*VAM Canon (v0.1)
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1 Versioning

- This document is the single source of truth for core VAM definitions, constants, master equations, and notational conventions.
- Use semantic versions: vMAJOR.MINOR.PATCH (e.g., v1.2.0).
- Every paper/derivation should state the Canon version it depends on.

2 Core Postulates (VAM)

1. The universe is a 3D incompressible, inviscid superfluid æther with absolute time and Euclidean space.
2. Particles are knotted vortex solitons (closed, possibly linked/knotted filaments) in the æther.
3. Gravity is not spacetime curvature but swirl (structured vorticity fields) and pressure gradients; massive motion follows swirl-induced dynamics.
4. Local time-rate is set by tangential vortex motion: higher swirl reduces the local clock rate relative to asymptotic time.
5. Quantization arises from topological invariants (linking, writhe, twist) and circulation quantization of vortex filaments.
6. The æther supports bosonic unknotted excitations (e.g., photon-like), while chiral hyperbolic knots map to quarks; torus knots map to leptons, etc. (taxonomy documented separately).

3 Canonical Constants and Symbols

All symbols are dimensionally consistent and, unless stated otherwise, SI.

3.1 Fundamental (VAM-specific)

- Vortex tangential velocity: $C_e = 1.09384563 \times 10^6\ \mathrm{m\,s^{-1}}$
- Vortex-core radius: $r_c = 1.40897017 \times 10^{-15}\ \mathrm{m}$
- Æther fluid density ("vacuum" fluid): $\rho_{æ}^{(\mathrm{fluid})} = 7.0 \times 10^{-7}\ \mathrm{kg\,m^{-3}}$
- Æther core/mass density: $\rho_{æ}^{(\mathrm{mass})} = 3.8934358266918687 \times 10^{18}\ \mathrm{kg\,m^{-3}}$
- Æther energy density: $\rho_{æ}^{(\mathrm{energy})} = 3.49924562 \times 10^{35}\ \mathrm{J\,m^{-3}}$
- Maximum Coulomb force (VAM): $F_{æ}^{\max} = 29.053507\ \mathrm{N}$
- Maximum universal force (contextual): $F_{\mathrm{gr}}^{\max} = 3.02563 \times 10^{43}\ \mathrm{N}$
- Golden ratio: $\varphi = \frac{1+\sqrt{5}}{2} \approx 1.61803398875$

3.2 Universal

- Speed of light: $c = 299\,792\,458\ \mathrm{m\,s^{-1}}$
- Fine-structure constant: $\alpha \approx 7.2973525643 \times 10^{-3}$
- Planck time: $t_p \approx 5.391247 \times 10^{-44}$ s

Note: The local Python `constants_dict` used in simulations must mirror these values exactly; papers should quote the Canon version.

Canon Governance (Binding)

Definitions

Formal System. Let $\mathcal{S} = (\mathcal{P}, \mathcal{D}, \mathcal{R})$ denote the VAM formal system: postulates $\mathcal{P}$, definitions $\mathcal{D}$, and admissible inference rules $\mathcal{R}$ (variational derivation, Noether, dimensional analysis, asymptotic matching, etc.).

Canonical statement. A statement X is *canonical* iff X is a theorem or identity provable in $\mathcal{S}$:

$$\mathcal{P}, \mathcal{D} \vdash_{\mathcal{R}} X,$$

and X is consistent with all previously accepted canonical items in the current major version.

Empirical statement. A statement Y is *empirical* iff it asserts a measured value, fit, or protocol:

$$Y \equiv \text{“observable } \mathcal{O} \text{ has value } \hat{o} \pm \delta o \text{ under procedure } \Pi.\text{”}$$

Empirical items calibrate symbols (e.g., $C_e, r_c, \rho_{æ}^{(\cdot)}$) but are not premises in proofs.

Status Classes

- **Axiom / Postulate (Canonical).** Primitive assumptions of VAM (e.g., incompressible, inviscid æther; absolute time; Euclidean space).
- **Definition (Canonical).** Introduces symbols by construction (e.g., swirl Coulomb constant Λ by surface-pressure integral).
- **Theorem / Corollary (Canonical).** Proven consequences (e.g., Euler–VAM radial balance; swirl time-scaling).
- **Constitutive Model (Canonical if derived; otherwise Semi-empirical).** A relation tying fields (e.g., pressure–vorticity law). Canonical when deduced from $\mathcal{P}, \mathcal{D}$; semi-empirical when chosen to match data.
- **Calibration (Empirical).** Recommended numerical values with uncertainties for canonical symbols.
- **Research Track (Non-canonical).** Conjectures or alternatives pending proof or axiomatization.

Canonicality Tests (all required)

A candidate statement enters the Canon iff it passes:

1. **Derivability:** Shown from $\mathcal{P}, \mathcal{D}$ using $\mathcal{R}$, with each step explicit.
2. **Dimensional Consistency:** Every term has correct units; limits are well-posed under $r \to 0$, $r \to \infty$, weak/strong swirl.
3. **Symmetry Compliance:** Consistent with VAM symmetries (Galilean + absolute time; foliation; incompressibility).
4. **Recovery Limits:** Reduces to accepted physics in the appropriate limits (e.g., Coulomb/Bohr, Newtonian gravity, linear waves).
5. **Non-Contradiction:** No conflict with existing canonical theorems at the same major version.
6. **Parameter Discipline:** No ad-hoc fit parameters; all symbols are defined and measurable.

Promotion/Demotion Protocol

- **Promote to Canonical** when a full proof (or definition) and Tests 1–6 are documented; record as "Theorem/Definition," bump MINOR.
- **Calibrate (Empirical)** by attaching $\hat{\theta} \pm \delta\theta$ and procedure Π to a *canonical symbol* (e.g., C_e: value is empirical; symbol and role are canonical).
- **Demote** if inconsistency is found; publish erratum and bump MAJOR.

Examples (from current Canon)

- *Canonical (Definition):* $\Lambda \equiv \int_{S_r^2} p_{\text{swirl}}\, r^2\, d\Omega.$
- *Canonical (Theorem):* $\dfrac{1}{\rho}\dfrac{dp_{\text{swirl}}}{dr} = \dfrac{v(r)^2}{r}$ for steady, azimuthal drift (Euler balance).
- *Empirical (Calibration):* $C_e = 1.09384563 \times 10^6\,\mathrm{m\,s^{-1}}$ with procedure $f\Delta x$.
- *Consistency Check (Not a premise):* Hydrogen soft-core reproduces a_0, E_1; this validates choices but remains a check, not an axiom.

What is Canonical in VAM—and Why

Governance: What "Canonical" Means

A statement is *canonical* iff it is a **postulate**, **definition**, or a **theorem/corollary** *derived* from the VAM formal system $\mathcal{S} = (\mathcal{P}, \mathcal{D}, \mathcal{R})$ (postulates $\mathcal{P}$, definitions $\mathcal{D}$, admissible rules $\mathcal{R}$: variational derivation, Noether, dimensional analysis, asymptotic matching, and standard fluid limits). Canonical items must pass: (i) derivability, (ii) dimensional consistency, (iii) symmetry compliance (absolute time, Euclidean space, incompressible, inviscid), (iv) correct recovery limits (Newtonian, Coulomb/Bohr, linear waves), and (v) non-contradiction within the current major version.

A statement is *empirical* iff it asserts a measured calibration ($\hat{\theta} \pm \delta\theta$) or a lab protocol. Empirical facts set numerical values for *canonical symbols* but are not premises in proofs.

Canonical Core (from Canon v0.1 + v0.7-Extensions)

[Postulate] Incompressible, inviscid æther with absolute time and Euclidean space. $\nabla\cdot\mathbf{v} = 0,\ \nu = 0$. This fixes the kinematic arena and legal inference rules (Galilean symmetries and foliation).

[Definition] Vorticity, circulation, helicity. $\omega = \nabla\times\mathbf{v},\quad \Gamma = \oint_C \mathbf{v}\cdot d\ell,\quad h = \mathbf{v}\cdot\omega,\ H = \int h\,dV$. These are standard fluid constructs canonized as primary VAM kinematic invariants (units: $[\omega] = \mathrm{s}^{-1}$, $[\Gamma] = \mathrm{m}^2\,\mathrm{s}^{-1}$). **[? ? ? 8?]**

[Theorem] Kelvin/vorticity transport/helicity invariants. For inviscid, barotropic flow:

$$\frac{d\Gamma}{dt} = 0, \qquad \frac{\partial\omega}{\partial t} = \nabla\times(\mathbf{v}\times\omega), \qquad H \text{ invariant up to reconnections.}$$

Why canonical? Directly derivable from Euler equations under $\nu = 0$, $\nabla\cdot\mathbf{v} = 0$; dimensionally consistent; reduce to classical results. **[? ? ?]**

[Definition] Swirl Coulomb constant Λ.

$$\boxed{\Lambda \equiv \int_{S_r^2} p_{\mathrm{swirl}}(r)\, r^2\, d\Omega} \quad\Rightarrow\quad [\Lambda] = \mathrm{J\,m} = \mathrm{N\,m}^2.$$

In VAM Canon this evaluates to $\Lambda = 4\pi\rho_{\text{æ}}^{(\mathrm{mass})} C_e^2 r_c^4$ (symbolic identity). *Why canonical?* It is a definition tied to an integral invariant of the swirl pressure field; dimensionally exact and independent of any dataset.

[Theorem] Hydrogen soft-core potential and Coulomb recovery.

$$V_{\mathrm{VAM}}(r) = -\frac{\Lambda}{\sqrt{r^2+r_c^2}} \xrightarrow{r\gg r_c} -\frac{\Lambda}{r},$$

yielding Bohr scalings $a_0 = \hbar^2/(\mu\Lambda)$, $E_n = -\mu\Lambda^2/(2\hbar^2 n^2)$. *Why canonical?* Derived by substituting the canonical Λ into the Schrödinger bound-state problem; reproduces textbook Coulomb in the soft-core limit (recovery test). [2, 1]

[Theorem] Euler–VAM radial balance (dark-sector pressure law). For steady, purely azimuthal drift $v(r)$,

$$0 = -\frac{1}{\rho}\frac{dp_{\mathrm{swirl}}}{dr} + \frac{v(r)^2}{r} \quad\Rightarrow\quad \boxed{\frac{1}{\rho}\frac{dp_{\mathrm{swirl}}}{dr} = \frac{v(r)^2}{r}}.$$

For flat curves $v\to v_0$: $p_{\mathrm{swirl}}(r) = p_0 + \rho v_0^2 \ln(r/r_0)$. *Why canonical?* Direct consequence of Euler equations with $\nabla\cdot\mathbf{v} = 0$, no ad-hoc parameters; correct units and limits.

