:**  $J_v^i(\mathbf{r}, t)$

These are effective sources or sinks of the vortex flow, representing how vortex filaments might “start” or “end” at boundaries or within certain knots.

### 4. Coupling Constants:

- **Permittivity-like constant:**  $\varepsilon_v$
- **Permeability-like constant:**  $\mu_v$

They set the strength and speed of wave-like excitations in the  $\mathcal{A}$ ether, analogous to  $\varepsilon_0, \mu_0$  in standard electromagnetism.

## 2. Gauss’s Law for VAM-Electric Field

In differential (index) form, the usual Gauss’s law  $\nabla \cdot \mathbf{E} = \rho/\varepsilon_0$  becomes:

$$\partial_i E_v^i = \frac{\rho_v}{\varepsilon_v}, \quad (1)$$

where  $\partial_i \equiv \frac{\partial}{\partial x^i}$ . This states that any net vortex “charge” density  $\rho_v$  produces a nonzero divergence in the field  $E_v^i$ .

## 3. Gauss’s Law for VAM-Magnetic Field

Because  $\mathbf{B}_v$  arises from rotating flows (akin to  $\nabla \times \mathbf{A}_v$ ), no “magnetic monopoles” exist in VAM:

$$\partial_i B_v^i = 0. \quad (2)$$

This condition expresses the purely solenoidal nature of vortex flows: vortex lines do not begin or end in free space (unless they meet boundaries or other vortex lines to form closed loops or knots).

#### 4. Faraday’s Law of Induction in VAM

The differential form of Faraday’s law,  $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ , in index notation becomes:

$$\epsilon_{ijk} \partial_j E_v^k = -\frac{\partial B_{v,i}}{\partial t}, \quad (3)$$

where  $\epsilon_{ijk}$  is the Levi-Civita symbol (with  $\epsilon_{123} = +1$ ). This implies that time-varying “magnetic” fields (i.e. time-varying vortex rotation patterns) induce an irrotational response in  $\mathbf{E}_v$ , preserving the fluid continuity.

#### 5. Ampère–Maxwell Law in VAM

In standard electromagnetism,  $\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \partial_t \mathbf{E}$ . The VAM analog is:

$$\epsilon_{ijk} \partial_j B_v^k = \mu_v J_{v,i} + \mu_v \epsilon_v \frac{\partial E_{v,i}}{\partial t}. \quad (4)$$

Here,  $\mathbf{J}_v$  is the effective “vortex current,” capturing how net inflows or outflows of vortex lines transit across a given area. Just as in Maxwell’s correction, a changing “electric” field ( $\partial_t E_{v,i}$ ) contributes to the curl of  $\mathbf{B}_v$ .

#### 6. Wave Propagation and VAM Light Speed

From (3) and (4), one can combine time derivatives and curls to show that  $\mathbf{E}_v$  and  $\mathbf{B}_v$  obey wave equations in vacuum-like regions (where  $\rho_v = 0$  and  $\mathbf{J}_v = 0$ ):

$$\partial_t^2 \mathbf{E}_v - \frac{1}{\mu_v \epsilon_v} \nabla^2 \mathbf{E}_v = 0,$$

and similarly for  $\mathbf{B}_v$ . This reveals a wave speed

$$v_{\text{wave}} = \frac{1}{\sqrt{\mu_v \epsilon_v}},$$

analogous to  $c = 1/\sqrt{\mu_0\varepsilon_0}$  in standard electromagnetism but now interpreted as the propagation speed of vortex-mediated disturbances in the  $\mathcal{A}$ ether.

## 7. Physical Interpretation and Unifying Principles

### 1. Irrotational vs. Solenoidal Components

The decomposition  $\mathbf{v} = \nabla\Phi_v + \nabla \times \mathbf{A}_v$  underpins the definitions of  $E_v^i$  and  $B_v^i$ . Source-like “charges” appear if vortex lines enter or exit a boundary; solenoidal loops remain closed, implying  $\partial_i B_v^i = 0$ .

### 2. Charge Conservation

Continuity equations in index form (not shown here) ensure  $\partial_t \rho_v + \partial_i J_v^i = 0$ , meaning net vortex “charge” is conserved in a closed system. This parallels electric charge conservation in standard Maxwell theory.

