Extended Mathematical Framework of DWARF Theory

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Abstract

We extend the DWARF (Dynamic Wake Accretion in Relativistic Fluids) theory by enriching its mathematical formalism. Building upon the original Lagrangian and flow-based constructs, we derive the inverse-square wake profile, introduce flow-based time dilation, model quantum analogs via field interference, and reformulate lensing phenomena as refractive index saturation. These findings provide the groundwork for a unification between fluid dynamics, emergent gravity, and quantum-like coherence in a non-geometric medium.

1 1. Classical DWARF Flow Equation

$$\frac{\partial \vec{v}}{\partial t} = -\nabla\Phi + \nu\nabla^2\vec{v} - \beta\vec{v} \tag{1}$$

2 2. Relativistic Generalization

$$u^\nu \nabla_\nu u^\mu = -\nabla^\mu\Phi + \nu\nabla^2 u^\mu - \beta u^\mu \tag{2}$$

$$\nabla_\mu(\rho u^\mu) = 0 \tag{3}$$

3 3. Emergent Potential and Pressure

$$\Phi = f(\rho) + \gamma\nabla_\mu u^\mu \tag{4}$$

$$P = \rho\frac{d\Phi}{d\rho} - \Phi(\rho) \tag{5}$$

4 4. Lagrangian Formalism

$$\mathcal{L}_{\text{DWARF}} = -\frac{1}{2}\rho u^\mu u_\mu - \rho\Phi(\rho) \tag{6}$$

Euler-Lagrange Equations:

$$\nabla_\mu(\rho u^\mu) = 0 \tag{7}$$

$$\delta\mathcal{L}/\delta\rho = -\frac{1}{2}u^\mu u_\mu - \Phi(\rho) - \rho\frac{d\Phi}{d\rho} \tag{8}$$

5 5. Inverse-Square Wake Derivation

From spherical symmetry and continuity:

$$\nabla\cdot(\rho\vec{v}) = 0 \tag{9}$$

$$\Rightarrow \Phi(r) \propto \frac{1}{r^2} \tag{10}$$

This demonstrates that wake strength naturally follows an inverse-square decay in radial flow fields.

6 6. Flow-Based Time Dilation

Time slows in denser or faster-moving regions of the field:

$$d\tau = \frac{dt}{\sqrt{1 + k|\vec{v}_{\text{field}}|^2}} \tag{11}$$

where k is a coupling constant governing time flow sensitivity to velocity field intensity.

7 7. Quantum Superposition via Field Interference

$$\Phi_{\text{net}} = \Phi_1 + \Phi_2 + 2\sqrt{\Phi_1 \Phi_2} \cos(\delta) \tag{12}$$

Random phase noise $\delta(t)$ induces decoherence, replicating collapse behavior.

8 8. Gravitational Lensing via Refractive Index Saturation

Let $n(x) \propto \rho(x)$ be the refractive index:

$$\theta \sim \int \nabla n(x)\, dx \tag{13}$$

This model captures light deflection as a natural outcome of medium density gradients, achieving achromatic lensing.

9 9. Optional: Tensor Bridge Hypothesis

Speculative mapping from DWARF flow to Einstein tensor:

$$G_{\mu\nu} \sim \langle \partial_\mu \vec{v} \partial_\nu \vec{v} \rangle_{\text{stat}} - \eta_{\mu\nu} \langle |\vec{v}|^2 \rangle \tag{14}$$

Ensemble statistics of wake gradients may approximate spacetime curvature macroscopically.

10 10. Summary and Outlook

These equations extend DWARF's capabilities into the relativistic, quantum-analog, and optical regimes. Future work will incorporate orbital mechanics, amplitude regulation, and full 3D simulations, forming a bridge between classical fluid models and post-Newtonian physics.