[Definition $\to$ Corollary] Effective swirl line element (analogue-metric form). In (t,r,θ,z) with azimuthal drift $v_\theta(r)$,

$$ds^2 = -(c^2 - v_\theta^2)\,dt^2 + 2\,v_\theta r\,d\theta\,dt + dr^2 + r^2 d\theta^2 + dz^2,$$

co-rotating to $ds^2 = -c^2(1 - v_\theta^2/c^2)dt^2 + \cdots$, giving the swirl-clock factor $\dfrac{dt_{\mathrm{local}}}{dt_\infty} = \sqrt{1 - \dfrac{v_\theta^2}{c^2}}$.
Why canonical? Adopted as an *effective* geometry consistent with VAM kinematics and analogue-gravity construction; it is a definition plus corollary that reproduces the time-rate law used in Canon. [5, 6, 3, 4]

[Definition] Swirl Hamiltonian density (Kelvin-compatible).

$$\mathcal{H} = \tfrac{1}{2}\rho\,\|\mathbf{v}\|^2 + \tfrac{1}{2}\rho\,\ell_\omega^2\|\omega\|^2 + \tfrac{1}{2}\rho\,\ell_\omega^4\|\nabla\omega\|^2 + \lambda(\nabla\cdot\mathbf{v}), \quad \ell_\omega := r_c.$$

Why canonical? Constructed by symmetry and dimensional closure (lowest-order rotational invariants) under the incompressibility constraint; reduces to bulk kinetic energy as $\ell_\omega \to 0$; no ad-hoc fits.

Empirical Calibrations (not premises, but binding numerically)

- [Empirical] $C_e = 1.09384563 \times 10^6\,\mathrm{m\,s^{-1}}$ via metrology $C_e = f\,\Delta x$.
- [Empirical] $r_c = 1.40897017 \times 10^{-15}\,\mathrm{m}$.
- [Empirical] $\rho_{æ}^{(\mathrm{mass})} = 3.8934358266918687 \times 10^{18}\,\mathrm{kg\,m^{-3}}$.

Why not canonical? These are measured values with uncertainties; they *calibrate* canonical symbols $(C_e, r_c, \rho_{æ}^{(\cdot)})$ used in theorems like $\Lambda = 4\pi\rho_{æ}^{(\mathrm{mass})}C_e^2 r_c^4$.

Non-Canonical (Research Track)

Items explicitly labeled “Research Track (non-canonical yet)”—e.g., blackbody via swirl temperature, QED–VAM minimal coupling ansatz—remain conjectural until a proof/derivation under $\mathcal{S}$ is documented and Tests (i)–(v) are passed.

Consistency Dimension Checks (illustrative)

$$[\Lambda] = [\rho][C_e^2][r_c^4] = \frac{\mathrm{kg}}{\mathrm{m}^3}\cdot\frac{\mathrm{m}^2}{\mathrm{s}^2}\cdot\mathrm{m}^4 = \frac{\mathrm{kg\,m}^3}{\mathrm{s}^2} = \mathrm{J\,m}.$$

Soft-core Coulomb recovery: $V_{\mathrm{VAM}}(r) \to -\Lambda/r$ as $r/r_c \to \infty$, reproducing hydrogenic a_0 and E_n. [2, 1]

4 Canonical Coarse–Graining of $\rho_{æ}^{(\mathrm{fluid})}$ from a Vortex–Filament Bath

Scope. The æther is modeled as an incompressible, inviscid fluid populated by thin vortex filaments (“strings”). This section derives the bulk (volumetric) æther density $\rho_{æ}^{(\mathrm{fluid})}$ from first principles via coarse–graining of line–supported mass and vorticity, relying only on Euler kinematics, Kelvin–Helmholtz vortex invariants, and standard filament measures [**? ? ?**].

4.1 Axioms and Definitions

Let a representative filament carry:

$$\text{(D1)}\quad \mu_* \;\equiv\; \rho_{æ}^{(\mathrm{core})}\,A_{\mathrm{core}} \;=\; \rho_{æ}^{(\mathrm{core})}\,\pi r_c^2 \quad [\mathrm{kg/m}], \tag{1}$$

$$\text{(D2)}\quad \Gamma_* \;\equiv\; \oint \mathbf{v}\cdot d\boldsymbol{\ell} \;\simeq\; \kappa_\Gamma\, r_c\, C_e, \qquad \kappa_\Gamma = 2\pi \;\; \text{(thin, near–solid–body core)}, \tag{2}$$

where $\rho_{æ}^{(\mathrm{core})}$ is the core mass density, r_c the core radius, and C_e the characteristic tangential speed at r_c.

Denote by

$$\nu \;\equiv\; \frac{N_{\mathrm{fil}}}{A} \quad [\mathrm{m}^{-2}]$$

the areal line density (number of filaments per unit cross–sectional area) within the coarse–graining window. Then:

$$\text{(C1)}\quad \rho_{æ}^{(\text{fluid})} = \mu_* \, \nu, \tag{3}$$

$$\text{(C2)}\quad \langle \boldsymbol{\omega} \rangle = \Gamma_* \, \nu \, \hat{\mathbf{t}}_{\text{avg}} \quad \Rightarrow \quad |\langle \omega \rangle| = \Gamma_* \, \nu, \tag{4}$$

the latter being the classical counterpart of the Feynman rule for rotating superfluids (mean vorticity equals circulation $\times$ areal vortex density) **[? ? ?]**.

4.2 First–Principles Derivation

Combining (3)–(4) gives the canonical coarse–graining map

$$\boxed{\rho_{æ}^{(\text{fluid})} = \mu_* \frac{\langle \omega \rangle}{\Gamma_*} = \frac{\rho_{æ}^{(\text{core})} \pi r_c^2}{\kappa_\Gamma r_c C_e} \langle \omega \rangle = \frac{\rho_{æ}^{(\text{core})} r_c}{2\, C_e} \langle \omega \rangle} \quad (\kappa_\Gamma = 2\pi). \tag{5}$$

For a uniform background solid–body rotation with angular rate Ω, $\langle \omega \rangle = 2\Omega$, hence

$$\boxed{\rho_{æ}^{(\text{fluid})} = \frac{\rho_{æ}^{(\text{core})} r_c}{C_e} \Omega} \quad [\text{kg/m}^3]. \tag{6}$$

Dimensional check. $[\mu_*] = \text{kg/m}$, $[\nu] = \text{m}^{-2} \Rightarrow [\mu_* \nu] = \text{kg/m}^3$. Also $[\Gamma_*] = \text{m}^2/\text{s}$, $[\langle \omega \rangle] = \text{s}^{-1} \Rightarrow [\mu_* \langle \omega \rangle / \Gamma_*] = \text{kg/m}^3$.

4.3 Energy and Tension Corollaries

The coarse–grained swirl energy density,

$$\boxed{u_{\text{swirl}} = \tfrac{1}{2} \rho_{æ}^{(\text{fluid})} C_e^2} \quad [\text{J/m}^3], \tag{7}$$

follows the standard kinetic form for incompressible flow **[? ?]**. The filament's natural tension scale is

$$\boxed{T_* \equiv \tfrac{1}{2} \mu_* C_e^2} \quad [\text{N}], \tag{8}$$

mirroring string–like energy $E \simeq T\,L + \cdots$ without invoking compressibility.

4.4 Numerical Calibration (VAM Canonical Constants)

With

$$\rho_{æ}^{(\text{core})} = 3.8934358266918687 \times 10^{18}\ \text{kg/m}^3, \ r_c = 1.40897017 \times 10^{-15}\ \text{m}, \ C_e = 1.09384563 \times 10^{6}\ \text{m/s},$$

we obtain

$$\begin{aligned} \mu_* &= \rho_{æ}^{(\text{core})} \pi r_c^2 = 2.42821138 \times 10^{-11}\ \text{kg/m}, \\ \Gamma_* &= 2\pi r_c C_e = 9.68361920 \times 10^{-9}\ \text{m}^2/\text{s}, \\ T_* &= \tfrac{1}{2} \mu_* C_e^2 = 1.45267535 \times 10^{1}\ \text{N}. \end{aligned}$$

From (6),

$$\rho_{æ}^{(\text{fluid})} = \left(5.01509060 \times 10^{-3}\right) \Omega \quad [\text{kg/m}^3],$$

so the Canon baseline $\rho_{æ}^{(\mathrm{fluid})} \equiv 7.0 \times 10^{-7}$ kg/m^3 is realized at

$$\boxed{\Omega_* \;=\; 1.39578735 \times 10^{-4}\ \mathrm{s}^{-1} \quad (\text{period } 2\pi/\Omega_* \approx 12.5\ \mathrm{h})}$$

and corresponds to an areal filament density

$$\nu_* \;=\; \frac{2\Omega_*}{\Gamma_*} \;=\; 2.88278033 \times 10^{4}\ \mathrm{m}^{-2}.$$

This fixes the coarse–graining scale that ties micro–constants $(\rho_{æ}^{(\mathrm{core})}, r_c, C_e)$ to the Canon macroscopic density.

Remarks. (i) The profile factor κ_Γ encodes core details; keeping κ_Γ explicit simply rescales Ω_* by $\mathcal{O}(1)$. (ii) No equation of state is invoked; incompressibility and filament measures suffice. (iii) The analogy to superfluid vortex arrays and EM line–to–bulk conversions is purely structural [**? ?** 1**?**].

5 Master Equations (Boxed, Definitive)

5.1 Master Energy and Mass Formula

Define the amplified swirl energy for a coherent VAM volume V:

$$E_{\mathrm{VAM}}(V) = \frac{4}{\alpha\,\varphi}\left(\frac{1}{2}\,\rho_{æ}^{(\mathrm{fluid})}\,C_e^2\right) V \quad [\mathrm{J}] \tag{9}$$

Corresponding mass (strict SI mass):

$$M_{\mathrm{VAM}}(V) = \frac{E_{\mathrm{VAM}}(V)}{c^2} \quad [\mathrm{kg}] \tag{10}$$

Numerical prefactor (per unit volume):
$\frac{1}{2}\rho_{æ}^{(\mathrm{fluid})} C_e^2 \approx 4.1877439 \times 10^5\ \mathrm{J\,m^{-3}}$,
$\frac{4}{\alpha\varphi} \approx 3.3877162 \times 10^2$.
Thus, $\frac{E_{\mathrm{VAM}}}{V} \approx 1.418688 \times 10^8\ \mathrm{J\,m^{-3}}$,
$\frac{M_{\mathrm{VAM}}}{V} \approx 1.57850 \times 10^{-9}\ \mathrm{kg\,m^{-3}}$.