### 3. Comparisons with Standard Maxwell Equations

While the form of equations (1)–(4) closely mirrors Maxwell’s, the VAM interpretation is purely fluidic: no four-dimensional spacetime curvature or external gauge fields are needed. Instead, all phenomena follow from the velocity field’s topology and boundary conditions in 3D Euclidean geometry.

## 8. Concluding Remarks

The index-based Maxwell–VAM equations confirm that, at the level of mathematical structure, VAM and classical electromagnetism share striking parallels:

1. **Gauss’s Laws** ensure source-like behavior for  $\mathbf{E}_v$  and the solenoidal nature of  $\mathbf{B}_v$ .
2. **Faraday’s Law** and **Ampère–Maxwell** relations describe how time-varying vortex flows couple the two field components, giving rise to wave-like propagation.
3. **VAM Coupling Constants**  $\mu_v, \varepsilon_v$  replace  $\mu_0, \varepsilon_0$  and set a wave speed  $\frac{1}{\sqrt{\mu_v \varepsilon_v}}$ .

Hence, the index form not only makes the theory precise for potential numerical implementation but also underscores how VAM’s fluid-based approach recovers Maxwell’s structure in a purely 3D, vorticity-driven setting.

## APPENDIX 4. TIME-DILATION / “LOCAL TIME” EQUATIONS WITH EXPONENTIAL CORRECTIONS

### 1. Physical Motivation

In VAM, gravity is replaced by vortex-induced pressure gradients, and velocity fields near the vortex core can be significant. Analogous to how general relativity predicts local time dilation near massive bodies, VAM predicts local “slowing” of clocks inside regions of fast swirl. Instead of appearing as geometric curvature in a 4D manifold, this effect arises from the energy cost (or fluid stress) that local vortex circulation imposes on physical processes.

To quantify the phenomenon, one introduces an *adjusted time*  $t_{\text{adjusted}}$  measured by clocks in a high-swirl region, relative to a “far-field” or “global” time  $\Delta t$  measured far from the vortex.

### 2. The Core Equations: An Overview

In many VAM treatments, the final results are given in two forms:

1. A **comprehensive expression** that includes gravitational-like coupling  $G_{\text{swirl}} M_{\text{effective}}(r)$ , the swirl velocity constant  $C_e$ , a global rotation  $\Omega$ , and an exponential factor  $e^{-r/r_c}$ :

$$t_{\text{adjusted}} = \Delta t \sqrt{1 - \frac{2 G_{\text{swirl}} M_{\text{effective}}(r)}{r c^2} - \frac{C_e^2}{c^2} e^{-r/r_c} - \frac{\Omega^2}{c^2} e^{-r/r_c}}.$$

2. A **simplified local-time ratio** in scenarios where vortex swirl dominates over other terms:

$$\frac{dt_{\text{adjusted}}}{dt} = \sqrt{1 - \frac{C_e^2}{c^2} e^{-r/r_c}}.$$

The exponential  $e^{-r/r_c}$  captures how the swirl (or rotation) is strong near the vortex core (small  $r$ ) but decays at larger distances. The parameter  $r_c$  is the characteristic core radius beyond which vortex speed saturates or becomes negligible.

### 3. Starting Point: Vortex-Induced Energy Gradient

#### 3.1 Effective Potential and Local Clock Rate

In VAM, the local flow of time is posited to depend on the fluid’s energy distribution around a vortex. Specifically:

$$\Delta\tau(\mathbf{r}) \approx \Delta t \sqrt{1 - \frac{\Phi_{\text{fluid}}(\mathbf{r})}{c^2}},$$

where  $\Phi_{\text{fluid}}$  plays the role of a local energy potential (analogous to gravitational potential in standard physics). If  $\Phi_{\text{fluid}}$  is large and negative (due to swirl-induced pressure deficits), local clocks run slower relative to a reference observer at  $\Phi_{\text{fluid}} = 0$ .

#### 3.2 Including Exponential Swirl Terms

The fluid swirl near radius  $r_c$  typically follows a form:

$$v_\theta(r) \sim C_e e^{-r/r_c},$$

reflecting that tangential velocity saturates near the core and decays outward. One can show that such a velocity field modifies the local “clock rate” by adding terms proportional to  $\frac{C_e^2}{c^2} e^{-r/r_c}$ . A similar exponential term appears for an angular velocity  $\Omega$  if the entire structure has global rotation.