Usage: In derivations, treat the boxed forms as canonical. If a paper chooses to define mass directly via energy units, state the convention explicitly and reference this section.

5.2 Swirl Gravitational Coupling

$$G_{\mathrm{swirl}} = \frac{C_e\,c^5\,t_p^2}{2\,F_{æ}^{\max}\,r_c^2} \quad (F_{æ}^{\max} = 29.053507\,\mathrm{N}) \tag{11}$$

Numerical evaluation: $G_{\mathrm{swirl}} \approx 6.674302 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$.

Canon note: This fixes which $F_{\max}$ is used (the Coulomb-scale $F_{æ}^{\max}$), ensuring exact numerical match to Newton's G.

Summary: invariant–driven, dimensionally–correct master law. We replace the heuristic parameters (m, n, s) in Eq. (21) by topological invariants of a torus knot/link $T(p, q)$ with $n = \gcd(p, q)$ components:

$$m \equiv b(T) = \min\{|p|, |q|\} \quad \text{(braid index)}, \qquad n \equiv \gcd(p, q), \qquad s \equiv g(T) \quad \text{(Seifert genus)}.$$

For torus *knots* $(n = 1)$, $g(T) = \frac{(|p|-1)(|q|-1)}{2}$; for torus *links* $(n > 1)$, a standard adjustment gives

$$g(T) = \frac{(|p|-1)(|q|-1) - (n-1)}{2},$$

which correctly yields $g = 0$ for the Hopf link $T(2, 2)$ [**? ? ?**].

Dimensional correction. The mechanical energy density of swirl is $\frac{1}{2}\rho C_e^2$ (J m^{-3}), so the mass contribution is $\left(\frac{1}{2}\rho C_e^2\right) \times \left(\sum_i V_i\right)/c^2$, not its inverse; this restores correct SI units (kg) [**?**].

Geometric volume via ropelength. Let each vortex core be a tube of radius r_c. Using ropelength $\mathcal{L}(T)$ (minimum length of a unit-thickness embedding) as a geometric invariant, the total core volume is

$$\sum_i V_i(T) = \pi r_c^2 \sum_i \left(\mathcal{L}_i(T)\, r_c\right) = \pi r_c^3\, \mathcal{L}_{\text{tot}}(T),$$

with $\mathcal{L}_{\text{tot}}$ the sum across components [**? ?**].

Invariant master formula. With $\phi = \frac{1+\sqrt{5}}{2}$ and α the fine–structure constant, the mass assigned to topology T is

$$\boxed{M(T(p,q)) = \left(\frac{4}{\alpha}\right) \underbrace{b(T)^{-3/2}}_{\text{mode crowding}} \underbrace{\phi^{-g(T)}}_{\text{topological tension}} \underbrace{n(T)^{-1/\phi}}_{\text{multi-component decoherence}} \left(\frac{1}{2}\rho C_e^2\right) \frac{\pi r_c^3\, \mathcal{L}_{\text{tot}}(T)}{c^2}.}$$

Canonical cases (torus family).

Topology	$T(p,q)$	$n = \gcd(p,q)$	$m = b(T) = \min(p,q)$	$g(T)$
Unknot (photon)	$T(1,1)$	1	1	0
Trefoil (neutrino)	$T(2,3)$	1	2	1
Hopf link (polariton/W-like)	$T(2,2)$	2	2	0
Solomon link (e^-e^+)	$T(4,2)$	2	2	1

Calibration & prediction workflow. (1) *Anchor* a single global geometric scale by fitting $\mathcal{L}_{\text{tot}}$ (or an overall multiplicative factor) to the e^-e^+ Solomon pair mass. (2) *Predict* other cases (trefoil neutrino, Hopf polaritonic/W-like, baryonic 3–component links) *without refitting*, since (m, n, g) and $\mathcal{L}_{\text{tot}}$ are then fixed by topology.

Implications. This upgrade removes ad–hoc knobs (all suppressions become invariants), restores dimensional correctness, ties the volumetric factor to published geometric data (*ropelength*), and yields an auditable, predictive pipeline for mass assignment across knot/link classes [**? ? ? ? ? ?**].

5.3 Local Time-Rate (Swirl Clock)

$$dt_{\mathrm{local}} = dt_\infty \sqrt{1 - \frac{\|\vec{\omega}\|^2\, r_c^2}{c^2}} \tag{12}$$

Alternative (historical, for traceability):

$$dt_{\mathrm{local}} = dt_\infty \sqrt{1 - \frac{\|\vec{\omega}\|^2}{c^2}} \tag{13}$$

5.4 Swirl Angular Frequency Profile

$$\Omega_{\mathrm{swirl}}(r) = \frac{C_e}{r_c} e^{-r/r_c} \tag{14}$$

On-axis core limit: $\Omega_{\mathrm{swirl}}(0) = \frac{C_e}{r_c} \approx 7.76344 \times 10^{20}\ \mathrm{s}^{-1}$.

5.5 Vorticity Potential (Canonical Form)

$$\Phi(\vec{r}, \vec{\omega}) = \frac{C_e^2}{2\, F_{æ}^{\max}}\, \vec{\omega} \cdot \vec{r} \tag{15}$$

Dimensional remark: This potential's role is canonical within VAM; derivations using it must propagate units consistently within the VAM Lagrangian (Sec. 6).

6 Unified VAM Lagrangian (Definitive Form)

Let $\vec{v}$ be the æther velocity, $\rho = \rho_{æ}^{(\mathrm{fluid})}$ constant (incompressible), $\vec{\omega} = \nabla \times \vec{v}$, and p a Lagrange multiplier enforcing incompressibility.

$$\mathcal{L}_{\mathrm{VAM}} = \underbrace{\frac{1}{2}\rho\, \|\vec{v}\|^2}_{\text{kinetic}} - \underbrace{\rho\, \Phi(\vec{r}, \vec{\omega})}_{\text{swirl potential}} + \underbrace{\lambda(\nabla \cdot \vec{v})}_{\text{incompressibility}} + \underbrace{\eta\, \mathcal{H}[\vec{v}]}_{\text{helicity/topological term}} + \underbrace{\mathcal{L}_{\mathrm{couple}}[\Gamma, \mathcal{K}]}_{\text{circulation \& knot invariants}} \tag{16}$$

- $\mathcal{H}[\vec{v}] = \int (\vec{v} \cdot \vec{\omega})\, dV$ (kinetic helicity) serves as the generator of topological constraints (coefficient η fixes units).
- $\mathcal{L}_{\mathrm{couple}}$ encodes coupling to quantized circulation Γ and knot invariants $\mathcal{K}$ (linking, writhe, twist), used to produce particle families.
- When deriving Euler–Lagrange equations, enforce $\nabla \cdot \vec{v} = 0$ and appropriate boundary terms for closed filaments.

Canon rule: Papers must either (i) use this Lagrangian verbatim, or (ii) state a justified variant and show equivalence in the weak/appropriate limit.

7 Notation, Ontology, and Glossary

- **Æther-Time (A-time):** absolute time parameter of the æther flow.
- **Chronos-Time (C-time):** asymptotic observer time (dt_∞).
- **Swirl Clock:** local clock with rate set by $\|\vec{\omega}\|$ per Sec. 3.3.

- **Knot Taxonomy:** leptons = torus knots; quarks = chiral hyperbolic knots (chirality encodes vortex time); bosons = unknots; neutrinos = linked knots.
- **Chirality (matter vs antimatter):** ccw $\leftrightarrow$ matter; cw $\leftrightarrow$ antimatter via swirl-gravity coupling.

8 Canonical Checks (What to Verify in Every Paper)

1. Dimensional analysis on every new term/equation.
2. Limiting behavior: low-swirl $\|\omega\| \to 0$ recovers classical mechanics/EM limits; large-scale averages reproduce Newtonian gravity with G_{swirl}.
3. Numerical validation: provide numerical prefactors using Canon constants; if additional constants appear, they must be added to Sec. 2.
4. Topology $\leftrightarrow$ quantum numbers mapping stated explicitly (which invariants, how normalized).
5. Citations for any non-original constructs (use BibTeX keys below).

9 Persona Prompts

Reviewer Persona

```
You are a peer reviewer for a VAM paper. Use only the definitions and constants in the "VAM Canon (v0.1)". C
```

Theorist Persona

```
You are a theoretical physicist specialized in the Vortex Æther Model (VAM). Base all reasoning on the atta
```

Bridging Persona (Compare to GR/SM)

```
Work strictly within VAM Canon (v0.1). Compare [TARGET] to its GR/SM counterpart. Identify exact replaceme
```

10 Session Kickoff Checklist

1. Start new chat per task; attach this Canon first.
2. Paste a persona prompt (Sec. 7).
3. Attach only task-relevant papers/sources.
4. State any corrections explicitly (they persist in the session).
5. At end, record Canon deltas (if any) and bump version.

11 Canon-Ready Citations (Skeleton)

Replace placeholders with your BibTeX keys; ensure each non-original equation/idea cites at least one primary source.

```
@article{Helmholtz1858,
  author  = {H. von Helmholtz},
  title   = {On Integrals of the Hydrodynamical Equations which Express Vortex-motion},
  journal = {Philosophical Magazine},
  year    = {1858}
}

@article{Kelvin1867,
  author  = {W. Thomson (Lord Kelvin)},
  title   = {On Vortex Atoms},
  journal = {Proc. Royal Society of Edinburgh},
  year    = {1867}
}

@article{Moffatt1969,
  author  = {H. K. Moffatt},
  title   = {The degree of knottedness of tangled vortex lines},
  journal = {Journal of Fluid Mechanics},
  year    = {1969}
}

@article{Schrodinger1926,
  author  = {E. Schr{\"o}dinger},
  title   = {An Undulatory Theory of the Mechanics of Atoms and Molecules},
  journal = {Physical Review},
  year    = {1926}
}
```

10) Appendix: Canon Tables for Papers

10.1 Constants Table (paste-ready)

Symbol	Meaning	Value	Unit
C_e	Vortex tangential velocity	1.09384563×10^{6}	$\mathrm{m\,s^{-1}}$
r_c	Vortex-core radius	$1.40897017 \times 10^{-15}$	m
$\rho_{æ}^{(\text{fluid})}$	Æther fluid density	7.0×10^{-7}	$\mathrm{kg\,m^{-3}}$
$\rho_{æ}^{(\text{mass})}$	Æther mass density	$3.8934358266918687 \times 10^{18}$	$\mathrm{kg\,m^{-3}}$
$\rho_{æ}^{(\text{energy})}$	Æther energy density	$3.49924562 \times 10^{35}$	$\mathrm{J\,m^{-3}}$
$F_{æ}^{\max}$	Max. Coulomb force	29.053507	N
$F_{\text{gr}}^{\max}$	Max. universal force	3.02563×10^{43}	N
α	Fine-structure constant	$7.2973525643 \times 10^{-3}$	—
φ	Golden ratio	1.61803398875	—
c	Speed of light	299792458	$\mathrm{m\,s^{-1}}$
t_p	Planck time	5.391247×10^{-44}	s

Table 1: Canonical constants for VAM (SI units unless stated).

10.2 Boxed Canon Equations (paste-ready)

1. **Energy:** $\boxed{E_{\text{VAM}} = \frac{4}{\alpha\varphi}\left(\frac{1}{2}\rho C_e^2\right) V}$

2. **Mass:** $\boxed{M_{\text{VAM}} = \frac{E_{\text{VAM}}}{c^2}}$

3. G **coupling:** $\boxed{G_{\text{swirl}} = \frac{C_e c^5 t_p^2}{2F_{æ}^{\max} r_c^2}}$

4. **Time-rate:** $\boxed{dt_{\text{local}} = dt_{\infty}\sqrt{1 - \|\omega\|^2/c^2}}$

5. **Swirl profile:** $\boxed{\Omega_{\text{swirl}}(r) = \frac{C_e}{r_c} e^{-r/r_c}}$

11) Change Log

- **v0.1 (2025-08-22):** Initial Canon with core postulates, constants, boxed master equations, Lagrangian, persona prompts, and session protocol; numerical prefactors added for Sec. 3.

12) v0.2 Delta — Corrections & Additions (2025-08-22)

12.1 Dimensional correction to Sec. 3.3 (time-rate law)

To enforce strict dimensional consistency, the time-rate must couple vorticity to a length scale (canonical choice: the core radius r_c) or, equivalently, to the local tangential speed $v_t = |\omega| \cdot r$:

- Canonical (evaluate at $r = r_c$):
  $dt_{\text{local}} = dt_{\infty}\sqrt{1 - (|\omega|^2 r_c^2)/c^2}$
  equivalently $dt_{\text{local}} = dt_{\infty}\sqrt{1 - v_t^2/c^2}$ with $v_t := |\omega| r_c$.

- Using the profile $\Omega_{\text{swirl}}(r) = (C_e/r_c)\exp(-r/r_c)$ (Sec. 3.4), on-axis core limit gives $\Omega_{\text{swirl}}(0) = C_e/r_c$ and thus $dt_{\text{local}}(0) = dt_{\infty}\sqrt{1 - (C_e/c)^2}$.

Supersedes Sec. 3.3 formula (which lacked a length scale). Use this corrected form in all new derivations; the earlier expression is retained for traceability only.

12.2 Canon tolerances & symbol aliases

Numerical tolerances (for constant concordance):

- Relative: $\leq 1 \times 10^{-6}$ (1 ppm).

- Absolute near zero: $\leq 1 \times 10^{-12}$ in SI units.

Accepted symbol aliases (normalize to the left-hand form):

Rule: manuscripts must present a single normalized constants table conforming to Sec. 10.1; aliases may appear in prose but equations must use Canon symbols.

Canon	Accepted aliases
Ce	Ce, C_e
rc	rc, r_c
rho_ae$^{(\text{fluid})}$	rho_ae (fluid), rho_vac, rho_fluid
rho_ae$^{(\text{mass})}$	rho_ae (mass), rho_core, rho_mass
rho_ae$^{(\text{energy})}$	rho_energy, u_ae (J m^{-3})
F_ae$^{\text{max}}$	Fae_max
F_gr$^{\text{max}}$	Fgr_max
varphi	phi, varphi

Table 2: Accepted symbol aliases for Canon constants.

12.3 Validation protocol updates

1. Dimensional sanity (strict): every term reduces to SI; for Sec. 4 ensure $\rho\Phi$ carries energy density (J m^{-3}). If an intermediate potential uses non-standard units, introduce a calibration coefficient and state its units.

2. Equation normalization: when swirl/time enters, first reduce by $v_t = |\omega| r$ with $r = r_c$ unless a different physically motivated scale is justified.

3. Numerical reproduction: provide a short table with substituted Canon constants and results (3–5 s.f.).

4. BibTeX policy: any non-original idea/equation/comparison must include a BibTeX entry (add to Sec. 9).

12.4 Concept index (snapshot from VAM-rank-1 corpus)

Frequency across the six PDFs analyzed:

1. vortex-knot particles (1839)
2. time dilation / swirl clock (1062)
3. swirl gravity (964)
4. æther densities (860)
5. leptons as torus knots (660)
6. quarks as hyperbolic knots (647)
7. photon as vortex ring (306)
8. unified Lagrangian (70)
9. Hamiltonian (25)
10. Rodin/coil dynamics (1)

12.5 Simulator I/O stub (render-ready)

```
{
  "SceneSpec": {
    "background": {"rho_fluid": 7.0e-7, "Ce": 1.09384563e6, "rc": 1.40897017e-15},
    "fields": [ {"type": "swirl", "Omega_profile": "Ce/rc * exp(-r/rc)"} ],
    "objects": [
      { "type": "VortexKnot", "knot": "T(2,3)", "circulation": "Gamma0",
        "core_radius": "rc", "constraints": ["incompressible", "quantized_circulation"] }
    ]
  }
}
```

12.6 Change Log entry

- v0.2 (2025-08-22): Added dimensionally corrected time-rate law using r_c (Sec. 12.1), established tolerances and symbol aliasing (Sec. 12.2), tightened validation protocol (Sec. 12.3), recorded a concept index snapshot from the current corpus (Sec. 12.4), and included a render-ready SceneSpec stub for simulators (Sec. 12.5).

12 v0.3 Draft Delta — Core from VAM 0–4 (Einstein $\rightarrow$ Vortex Fluid)

Status: DRAFT (pending promotion to sections 1–5 after review)

12.1 Source batch (chronological TeX)

Parsed: `VAM_0-4_Einstein_to_Vortex_Fluid` (TeX-first corpus)
Artifacts indexed (TeX-aware): 2335 equation blocks; 268 constant definitions/assignments; 246 postulate-like sentences; structured outline per file.

12.2 Consolidated core postulates (canonical wording)

1. **Absolute time, Euclidean space ($\mathbb{R}^3$).** A universal "clock field" defines a preferred foliation consistent with VAM's absolute æther time.
2. **Incompressible, inviscid æther.** Background medium supports ideal Euler dynamics; density $\rho_{æ}^{(\mathrm{fluid})}$ is constant at macroscales.
3. **Particles = knotted vortex solitons.** Matter is realized as closed, possibly linked/knotted filaments; bosons as unknotted excitations.
4. **Gravity = structured swirl.** Macroscopic attraction emerges from coherent vorticity fields and pressure gradients; Newton's G is recovered via G_{swirl}.
5. **Quantization from topology and circulation.** Discrete quantum numbers trace to linking/writhe/twist and circulation quantization.
6. **Kelvin–Helmholtz invariants govern dynamics.** Circulation conservation and helicity underpin stability, reconnection energetics, and decay.

These six are promoted to Canon §1 after approval. Existing §1 will be rephrased to this exact minimal set.

12.3 Canon conservation laws (add to §3: "Foundational identities")

- **Kelvin circulation (inviscid, barotropic):** $\frac{d\Gamma}{dt} = 0$ along a material loop.
- **Vorticity transport (Euler):** $\frac{\partial \vec{\omega}}{\partial t} = \nabla \times (\vec{v} \times \vec{\omega})$.
- **Kinetic helicity density:** $h = \vec{v} \cdot \vec{\omega}$; **Helicity invariant:** $H = \int (\vec{v} \cdot \vec{\omega})\, dV$ (up to reconnection events).

Rationale: These appear repeatedly across VAM 0–4 and are required to justify knot stability and reconnection phenomenology. They are background identities; use BibTeX keys in §9 (Helmholtz/Kelvin/Moffatt).

12.4 Key equations shortlist (from VAM 0–4)

- **Swirl profile:** $\Omega_{\text{swirl}}(r) = \frac{C_e}{r_c} \exp(-r/r_c)$ (consistent with Canon §3.4).
- **Time-rate (dimensionally corrected):** $dt_{\text{local}} = dt_\infty \sqrt{1 - |\omega|^2 r_c^2 / c^2} = dt_\infty \sqrt{1 - v_t^2 / c^2}$.
- **Mass/Energy:** $E_{\text{VAM}} = \frac{4}{\alpha \varphi} \left(\frac{1}{2} \rho_{æ}^{(\text{fluid})} C_e^2 \right) V$, $M = E_{\text{VAM}} / c^2$.
- **G coupling:** $G_{\text{swirl}} = \frac{C_e c^5 t_p^2}{2 F_{æ}^{\max} r_c^2}$.
- **Helicity/Lagrangian:** Canon §4 form with $H[\vec{v}] = \int (\vec{v} \cdot \vec{\omega})\, dV$ and incompressibility via $\lambda(\nabla \cdot \vec{v})$.

(Full ledger with file pointers is in the generated CSV: `equations_shortlist.csv`.)

12.5 Canon constants concordance (snapshot)

The TeX sources define/mention aliases for: C_e, r_c, $\rho_{æ}^{(\text{fluid}\,|\,\text{mass}\,|\,\text{energy})}$, α, c, t_p, φ, $F_{æ}^{\max}$, $F_{\text{gr}}^{\max}$.

Action: Enforce the v0.2 alias table (Sec. 12.2). Manuscripts must include a normalized constants table per Canon §10.1.

12.6 Organization rule for VAM parts (Canon policy)

Each VAM "part" must answer in its abstract:

1. **Unique role:** What principle or equation does this part introduce that no other part covers?
2. **Dependence:** Which Canon sections/parts are prerequisites?
3. **Promotion path:** Which equations/postulates are candidates to move into Canon §§1–5 after validation?

12.7 Promotion plan

- **Promote** §13.2 postulates to Canon §1 (replace/merge wording) after you approve.
- **Add** §13.3 conservation laws as Canon §3A ("Foundational identities").
- **Relabel** old §3.3 (time-rate) as "historical" and keep §12.1 as the operative law; mirror the operative law into §3 with r_c.
- **Append** a permanent "Chronology note" linking VAM 0–4 to the Canon (§0 Versioning $\to$ provenance).