## 4. Derivation Outline

### 1. Define the Local Lapse Function

In analogy to relativity, one can define a “lapse” or rate function  $\alpha(r)$  that satisfies:

$$d\tau = \alpha(r) dt.$$

VAM sets  $\alpha(r) \approx \sqrt{1 - (\text{energy density} / \text{reference})}$ .

### 2. Contribution from Vortex Gravity

If there is an effective mass distribution  $M_{\text{effective}}(r)$  and swirl-based gravitational coupling  $G_{\text{swirl}}$ , the standard gravitational potential near radius  $r$  contributes a term

$$- \frac{2 G_{\text{swirl}} M_{\text{effective}}(r)}{r c^2}$$

inside the square root.

### 3. Swirl Velocity at the Core

For short-range swirl,

$$v_{\theta}^2(r) \approx C_e^2 e^{-r/r_c},$$

modifies the local energy budget. By comparing this swirl energy to the total fluid energy baseline, one arrives at the factor

$$-\frac{C_e^2}{c^2} e^{-r/r_c}.$$

### 4. Rotational Term

A global rotation  $\Omega$  near the vortex adds a further pressure deficit or frame-dragging-like effect:

$$-\frac{\Omega^2}{c^2} e^{-r/r_c}.$$

This captures the idea that rotating flows produce an additional local time adjustment, reminiscent of the Lense–Thirring effect in general relativity, but explained by fluid swirl here.

### 5. Combine Terms under the Square Root

Since these corrections are typically small, they appear as subtractions from unity inside the root. The final local time expression is:

$$t_{\text{adjusted}} = \Delta t \sqrt{1 - \frac{2 G_{\text{swirl}} M_{\text{effective}}(r)}{r c^2} - \frac{C_e^2}{c^2} e^{-r/r_c} - \frac{\Omega^2}{c^2} e^{-r/r_c}}.$$

### 5. Simplified Equation for Core-Dominated Time Flow

When the swirl term  $C_e^2 e^{-r/r_c}$  is the primary correction, ignoring gravitational and rotation:

$$\frac{dt_{\text{adjusted}}}{dt} = \sqrt{1 - \frac{C_e^2}{c^2} e^{-r/r_c}}.$$

**Interpretation:** At large  $r$ ,  $e^{-r/r_c}$  is negligible; the local clock rate nearly matches the global rate. Near  $r \approx r_c$ , the swirl velocity is maximal, producing the largest downward shift in time.

## 6. Physical Implications

### 1. Near-Core “Time-Warp”

The swirl velocity effectively slows down processes in the vortex interior, an alternative to relativistic time dilation. If  $C_e \approx 10^6$  m/s and  $r_c \approx 10^{-15}$  m, time flow is significantly modified on nuclear scales, though such effects remain imperceptible at macroscopic distances.

### 2. Frame-Dragging Analogs

The  $\Omega^2 e^{-r/r_c}$  term parallels the dragging of inertial frames in rotating solutions of general relativity (e.g., Kerr black holes). In VAM, it arises from swirl vortex lines near the rotating core.

### 3. Matching Observational Data

- **Atomic Clocks:** Subtle shifts in energy levels or clock rates in high-swirl environments (e.g., near rotating superfluid analogs) might test these predictions.
- **Compact Objects:** If black hole-like or neutron star-like objects are reinterpreted as extremely dense vortex cores, the same formula might guide how local time differs from a distant observer’s measure.

## 7. Concluding Remarks

The **time-dilation / local-time** equations in VAM repackage gravitational and rotational swirl effects into a single, three-dimensional fluid framework. Instead of four-dimensional spacetime curvature:

- $\frac{2G_{\text{swirl}}M_{\text{eff}}}{rc^2}$  mimics Newtonian-style gravitational potential,
- $\frac{C_e^2}{c^2}e^{-r/r_c}$  captures near-core swirl velocity,
- $\frac{\Omega^2}{c^2}e^{-r/r_c}$  encodes global rotation’s contribution.

This approach provides a conceptual and mathematical blueprint for investigating phenomena typically attributed to general relativity—like gravitational lensing or time dila-

tion—purely in terms of vortex flows, fluid helicity, and pressure gradients in an absolute-time, 3D Euclidean medium.

## APPENDIX 5. THE RELATION $\frac{\hbar^2}{2M_e} = \frac{F_{\max} R_c^3}{5\lambda_c C_e}$

This relation links fundamental quantum mechanical parameters ( $\hbar, M_e$ ) to VAM-specific constants ( $F_{\max}, R_c, \lambda_c, C_e$ ). The key idea is that a characteristic quantum energy scale  $\frac{\hbar^2}{2M_e}$  can be matched to a vortex-based expression involving maximum force, core radius, and swirl velocity, illustrating VAM’s unification of quantum and vortex phenomena.

### 1. Overview of Symbols

- $\hbar$ : Reduced Planck’s constant, defining quantum scales.
- $M_e$ : Electron mass, though the same reasoning could apply to other fundamental masses in principle.
- $F_{\max}$ : The proposed maximum force in VAM ( $\approx 29$  N), acting as an upper bound on force transmission in vortex cores.
- $R_c$ : The characteristic vortex-core radius (often  $\sim 10^{-15}$  m), comparable to nuclear or Coulomb-barrier length scales.
- $\lambda_c$ : A Compton-like wavelength for the electron or the relevant particle (e.g.,  $\lambda_c = \frac{h}{M_e c}$ ), signifying the typical quantum “size” of wave-like effects.
- $C_e$ : The swirl velocity constant ( $\sim 10^6$  m/s), derived from vortex quantization in VAM.

The left-hand side (LHS),

$$\frac{\hbar^2}{2 M_e},$$

often appears in quantum mechanical contexts as a characteristic measure of kinetic energy for an electron or the scaling for quantum bound states.



## 2. Physical Motivation

### 2.1 Matching a Quantum Kinetic Term

In non-relativistic quantum mechanics,  $\frac{\hbar^2}{2M_e}$  sets the characteristic energy scale for phenomena such as the Bohr model's ground-state energy (up to multiplicative constants), the Rydberg constant, and other discrete-level calculations. It represents roughly the minimal “quantum kinetic” energy or the scale at which wave-like properties dominate the electron's behavior.

### 2.2 VAM's Vortex-Energy Expression

In the Vortex Æther Model, stable vortex structures have an internal energy governed by tension-like forces, plus the swirling velocity distribution. When boundary conditions (like  $r_c$ ,  $\lambda_c$ , and the maximum force  $F_{\max}$ ) are imposed, one obtains a formula for the characteristic energy or momentum cost of confining the vortex core to radius  $R_c$ .

## 3. The Derivation in Steps

### 1. Maximum Force and Core Volume

VAM posits that the strongest force permissible within a region of size  $R_c$  is  $F_{\max}$ . Over distances of the order  $R_c$ , the total “energy toll” might be approximated by  $F_{\max} \times R_c$ . However, since we're dealing with a three-dimensional structure, corrections involving  $R_c^3$  come into play, typically capturing volumetric or geometric constraints.

### 2. Compton Wavelength Factor

In quantum mechanics,  $\lambda_c$  sets the typical scale where particle wave effects become crucial. If the vortex is confined further to scale  $R_c$ , the ratio  $\frac{R_c}{\lambda_c}$  indicates how much smaller (or bigger) the vortex core is relative to the particle's natural quantum “size.”

### 3. Dimensionless Geometry Factor

The coefficient  $\frac{1}{5}$  can emerge from integrating the potential or velocity distribution across a spherical or toroidal region, or from analyzing the dimensionless combination:

$$\frac{F_{\max} R_c^3}{\lambda_c C_e}$$

in a geometry-specific integral. Precise fluid-dynamics or topological arguments determine the factor 5 (analogous to how certain integrals in the Bohr model yield  $\frac{1}{2}$ ,  $\frac{1}{4}$ , or other dimensionless numbers).

Putting these elements together, one obtains:

$$\frac{\hbar^2}{2M_e} \sim \frac{F_{\max} R_c^3}{5 \lambda_c C_e}.$$

#### 4. Dimensional Analysis

##### 4.1 Left-Hand Side

$\hbar^2/(2M_e)$  has dimensions of energy:

$$[\hbar^2/(2M_e)] = \frac{(\text{J} \cdot \text{s})^2}{\text{kg}} \rightarrow \text{J} \text{ (kg m}^2/\text{s}^2\text{)}.$$

##### 4.2 Right-Hand Side

1.  $F_{\max}$ :  $\text{N} = \text{kg m/s}^2$ .
2.  $R_c^3$ :  $\text{m}^3$ .
3.  $\lambda_c$ :  $\text{m}$ .
4.  $C_e$ :  $\text{m/s}$ .