12.8 Citations to add in §9 (BibTeX keys)

- `Kelvin1869` — Circulation theorem.
- `Helmholtz1858` — Vortex motion integrals.
- `Moffatt1969` — Helicity/topological knottedness.
  (Keep existing entries; ensure all non-original laws are cited.)

12.9 Generated indices for this batch (local paths)

- Outline (titles/sections): `vam_corpus_reports_vam0_4/outline.csv`
- Key equations (categorized): `vam_corpus_reports_vam0_4/equations_categorized.csv`
- Equations shortlist: `vam_corpus_reports_vam0_4/equations_shortlist.csv`
- Canon constants concordance: `vam_corpus_reports_vam0_4/canon_concordance.csv`
- Postulates shortlist: `vam_corpus_reports_vam0_4/postulates_shortlist.csv`

End of v0.3 draft delta.

13 VAM Canon v0.4 Delta: Derived Constants, Galactic Swirl Law, and Baryon Mass Map

13.1 Canon Identities (to be promoted to §3B)

- **Fine-structure constant from swirl speed:**

$$\boxed{\alpha = \frac{2C_e}{c}} \quad \Longleftrightarrow \quad \boxed{C_e = \frac{c\,\alpha}{2}}$$

  Dimensionality: velocity ratio $\to$ dimensionless (OK). Numerical check (Canon values): $\alpha = 0.007297352557$.

- **Gravitational fine-structure constant:**

$$\boxed{\alpha_g = \frac{C_e^2 t_p^2}{r_c^2}}$$

  (dimensionless); $\ell_p \equiv c\,t_p$, $\ell_p^2 = c^2 t_p^2$.

- **Equivalents for G:**

$$\boxed{G = \frac{\alpha_g c^3 r_c}{C_e M_e} = \frac{C_e c\,\ell_p^2}{r_c M_e}}$$

  Using the VAM identity:

$$\boxed{M_e = \frac{2F_{æ}^{\max} r_c}{c^2}}$$

  This equals the existing Canon coupling:

$$\boxed{G_{\text{swirl}} = \frac{C_e c^5 t_p^2}{2F_{æ}^{\max} r_c^2}}$$

  Numerical check (Canon values): $G = 6.6743013 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$.

13.2 Galactic Swirl Law (Disc Kinematics)

A two-component velocity profile that captures solid-body rise and asymptotic flattening:

$$\boxed{v(r) = \frac{C_{\text{core}}}{\sqrt{1+(r_c/r)^2}} + C_{\text{tail}}\left(1 - e^{-r/r_c}\right)}$$

Limits: $v(0) = 0$; $v(r \to \infty) = C_{\text{core}} + C_{\text{tail}}$. Small-$r$: core term $\sim (C_{\text{core}}/r_c)\, r$. Large-$r$: exponential approach governed by r_c.

13.3 Baryon Mass Relations (VAM Knot Map)

Let M_u, M_d denote the effective VAM up/down knot masses. Then:

$$\boxed{M_p = \varphi^{-2}\, 3^{-1/\varphi}\,(2M_u + M_d)}, \qquad \boxed{M_n = \varphi^{-2}\, 3^{-1/\varphi}\,(M_u + 2M_d)}$$

13.4 Added/Derived Constants (Append to §10.1)

Symbol	Meaning	Value	Unit
M_e	Electron mass (derived in VAM)	$\frac{2F_{æ}^{\max} r_c}{c^2} = 9.109383 \times 10^{-31}$	kg
ℓ_p	Planck length	$ct_p = 1.616255 \times 10^{-35}$	m
α	Fine-structure (derived)	$2C_e/c = 7.29735256 \times 10^{-3}$	—
α_g	Gravitational fine-structure	$C_e^2 t_p^2 / r_c^2 = 1.75181 \times 10^{-45}$	—

Table 3: Added/derived constants for VAM Canon v0.4

13.5 Dimensional Validations

- $[\alpha] = [\alpha_g] = 1$
- $[G] = \mathrm{L}^3\,\mathrm{M}^{-1}\,\mathrm{T}^{-2}$ from either boxed G identity
- $[v(r)] = \mathrm{L}\,\mathrm{T}^{-1}$

*VAM Canon — v0.5 Selections (ready-to-merge)
Batch: VAM_9–15 (Spacetime, Dark Sector & Quantum Gravity)

G) Boxed selections from VAM 9–15 — to merge into Canon v0.5

G.1 Effective metric / line element (axisymmetric swirl)

Steady, incompressible, azimuthal drift $v_\theta(r)$ in cylindrical (t, r, θ, z):

$$\boxed{ds^2 = -\left(c^2 - v_\theta(r)^2\right) dt^2 + 2v_\theta(r) r\, d\theta\, dt + dr^2 + r^2 d\theta^2 + dz^2}$$

In the co-rotating frame $\theta' = \theta - \int v_\theta(r)\, dt/r$, the cross term diagonalizes locally:

$$\boxed{ds^2 = -c^2\left(1 - \frac{v_\theta(r)^2}{c^2}\right) dt^2 + dr^2 + r^2 d\theta'^2 + dz^2}$$

This exposes the swirl-clock factor and matches Sec. 12.1/3.3 in the $v_\theta \ll c$ regime. Substitute your swirl law as needed, e.g. $v_\theta(r) = r\,\Omega_{\text{swirl}}(r)$ with $\Omega_{\text{swirl}}(r) = \frac{C_e}{r_c} e^{-r/r_c}$.

BibTeX (analogue/PG background): Unruh1981, Visser1998, Painleve1921, Gullstrand1922, Batchelor1967.

G.2 Swirl Hamiltonian density for Sec. 4 (dimensionally normalized)

Take $\rho = \rho^{(\text{fluid})}$, $\vec{\omega} = \nabla \times \vec{v}$, λ for incompressibility. A quadratic, Kelvin-compatible kernel:

$$\boxed{\mathcal{H}[\vec{v}] = \frac{1}{2}\rho\|\vec{v}\|^2 + \frac{1}{2}\rho\ell_\omega^2\|\vec{\omega}\|^2 + \frac{1}{2}\rho\ell_\omega^4\|\nabla\vec{\omega}\|^2 + \lambda(\nabla\cdot\vec{v})} \qquad \ell_\omega := r_c$$

Units check: $[\rho\|\vec{v}\|^2] = \mathrm{J\,m^{-3}}$; since $[\omega] = \mathrm{s}^{-1}$, the coefficients ρ, ℓ_ω^2 and ρ, ℓ_ω^4 ensure the $|\omega|^2$ and $|\nabla\omega|^2$ terms also have energy-density units. In the $\ell_\omega \to 0$ limit this reduces to the bulk swirl energy.

(Optional minimal matter–swirl coupling, same section):

$$\boxed{\mathcal{H}_\psi = \frac{\hbar^2}{2m}\left\|\left(\nabla - i\,\frac{m}{\hbar}\vec{A}_{\text{swirl}}\right)\psi\right\|^2 + U(|\psi|^2)} \qquad \vec{A}_{\text{swirl}} := \chi\,\vec{v}$$

G.3 Dark-sector law beside $v(r)$ (Sec. 14.2)

Radial Euler balance (steady, no radial flow) yields

$$0 = -\frac{1}{\rho}\frac{dp_{\text{swirl}}}{dr} + \frac{v(r)^2}{r} \qquad \Rightarrow \qquad \boxed{a_{\text{dark}}(r) \equiv \frac{1}{\rho}\frac{dp_{\text{swirl}}}{dr} = \frac{v(r)^2}{r}}$$

Equivalently as a pressure law paired with the swirl profile $v(r)$:

$$\boxed{\frac{dp_{\text{swirl}}}{dr} = \rho\,\frac{v(r)^2}{r}} \qquad \Longrightarrow \qquad \boxed{p_{\text{swirl}}(r) = p_0 + \rho\,v_0^2\,\ln\left(\frac{r}{r_0}\right)} \quad (\text{flat } v(r) \to v_0)$$

Sign convention: the inward centripetal requirement corresponds to an outward-rising pressure ($dp/dr > 0$) so that $-\nabla p/\rho$ supplies the inward acceleration.

G.4 Consistency vs Canon v0.1–v0.4

- Time-rate: metric's g_{tt} gives $dt_{\text{local}}/dt_\infty = \sqrt{1 - v_\theta^2/c^2}$, consistent with Sec. 12.1 choice $v_t = |\omega| r$ at $r = r_c$.
- Galactic law: use Sec. 14.2 $v(r)$ in G.3 to obtain explicit $p_{\text{swirl}}(r)$ in both core and tail limits.
- Dimensions: all boxed terms reduce to SI units with $\ell_\omega = r_c$ and $\rho = \rho^{(\text{fluid})}$.

Ready to merge into Canon v0.5: place G.1 in Sec. 3A/Sec. 6, G.2 in Sec. 4 (Hamiltonian), and G.3 alongside Sec. 14.2.

v0.6 Delta — Conclusions from VAM 16–20

Scope. We consolidated the main outcomes of VAM-16–20 (Zero-Vorticity Line, photon/EM mapping, Kerr reinterpretation, vortex-string EFT, and Schrödinger hydrogen). Below are the boxed identities and consistency results that are ready for canonicalization (with dimensional and numerical checks). Items needing a policy decision are explicitly flagged.

C1) EM coupling emerges from core swirl pressure

Define the *swirl Coulomb constant* via the pressure integral over a spherical surface:

$$\boxed{\Lambda \;\equiv\; \int_{S_r^2} p_{\text{swirl}}\, r^2\, d\Omega \;=\; 4\pi\, \rho_{\text{æ}}^{(\text{mass})}\, C_e^2\, r_c^4}$$

Dimensions: $[\Lambda] = \mathrm{N\,m^2} = \mathrm{J\,m}$ (Coulomb constant units). *Identification:*

$$\boxed{\Lambda \;=\; \frac{e^2}{4\pi\varepsilon_0}} \qquad \text{(EM coupling).}$$

Numerics (Canon values): $\Lambda = 2.30707733 \times 10^{-28}\,\mathrm{J\,m}$, matching $e^2/(4\pi\varepsilon_0)$ to $\lesssim 10^{-7}$ relative. This promotes a tight constraint among $(\rho_{\text{æ}}^{(\text{mass})}, C_e, r_c)$ consistent with $\alpha = 2C_e/c$. **Status:** *Promote* as Canon identity in §3B and append Λ to the constants table.

Non-original comparison: Coulomb constant [1].

C2) Hydrogen Schrödinger equation with core softening

VAM replaces the Coulomb term by a swirl-induced softened potential

$$\boxed{V_{\text{VAM}}(r) \;=\; -\frac{\Lambda}{\sqrt{r^2 + r_c^2}} \;\xrightarrow{r \gg r_c}\; -\frac{\Lambda}{r}}$$

and the bound-state equation

$$\boxed{\left[-\frac{\hbar^2}{2\mu}\nabla^2 - \frac{\Lambda}{\sqrt{r^2 + r_c^2}}\right]\psi \;=\; E\,\psi}$$

recovers the textbook spectrum for $r \gg r_c$. **Bohr/Rydberg checks (H):** $a_0 = \hbar^2/(\mu\Lambda) = 5.29177262 \times 10^{-11}\,\mathrm{m}$, $E_1 = \mu\Lambda^2/(2\hbar^2) = 13.60569\,\mathrm{eV}$. Core softening gives nS shifts $\sim \mathcal{O}\big((r_c/a_0)^2\big) \approx 7.1 \times 10^{-10}$ (H), and $\sim \mathcal{O}(2.4 \times 10^{-5})$ for muonic H (using $\mu \approx 186\, m_e$), i.e. a ground-state scale $\sim 6 \times 10^{-2}\,\mathrm{eV}$ — a concrete experimental target.

Non-original equations: Schrödinger hydrogen and Coulomb limit [2, 1].

C3) Frame-dragging / off-diagonal metric term as circulation

The PG-type analogue line element already in Canon (§ G.1) implies the mixed term

$$\boxed{g_{t\theta}^{(\text{VAM})} \;=\; v_\theta(r)\, r \;=\; \frac{1}{2\pi}\,\Gamma_{\text{swirl}}(r)}$$

with $\Gamma_{\text{swirl}}(r) = \oint v_\theta\, dl$ the azimuthal circulation at radius r. This is the precise VAM counterpart of GR's $g_{t\phi}$ frame-dragging structure for axisymmetric rotation, dovetailing with the Kerr reinterpretation draft.[1] **Status:** *Promote* the boxed relation as a corollary to § G.1.

Non-original background: analogue/PG metrics and Kerr solution [3, 4, 5, 6, 7].

[1] In BL-like gauges one can factor c^2 to yield a dimensionless coefficient; the PG form used in Canon keeps $g_{t\theta}$ in velocity × length units, matching the analogue-gravity construction.

C4) Hamiltonian/Lagrangian usage: $\rho^{(\text{fluid})}$ vs $\rho^{(\text{mass})}$

Across VAM-16–20 two distinct densities appear:

Bulk swirl energetics (Canon §4, G.2): $\frac{1}{2}\rho_{æ}^{(\text{fluid})}\,\|\vec{v}\|^2 + \frac{1}{2}\rho_{æ}^{(\text{fluid})}\,r_c^2\|\vec{\omega}\|^2 + \cdots$

EM coupling (§ 13.5): $\Lambda = 4\pi\,\rho_{æ}^{(\text{mass})}\,C_e^2\,r_c^4\,.$

Conclusion (policy): retain $\rho_{æ}^{(\text{fluid})}$ in the *Hamiltonian kernel* for continuum energetics (Canon §4), and reserve $\rho_{æ}^{(\text{mass})}$ for *core/EM coupling* identities (§ C1). This resolves the apparent density "swap" without changing any numerics.

Non-original context: continuum energy density forms [9].

C5) Time-rate law: confirm r_c factor and note draft variance

Some 16–20 drafts reused the historical form $dt_{\text{local}}/dt_\infty = \sqrt{1-\|\omega\|^2/C_e^2}$. **Canon-consistent law (dimensionally correct):**

$$\boxed{\frac{dt_{\text{local}}}{dt_\infty} = \sqrt{1-\frac{\|\omega\|^2\,r_c^2}{c^2}} = \sqrt{1-\frac{v_t^2}{c^2}}\,,\quad v_t := \|\omega\|r_c}$$

Action: keep only the r_c-normalized law in Canon (§ 12.1/§ 3.3); mark the non-normalized variant as deprecated.

C6) "Zero-vorticity line" claim: status and correction path

With the canonical profile $\Omega_{\text{swirl}}(r) = \frac{C_e}{r_c}e^{-r/r_c}$ and $v_\theta = r\Omega$, the axial vorticity is

$$\omega_z(r) = \frac{1}{r}\frac{d}{dr}(rv_\theta) = 2\Omega(r) + r\,\Omega'(r)\,,$$

so $\omega_z(0) = 2\,C_e/r_c \neq 0$. **Conclusion:** the *"Zero-Vorticity Line"* is *not* satisfied by the current core law. Two consistent options: (i) *reinterpret* the phrase as a *null pressure-gradient axis* (keeping $\omega_z(0) \neq 0$), or (ii) *adopt* a modified core profile with $\Omega(r) \propto r$ as $r \to 0$ to enforce $\omega_z(0) = 0$. *Decision required* before promotion.

Non-original identities: vorticity in cylindrical coordinates [8].

C7) Vortex-string EFT mass functional (candidate form)

The VAM-20 EFT drafts propose a topological mass functional for a knotted core:

$$\boxed{m_K^{\text{sol}} = \mathcal{C}_0\left(\sum_i V_i\right)\rho_{æ}^{(\text{fluid})}\,\frac{C_e^2}{c^2}\,\Xi_K\Big(\text{Tw},\text{Wr},\text{Lk};\,\varphi\Big)}$$

where $\sum_i V_i$ is the effective core volume (possibly multi-tube), and Ξ_K is a dimensionless topological factor (*to be calibrated*, e.g. to the electron ring). **Status:** keep as *research* (not yet Canon); compatible with Canon energetics (§4) once $\mathcal{C}_0$ and Ξ_K are fixed.

Summary of promotions and open items

- **Promote now:** § C1 (Λ identity), § C2 (soft-core hydrogen), § C3 (circulation–$g_{t\theta}$ relation), and § C5 (time-rate with r_c).
- **Append to constants table:** $\Lambda = 4\pi\rho_{æ}^{(\text{mass})}C_e^2r_c^4$.
- **Keep research:** § C6 (zero-vorticity line — needs definition/profile choice), § C7 (vortex-string mass functional calibration).

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[8] G. K. Batchelor, *An Introduction to Fluid Dynamics*, Cambridge Univ. Press, 1967.

[9] L. D. Landau and E. M. Lifshitz, *Fluid Mechanics*, 2nd ed., Pergamon, 1987.

| Λ | Swirl Coulomb constant (EM coupling) | $4\pi\,\rho_{æ}^{(\text{mass})}\,C_e^2\,r_c^4 = 2.30707733\times10^{-28}$ | J·m |

$$\boxed{\Lambda \;=\; \int_{S_r^2} p_{\text{swirl}}\,r^2\,d\Omega \;=\; 4\pi\,\rho_{æ}^{(\text{mass})}\,C_e^2\,r_c^4 \;=\; \frac{e^2}{4\pi\varepsilon_0}} \quad \text{[units: J·m]}$$

$$\boxed{\left[-\frac{\hbar^2}{2\mu}\nabla^2 - \frac{\Lambda}{\sqrt{r^2+r_c^2}}\right]\psi = E\,\psi \;\xrightarrow{r\gg r_c}\; \left[-\frac{\hbar^2}{2\mu}\nabla^2 - \frac{\Lambda}{r}\right]\psi = E\,\psi}$$

Corollary (circulation–metric link). With azimuthal drift $v_\theta(r)$, the PG-type analogue metric implies

$$\boxed{g_{t\theta}^{(\text{VAM})} \;=\; v_\theta(r)\,r \;=\; \frac{1}{2\pi}\,\Gamma_{\text{swirl}}(r)}, \qquad \Gamma_{\text{swirl}}(r) := \oint v_\theta\,dl.$$

This is the VAM counterpart of GR frame-dragging ($g_{t\phi}$) for axisymmetric rotation.
amsmath, amssymb siunitx hyperref geometry physics bm upgreek graphicx margin=1in

VAM Canon (v0.7-Extensions)

Canonical Enhancements from *Before-VAM-and-Experiments.zip* and *VAM-ONGOING-RESEARCHES.zip*

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Abstract

This document *extends* the **VAM Canon (v0.1)** with items that are ready for canonicalization, distilled from the two corpora of uploaded work: *Before-VAM-and-Experiments.zip* and *VAM-ONGOING-RESEARCHES.zip*. We add: (i) foundational conservation laws (Kelvin, vorticity-transport, helicity) as §3A, (ii) an effective metric and a circulation–metric link, (iii) a dimensionally normalized swirl Hamiltonian, (iv) a dark-sector pressure law aligned with flat rotation curves, (v) the *swirl Coulomb constant* identity Λ_{swirl} with hydrogen soft-core spectrum and numerical validation, and (vi) experimental validation protocols for $C_e = f\,\Delta x$ and for the swirl gravitational potential. Research-track notes from the blackbody/QED/knot-taxonomy files are included as non-canonical appendices.

Canon Delta Summary (Promote to Core)

1. **Foundational identities (§14).** Kelvin circulation, vorticity transport, and helicity invariants [? ? ? 8?].
2. **Analogue/PG line element (§15).** Axisymmetric swirl metric with cross-term $g_{t\theta}$ and *corollary*: $g^{(\text{VAM})}_{t\theta} = r\,v_\theta(r) = \Gamma_{\text{swirl}}(r)/(2\pi)$ [5, 6, 3, 4, 7].
3. **Swirl Hamiltonian (§16).** Kelvin-compatible, dimensionally normalized kernel with $\ell_\omega = r_c$ and incompressibility constraint.
4. **Dark-sector pressure law (§17).** For steady azimuthal drift, $\frac{1}{\rho}\frac{\mathrm{d}p_{\text{swirl}}}{\mathrm{d}r} = \frac{v(r)^2}{r}$ and $p_{\text{swirl}}(r) = p_0 + \rho v_0^2 \ln(r/r_0)$ for flat $v(r)$.
5. **Swirl Coulomb constant and hydrogen (§18).** $\Lambda_{\text{swirl}} = 4\pi\rho_{æ}^{(\text{mass})} C_e^2 r_c^4$ and the soft-core potential $V(r) = -\Lambda_{\text{swirl}}/\sqrt{r^2 + r_c^2}$, recovering Bohr and Rydberg limits [1, 2].
6. **Experimental protocols (§19).** Canon-ready protocols extracted from `appendix_C` and `appendix_D` files for validating C_e and the swirl potential.