So:

$$\frac{F_{\max} R_c^3}{\lambda_c C_e} = \frac{\text{kg m/s}^2 \times \text{m}^3}{\text{m} \times \text{m/s}} = \text{kg} \frac{\text{m}^2}{\text{s}^2} = \text{J},$$

an energy dimension. Multiplying by the factor  $\frac{1}{5}$  remains dimensionless, so the entire RHS is in joules, matching the LHS.

#### 5. Interpretational Notes

##### 1. Quantum–Vortex Bridge

This equation effectively sets the scale at which quantum kinetic energy meets vortex

tension or confinement energy. It is reminiscent of how in the Bohr model, balancing centripetal force with electrostatic force yields discrete orbits; here, one is balancing quantum scales with fluidic swirl constraints.

## 2. Role of $F_{\max}$

Interpreting  $F_{\max} \approx 29\text{ N}$  as a universal upper force constant is controversial but fundamental in some versions of VAM. This relation uses that concept to link the quantum domain ( $\hbar$ ) with a distinct fluidic limit.

## 3. Predictive Capability

If one treats  $R_c$ ,  $\lambda_c$ , and  $C_e$  as measured or derived from other parts of the model (e.g., swirl velocity derivation, Compton-like lengths, typical nuclear scales), then the above formula becomes a check on consistency. Any discrepancy might indicate either a missing topological factor or a different boundary condition for the vortex core.

## 6. Concluding Remarks

By equating a fundamental quantum kinetic energy scale  $\frac{\hbar^2}{2M_e}$  to a fluidic expression involving  $(F_{\max}, R_c, \lambda_c, C_e)$ , the Vortex Æther Model underscores its thesis that quantum parameters and superfluid vortex parameters are not separate realms but facets of the same fluid-based picture:

$$\boxed{\frac{\hbar^2}{2M_e} = \frac{F_{\max} R_c^3}{5 \lambda_c C_e}}.$$

This neat match highlights how stable vortex structures in the Æther might be subject to quantization and force constraints that mirror those found in conventional quantum mechanics. While additional factors (e.g., geometric integrals, topological constraints) may refine or shift the coefficient  $1/5$ , the core takeaway is that *quantum-scale energies can emerge from purely fluid-dynamic constraints* in VAM.

## 6. DETAILED KNOT THEORY CONNECTIONS (IF HEAVILY MATHEMATICAL)

### 1. Rationale for Knot-Theoretic Treatment

#### 1. Historical Precedent

Helmholtz and Lord Kelvin proposed that atomic structure could be understood as vortex rings or knots in an inviscid fluid. VAM extends this notion to all fundamental particles, hypothesizing that stable or metastable particles correspond to distinct knot configurations.

#### 2. Helicity and Conservation

VAM relies on the conservation of fluid helicity:

$$\mathcal{H} = \int \boldsymbol{\omega} \cdot \mathbf{v} \, dV,$$

for an inviscid fluid. In knot-theory language,  $\mathcal{H}$  is related to the *linking* and *writhe* of vortex filaments.

#### 3. Particle Identities via Topology

Particle-like properties (charge, spin, baryon number) could be mapped to topological invariants (e.g., linking number, knot polynomials). A trefoil vortex might, for instance, represent a minimal “stable” topology, while more complicated links correspond to higher-generation or composite particles.

## 2. Mathematical Foundations

### 2.1 Linking Number and Knot Polynomials

- **Linking Number**  $Lk(\Gamma_1, \Gamma_2)$ :

For two closed curves (vortex filaments)  $\Gamma_1$  and  $\Gamma_2$  in 3D, the linking number measures how many times they wrap around each other. In fluid terms, nonzero linking can reflect topological coupling or “bound states.”

- **Knot Polynomials (Jones, Alexander, HOMFLY)**:

These polynomials classify knots and links beyond simple linking number. In VAM,

they help distinguish different stable or quasi-stable vortex knots that might correspond to different quantum states or particle “types.”