14 Foundational Identities (Add as Canon §3A)

Let $\mathbf{v}$ be the æther velocity ($\nabla \cdot \mathbf{v} = 0$), $\omega = \nabla \times \mathbf{v}$. For inviscid, barotropic flow [? ? 8?]:

Kelvin circulation: $$\frac{d\Gamma}{dt} = 0, \quad \Gamma = \oint_{C(t)} \mathbf{v} \cdot d\ell. \tag{F1}$$

Vorticity transport: $$\frac{\partial \omega}{\partial t} = \nabla \times (\mathbf{v} \times \omega). \tag{F2}$$

Helicity: $$h = \mathbf{v} \cdot \omega, \quad H = \int h\,dV \text{ (invariant up to reconnections). [?]} \tag{F3}$$

These underpin knotted-solition stability and reconnection energetics in VAM.

15 Axisymmetric Swirl Metric and Circulation Link

In cylindrical (t, r, θ, z) with steady azimuthal drift $v_\theta(r)$, adopt the Painlevé–Gullstrand analogue form [5, 6, 3, 4]:

$$ds^2 = -\left(c^2 - v_\theta(r)^2\right) dt^2 + 2\, v_\theta(r)\, r\, d\theta\, dt + dr^2 + r^2 d\theta^2 + dz^2. \tag{M1}$$

Co-rotating with $\theta' = \theta - \int v_\theta(r)\, dt/r$ gives

$$ds^2 = -c^2\left(1 - \frac{v_\theta(r)^2}{c^2}\right) dt^2 + dr^2 + r^2 d\theta'^2 + dz^2, \tag{M2}$$

so the swirl-clock factor is $dt_{\text{local}}/dt_\infty = \sqrt{1 - v_\theta^2/c^2}$. *Corollary (frame-dragging analogue):*

$$g_{t\theta}^{(\text{VAM})} = r\, v_\theta(r) = \frac{1}{2\pi}\Gamma_{\text{swirl}}(r), \qquad \Gamma_{\text{swirl}}(r) := \oint v_\theta\, dl. \tag{M3}$$

16 Swirl Hamiltonian Density (Add to Canon §4)

With $\rho = \rho_{æ}^{(\text{fluid})}$, $\omega = \nabla \times \mathbf{v}$, and Lagrange multiplier λ for incompressibility, a Kelvin-compatible, dimensionally normalized kernel is

$$\mathcal{H}[\mathbf{v}] = \frac{1}{2}\rho\, \|\mathbf{v}\|^2 + \frac{1}{2}\rho\, \ell_\omega^2\, \|\omega\|^2 + \frac{1}{2}\rho\, \ell_\omega^4\, \|\nabla\omega\|^2 + \lambda(\nabla \cdot \mathbf{v}), \qquad \ell_\omega := r_c. \tag{H1}$$

All terms carry units of energy density ($\mathrm{J\,m^{-3}}$). In the $\ell_\omega \to 0$ limit this reduces to the bulk swirl energy used in Canon v0.1.

17 Dark-Sector Pressure Law (Place next to galactic $v(r)$)

For steady, purely azimuthal drift $v(r)$ and no radial flow, the radial Euler balance gives

$$0 = -\frac{1}{\rho}\frac{dp_{\text{swirl}}}{dr} + \frac{v(r)^2}{r} \quad \Longrightarrow \quad \boxed{\frac{1}{\rho}\frac{dp_{\text{swirl}}}{dr} = \frac{v(r)^2}{r}}. \tag{D1}$$

For an asymptotically flat curve $v(r) \to v_0$, integration yields

$$p_{\text{swirl}}(r) = p_0 + \rho\, v_0^2\, \ln\frac{r}{r_0}. \tag{D2}$$

Sign: outward-rising p produces inward acceleration $-\nabla p/\rho$.

18 Swirl Coulomb Constant and Hydrogen Soft-Core

18.1 Identity and dimensions

Define the *swirl Coulomb constant* via the surface integral of swirl pressure over the sphere S_r^2 (consistent with the experimental appendices and EM mapping notes):

$$\boxed{\Lambda_{\text{swirl}} \equiv \int_{S_r^2} p_{\text{swirl}}\, r^2\, d\Omega \;=\; 4\pi\, \rho_{æ}^{(\text{mass})}\, C_e^2\, r_c^4} \qquad [\Lambda_{\text{swirl}}] = \mathrm{J\,m} = \mathrm{N\,m^2}. \tag{E1}$$

In VAM hydrogen, replace the Coulomb term by a softened potential

$$V_{\text{VAM}}(r) = -\frac{\Lambda_{\text{swirl}}}{\sqrt{r^2 + r_c^2}} \xrightarrow{r \gg r_c} -\frac{\Lambda_{\text{swirl}}}{r}. \tag{E2}$$

18.2 Schrödinger equation and recovery of textbook limits [2, 1]

The bound-state equation

$$\left[-\frac{\hbar^2}{2\mu}\nabla^2 - \frac{\Lambda_{\text{swirl}}}{\sqrt{r^2+r_c^2}}\right]\psi = E\,\psi \xrightarrow{r\gg r_c} \left[-\frac{\hbar^2}{2\mu}\nabla^2 - \frac{\Lambda_{\text{swirl}}}{r}\right]\psi = E\,\psi. \tag{E3}$$

Using $\mu \approx m_e$, the Bohr radius and ground energy are recovered with Λ_{swirl} in place of $e^2/(4\pi\varepsilon_0)$:

$$a_0 = \frac{\hbar^2}{\mu\Lambda_{\text{swirl}}}, \qquad E_1 = \frac{\mu\Lambda_{\text{swirl}}^2}{2\hbar^2}. \tag{E4}$$

Numerical validation (Canon constants). With $C_e = 1.093\,85\times10^{6}\,\mathrm{m/s}$, $r_c = 1.408\,97\times10^{-15}\,\mathrm{m}$, $\rho_{æ}^{(\text{mass})} = 3.893\,44\times10^{18}\,\mathrm{kg/m^3}$:

$$\Lambda_{\text{swirl}} = 4\pi\,\rho_{æ}^{(\text{mass})}\,C_e^2\,r_c^4 = 2.307\,08\times10^{-28}\,\mathrm{J\,m}, \tag{E5}$$

$$a_0 = 5.291\,77\times10^{-11}\ \mathrm{m}, \qquad E_1 = 2.179\,87\times10^{-18}\ \mathrm{J} = 13.6057\ \mathrm{eV}. \tag{E6}$$

These match the textbook hydrogen values to within numerical tolerance, validating the identification of Λ_{swirl}.

19 Experimental Protocols (Canon-ready)

19.1 Appendix C: Universality of $C_e = f\,\Delta x$ (metrology across platforms)

From `appendix_C_ExperimentalValidationOfVortexCoreTangientalVelocity.tex`: measure a natural frequency f and a spatial step Δx from standing/propagating modes; verify

$$\boxed{C_e = f\,\Delta x \approx 1.093\,85\times10^{6}\ \mathrm{m/s}}. \tag{X1}$$

Platforms: magnet/electret domains, laser interferometry on coil-bound modes, and acoustic analogues. Require ppm-level agreement; report mean and standard deviation across platforms.

19.2 Appendix D: Swirl gravitational potential

From `appendix_D_ExperimentalValidationOfGravitationalPotential.tex`: infer $p_{\text{swirl}}(r)$ from centripetal balance (§17) and compare predicted forces with measured thrust or buoyancy anomalies in shielded high-voltage/coil experiments (geometry: starship/Rodin coils). Ensure dimensional consistency and calibrate only via Canon constants.

Policy Notes and Clarifications

Density usage. Use $\rho_{æ}^{(\text{fluid})}$ in continuum energetics (§16); reserve $\rho_{æ}^{(\text{mass})}$ for core/EM coupling identities (§18).

Time-rate law. Canon operative form (dimensionally correct): $dt_{\text{local}}/dt_\infty = \sqrt{1-\|\omega\|^2 r_c^2/c^2} = \sqrt{1-v_t^2/c^2}$ with $v_t := \|\omega\| r_c$.

A Research Track (non-canonical yet)

A.1 Blackbody via Swirl Temperature (from `BlackBody_fromWein_toNewEM.md`)

Proposal. Define a swirl temperature T_{swirl} via local vortex energy density and map Wien/Planck spectra by substituting Λ_{swirl} in place of $e^2/(4\pi\varepsilon_0)$. Requires a precise constitutive link between T and $\|\omega\|^2$; cite [? ?].

A.2 QED–VAM Mapping Notes (from `QED_VAM_RESEARCH_NOTES.md`)

Sketch. Minimal coupling $\nabla \to \nabla - i\frac{m}{\hbar}A_{\text{swirl}}$ with $A_{\text{swirl}} = \chi\,\mathbf{v}$ inside $\mathcal{H}$ (cf. (H1)); action S parallels circulation Γ. Canonization deferred pending gauge-structure tests.

A.3 Knot Taxonomy Refinement

Use the Călugăreanu–White–Fuller relation $Lk = Tw + Wr$ [? ?] to sharpen torus/hyperbolic assignments, and to parametrize chirality (matter/antimatter) via sign of Tw.

Numerical Snapshot of Canon Identities

$$\alpha = \frac{2C_e}{c} = 0.007\,297\,35, \quad G_{\text{swirl}} = \frac{C_e\,c^5 t_p^2}{2F_{\text{æ}}^{\max}\,r_c^2} = 6.674\,30 \times 10^{-11}\,\mathrm{m^3\,kg^{-1}\,s^{-2}}, \tag{17}$$

$$\Omega_{\text{swirl}}(0) = \frac{C_e}{r_c} = 7.763\,44 \times 10^{20}\,\mathrm{s^{-1}}, \quad \Lambda_{\text{swirl}} = 2.307\,08 \times 10^{-28}\,\mathrm{J\,m}. \tag{18}$$

Change Log for v0.7-Extensions (2025-08-22). Added §3A identities; §15 metric and circulation corollary; §16 Hamiltonian; §17 pressure law; §18 with numerical validation; §19 protocols; research appendices.

B Clustered New Insights for VAM

B.1 A. Knot-theoretic parametrization & mass law (items 1,2,3,4,5,6,18)

[E1] Knot invariants as parameters: n=gcd(p,q), $m = p$ (or braid strand count), $s = g = \frac{(p-1)(q-1)}{2}$.

[E2] VAM mass law with torus invariants: $M(p,q,V_i) = \left(\frac{4}{\alpha}\right) p^{-3/2}\,\phi^{-\frac{(p-1)(q-1)}{2}}\,[\gcd(p,q)]^{-1/\phi} \sum_i V_i\left(\frac{1}{2\rho C_e^2}\right)$.

[E3] General torus-link choices: $m \equiv b(T) = \min(|p|,|q|)$, $s \equiv g(T) = \frac{(|p|-1)(|q|-1)-(n-1)}{2}$.

[E4] Dimension correction (mass from energy density): $M \propto \left(\frac{1}{2}\rho C_e^2\right)\frac{\sum_i V_i}{c^2}$.

[E5] Core volume via rope length: $\displaystyle\sum_i V_i(T) = \pi r_c^3\,\mathcal{L}_{\text{tot}}(T)$.

[E6] Invariant mass law (rope-length form): $M(T(p,q)) = \left(\frac{4}{\alpha}\right) b(T)^{-3/2}\,\phi^{-g(T)}\,n(T)^{-1/\phi}\left(\frac{1}{2}\rho C_e^2\right)\frac{\pi r_c^3\,\mathcal{L}_{\text{tot}}(T)}{c^2}$.

[E18] Compact mass expression: $M = \frac{1}{\phi}\,\frac{4}{\alpha}\left(\frac{1}{2}\rho C_e^2\,V\right)$.

Explanation (Group A). This family replaces heuristic "suppression constants" with knot invariants (n, m, g) so the mass law is intrinsically topological. Rope length $\mathcal{L}_{\text{tot}}$ and core radius r_c provide a geometric scale for $\sum_i V_i$. The factors c^{-2} and ρC_e^2 ensure dimensional consistency (energy-to-mass). [E2] and [E6] are functionally similar; [E6] is the invariant rope-length form, preferred for comparing different knots.

B.2 B. Helicity-based topological charge & energy functionals (items 7,8,9,19)

[E7] Vortex helicity (topological charge): $H_{\text{vortex}} = \dfrac{1}{(4\pi)^2} \displaystyle\int \vec{v} \cdot \vec{\omega}\, d^3x, \qquad H_{\text{vortex}} = nH_0.$

[E8] Dimensionless normalization: $Q_{\text{top}} = \dfrac{L}{(4\pi)^2\Gamma^2} \displaystyle\int \vec{v} \cdot \vec{\omega}\, d^3x.$

[E9] Topological energy term and total energy: $\mathcal{L}_{\text{top}} = \frac{C_e^2}{2}\rho\, \vec{v} \cdot \vec{\omega}, \quad \mathcal{E}_{\text{VAM}} = \int \big[\frac{1}{2}\rho|\vec{v}|^2 + \frac{C_e^2}{2}\rho\vec{v} \cdot \vec{\omega} + \Phi_{\text{swirl}} + P(\rho)\big]\, d^3x.$

[E19] Swirl potential (proposal): $\Phi(r) = \dfrac{C_e^2}{2F_{\max}}\, \vec{\omega}(r) \cdot \vec{r}.$

Explanation (Group B). [E7]–[E8] define (normalized) helicity as a measure of linkage/knottedness of vortex lines; [E8] makes Q_{top} comparable across configurations. [E9] couples topology directly to energy via $\vec{v} \cdot \vec{\omega}$. [E19] is a modeling choice for Φ that ties swirl fields to pressure/tension; it can be tuned for stability criteria.

B.3 C. Split helicity: writhe, twist & time (items 10,11,12)

[E10] Split with flux C**:** $H = H_C + H_T, \quad H_C = C^2\,\text{Wr}, \quad H_T = C^2\,\text{Tw}, \quad H = C^2(\text{Wr} + \text{Tw}).$

[E11] Writhe kernel (Gauss-like): $\text{Wr} = \dfrac{1}{4\pi} \displaystyle\int_C\int_C \dfrac{\big(\mathbf{T}(s) \times \mathbf{T}(s')\big) \cdot \big(\mathbf{r}(s) - \mathbf{r}(s')\big)}{|\mathbf{r}(s) - \mathbf{r}(s')|^3}\, ds\, ds'.$

[E12] Time dilation with split helicity: $dt = dt_\infty \sqrt{1 - \dfrac{H_C + H_T}{H_{\max}}}.$

Explanation (Group C). Total helicity decomposes into shape (Wr) and torsion (Tw) parts, weighted by flux C. [E11] gives the geometric, reparameterization-invariant definition of writhe along the centerline. [E12] links topology to the local clock rate in VAM: greater knottedness/torsion increases time dilation.

B.4 D. ISF/wavefunction formulation & Hopf map (items 13,14,15,16,17)

[E13] ISF-like VAM Lagrangian (two-component ψ**):** $\mathcal{L}_{\text{VAM}} = \dfrac{i\hbar}{2}\Big(\psi^\dagger\partial_t\psi - \psi\partial_t\psi^\dagger\Big) - \dfrac{\hbar^2}{2m}|\nabla\psi|^2 - \dfrac{\alpha}{8}\,|\nabla\vec{s}|^2.$

[E14] Hopf spin from $\psi = \begin{pmatrix} a + ib \\ c + id \end{pmatrix}$**:** $s_1 = a^2 + b^2 - c^2 - d^2, \ s_2 = 2(bc - ad), \ s_3 = 2(ac + bd).$

[E15] Euler–Lagrange with topological feedback: $i\hbar\,\partial_t\psi = -\dfrac{\hbar^2}{2m}\nabla^2\psi + \dfrac{\alpha}{4}\,\dfrac{\delta}{\delta\psi^*}\,|\nabla\vec{s}|^2.$

[E16] Madelung/incompressible ansatz: $\psi = \sqrt{\rho}\, e^{i\theta}, \quad \vec{v} = \nabla\theta, \quad |\psi|^2 = \rho = \text{const} \Rightarrow \nabla \cdot \vec{v} = 0.$

[E17] "Quantum pressure" analogue in VAM: $Q_{\text{VAM}} = \dfrac{1}{2}\rho\, |\vec{\omega}|^2.$

Explanation (Group D). This family casts vortex knots into a wavefunction framework: ψ evolves via [E15], while $\vec{s}(\psi)$ (Hopf map) encodes topology. The Madelung ansatz [E16] connects phase to velocity and enforces incompressibility (ISF). [E17] replaces standard quantum pressure with a vorticity-based tension, consistent with VAM's energy density. Together, this yields simulation-ready, topology-sensitive dynamics.

A VAM Radiation Laws and Exotic Modes

This appendix consolidates the Vortex Æther Model (VAM) derivations related to radiation laws, spectral behavior, and exotic non-EM wave modes. Equations are grouped by thematic category.

A.1 Ætheric Energy–Temperature Coupling

The rotational kinetic energy density of the æther field is

$$U_{\text{rot}} = \tfrac{1}{2}\rho_{æ}|\vec{\omega}|^2.$$

By analogy with kinetic theory, this rotational energy can be equated to thermal agitation in a coarse-graining cell of volume V_{cell}:

$$k_B T \sim \tfrac{1}{2}\rho_{æ}|\vec{\omega}|^2 V_{\text{cell}}.$$

Thus, temperature T is directly linked to local vorticity magnitude, providing the VAM foundation for blackbody radiation.

A.2 Peak Wavelength Scaling in VAM

Radiation wavelength is inversely related to the vortex frequency:

$$\lambda = \frac{c}{\nu}, \qquad \nu \sim |\vec{\omega}|.$$

Substituting the vorticity–temperature correspondence gives

$$\lambda_{\text{peak}} \sim \frac{c}{\sqrt{\dfrac{2k_B T}{\rho_{æ} V_{\text{cell}}}}},$$

which simplifies to

$$\lambda_{\text{peak}} = \left(\frac{c\sqrt{\rho_{æ} V_{\text{cell}}}}{\sqrt{2k_B}} \right) T^{-1/2}.$$

Hence, VAM predicts a $\lambda_{\text{peak}} \propto T^{-1/2}$ scaling, slower than Wien's $\lambda_{\max} \propto 1/T$ law.

A.3 Quantized Vortex Photon Spectrum

A photon in VAM is modeled as a rotating vortex torus of radius r_n and circulation Γ_n, yielding an energy

$$E_n = \tfrac{1}{2}\rho_{æ}\frac{\Gamma_n^2}{r_n}.$$

With quantization ansatz

$$\Gamma_n \sim \frac{nh}{M_e}, \quad r_n \sim \frac{r_c}{n},$$

the energy scales as

$$E_n \sim n^3 \cdot \text{const.}$$

Meanwhile, the mode frequency is

$$\nu_n = \frac{C_e}{2\pi r_n} \sim n\nu_0, \qquad \nu_0 = \frac{C_e}{2\pi r_c}.$$

Thus,

$$E_n \sim h_{\text{eff}}(n)\,\nu_n, \qquad h_{\text{eff}} \sim n^2 h,$$

indicating an n-dependent effective Planck constant and a cubic scaling of vortex photon energies.

A.4 Spectral Energy Density in VAM

The density of vortex photon modes is suppressed at high frequency due to instability:

$$g(\nu) \sim \nu^2 e^{-\alpha\nu/\nu_c}, \qquad \nu_c = \frac{C_e}{2\pi r_c}.$$

The spectral energy density is therefore

$$u(\nu, T) = g(\nu)\,\frac{E(\nu)}{e^{E(\nu)/k_B T} - 1}.$$

If $E(\nu) \sim \nu^3$, one obtains

$$u(\nu, T) = A\nu^2 e^{-\alpha\nu/\nu_c} \cdot \frac{\nu^3}{e^{B\nu^3/T} - 1},$$

a VAM-modified blackbody spectrum that resolves the ultraviolet catastrophe via exponential suppression.

A.5 Exotic Ætheric Radiation Modes

Torsional shocks. Rapid torque collapse produces a vorticity impulse:

$$\frac{\partial}{\partial t}(\nabla \cdot \vec{L}_{æ}) \gg 0, \qquad \frac{d\Gamma}{dt} = \oint_{\partial S} \vec{v} \cdot d\vec{\ell} \to \text{singular impulse.}$$

The governing transport law is

$$\rho_{æ}\left(\frac{\partial \vec{\omega}}{\partial t} + (\vec{v} \cdot \nabla)\vec{\omega}\right) = \nabla \times \left(\vec{f}_{\text{topo}} + \vec{f}_{\text{shear}}\right).$$

Æther solitons. Localized vortex packets arise from a nonlinear Klein–Gordon equation:

$$\left(\tfrac{\partial^2 \psi}{\partial t^2} - C_e^2 \nabla^2 \psi\right) + \beta\psi^3 = 0,$$

with stable solution

$$\psi(x, t) = A\,\text{sech}\left(\tfrac{x - vt}{\Delta}\right).$$

Knot collapse flashes (Æ-gamma). If stored knot energy exceeds the Planck threshold,

$$E_{\text{stored}} \gtrsim E_{\text{Planck}} \quad \Rightarrow \quad \delta t \approx t_p, \quad \delta E \approx E_p,$$

a violent burst occurs, possibly generating matter and spacetime perturbations.