(Example) : Trefoil knot  $\longrightarrow$  nontrivial Jones polynomial.

## 2.2 Reidemeister Moves and Vortex Reconnection

- **Reidemeister Moves:**

In knot theory, these local transformations alter how a knot is drawn but not its fundamental topology. In fluid mechanics, *vortex reconnection* can sometimes analogously break or join vortex filaments. If the fluid is truly inviscid and the vortex filaments never intersect, the “knot type” remains preserved—i.e. stable topological quantum states.

- **Suppression of Reconnection:**

VAM assumes that stable elementary particles rarely undergo reconnection transitions, mirroring the observed stability of protons or electrons. Under high-energy conditions, partial reconnections might occur, paralleling processes akin to particle decay or scattering.

## 3. Helicity as a Topological Measure of “Charge”

### 3.1 Helicity Integral

$$\mathcal{H} = \int_{\Omega} \boldsymbol{\omega} \cdot \mathbf{v} \, dV,$$

where  $\boldsymbol{\omega} = \nabla \times \mathbf{v}$ . This integral is invariant in an ideal fluid, analogous to how electric charge or baryon number is conserved in particle physics.

### 3.2 Linking Number Relation

Under certain simplifying assumptions (e.g. disjoint vortex tubes with localized cross-sections), fluid helicity can be related to the sum of linking numbers of vortex loops:

$$\mathcal{H} \approx \kappa \sum_{\alpha, \beta} Lk(\Gamma_\alpha, \Gamma_\beta),$$

where  $\kappa$  is the circulation quantum ( $\approx h/m$ ) in a superfluid. Thus, each pair of linked vortex filaments contributes a discrete topological “charge,” reminiscent of how quarks in QCD carry color or how fundamental charges add in QED.

## 4. Potential Particle Mapping

### 1. Single-Knot States:

- **Electron-Like:** A trefoil or figure-eight knot vortex with one quantum of circulation, giving charge  $\pm e$  if oriented or anti-oriented.
- **Neutrino-Like:** Possibly a simpler (unknotted) but twisted filament, carrying minimal or zero net linking with other loops.

### 2. Multi-Knot States:

- **Proton-Like:** Could be a compound link of three twisted sub-loops (“three quarks” motif), each sub-loop carrying fractional circulation. Their total linking yields net “+1” charge.
- **Meson-Like:** A link of two oppositely oriented vortex filaments that can separate or annihilate each other under reconnection analogies—akin to quark-antiquark pairs.

### 3. Decay Channels:

Changes in topological invariants might mimic particle decays; strong or electromagnetic interactions might correspond to partial reconnections under specific energy thresholds. The near-invisibility of processes like proton decay implies either extremely high topological barriers or near-perfect helicity conservation in the vortex fluid.

## 5. Open Questions and Theoretical Extensions

### 1. Non-Abelian Structures

QCD’s non-Abelian gauge group ( $SU(3)$ ) might require more complicated knot invariants, or a tangle of vortex tubes representing color confinement. Current knot polynomials may not fully capture non-Abelian “holonomies” in fluid flow, leaving a gap between VAM and the full Standard Model.

### 2. Multi-Loop Entanglement

Real-world baryons or nuclei might correspond to highly entangled vortex webs. Determining their stable topological classes could be extremely challenging mathematically but offers a route to unify nuclear physics and fluid dynamics in a single, 3D Euclidean framework.

### 3. Exact Correspondences

Detailed mappings from knot polynomials to quantum numbers (e.g. electric charge, spin, isospin) remain largely speculative. Progress in topological quantum field theory might illuminate how to treat certain polynomial invariants as direct analogs of gauge-group representations.

## 6. Conclusion and Outlook

Knot theory provides a powerful lens through which VAM interprets stable or metastable vortex states as “particles.” By tying helicity conservation and linking numbers to quantum numbers—charge, baryon number, and spin—VAM aspires to a topological unification of fluid mechanics and particle physics. Although many challenges remain (particularly regarding the full  $SU(3)$  or non-Abelian gauge structure of the Standard Model), the mathematical framework of knot invariants and vortex reconnection offers a fresh perspective on why certain particles exist, why they are stable, and how quantum phenomena might ultimately be the manifestation of tangled yet robust vortex flows in an inviscid *Æther*.