The Density of the Æther: A Modern Derivation within the Vortex Æther Model

Abstract

This article refines previous estimates of the Æther's density, $\rho_{æ}$, in the Vortex Æther Model (VAM). Integrating findings from quantum vortex dynamics, superfluid helium, gravitomagnetic frame-dragging, and cosmological vacuum energy, we propose constrained ranges for $\rho_{æ}^{(\text{fluid})}$ and $\rho_{æ}^{(\text{energy})}$ and examine their implications across scales.

1 Introduction

In VAM, the Æther is a structured, inviscid medium supporting vorticity and energy transfer. Two key densities are defined:

- $\rho_{æ}^{(\text{fluid})}$: mass density akin to a classical fluid.
- $\rho_{æ}^{(\text{energy})}$: energy density stored in vorticity.

2 Vorticity and Energy Density

The vorticity energy density is:

$$U_{\text{vortex}} = \rho_{æ}^{(\text{energy})} = \frac{1}{2}\rho_{æ}^{(\text{fluid})}|\vec{\omega}|^2$$

with

$$|\vec{\omega}| = \sqrt{\omega_x^2 + \omega_y^2 + \omega_z^2}$$

3 Quantum Anchoring of Vorticity

To ground the model in fundamental physics, we define vorticity using the fine-structure constant α and Compton angular frequency ω_C:

$$|\vec{\omega}| = \alpha \cdot \omega_C = \alpha \cdot \frac{m_e c^2}{\hbar}$$

Given $r_c = \frac{1}{2} r_e$, the density becomes:

$$\rho_{æ}^{(\text{fluid})} = \frac{2 m_e c^2}{\left(\alpha \cdot \frac{m_e c^2}{\hbar}\right)^2 r_c^3} \approx 7 \times 10^{-7} \text{ kg m}^{-3}$$

4 Experimental and Theoretical Support

Empirical support includes superfluid helium vortex dynamics [1], frame-dragging analogs in vortex fields [2], and superconductive gravitational coupling [3].

5 Vacuum Energy Context

The vacuum energy density derived from the cosmological constant $\Lambda \sim 10^{-52}$ m^{-2} is given by:

$$\rho_{\text{vacuum}} = \frac{\Lambda c^2}{8\pi G} \sim 5 \times 10^{-9} \, \text{kg/m}^3$$

To relate this vacuum energy to the Æther fluid density in the VAM framework, we apply a quantum scaling via the fine-structure constant α. Assuming:

$$\rho_{æ}^{(\text{fluid})} \approx \frac{\rho_{\text{vacuum}}}{\alpha}$$

we obtain:

$$\rho_{æ}^{(\text{fluid})} \approx \frac{5 \times 10^{-9}}{1/137.036} \approx 6.85 \times 10^{-7} \, \text{kg/m}^3$$

This coincides with the value derived independently from vortex energy dynamics, suggesting that vacuum energy may serve as a lower bound or projection of the structured Æther's fluid density.

5.1 Core Vorticity Energy Density

Given the tangential eddy velocity $C_e = 1.094 \times 10^6\,\mathrm{m/s}$ and vortex core radius $r_c = 1.409 \times 10^{-15}\,\mathrm{m}$, the vorticity magnitude is:

$$|\vec{\omega}| = \frac{2C_e}{r_c} \approx 1.55 \times 10^{21}\,\mathrm{s}^{-1}$$

Substituting this and the fluid density $\rho_{æ}^{(\mathrm{fluid})} \approx 7 \times 10^{-7}\,\mathrm{kg/m^3}$ into the vorticity energy density expression:

$$\rho_{æ}^{(\mathrm{energy})} = \frac{1}{2}\rho_{æ}^{(\mathrm{fluid})}|\vec{\omega}|^2 \approx 8.44 \times 10^{35}\,\mathrm{J/m^3}$$

In natural units where $c = 1$, this corresponds to a normalized energy density:

$$\rho_{æ}^{(\mathrm{energy})}\Big|_{c=1} \approx \frac{8.44 \times 10^{35}}{(2.998 \times 10^8)^2} \approx 9.39 \times 10^{18}\,\mathrm{kg/m^3}$$

This density reflects the immense localized energy associated with a knotted quantum vortex, reinforcing the physical viability of Æther dynamics in subatomic structures.

6 Galaxy Rotation and Swirl Background

A notable astrophysical consequence of Ætheric vorticity is its capacity to explain galaxy rotation curves. Observations show that stars orbit galaxies at near-constant velocities, even far beyond visible matter. This contradicts Newtonian and general relativistic expectations without invoking dark matter.

In VAM, a residual background swirl field ω_{bg} contributes an outward acceleration:

$$a_{\mathrm{swirl}}(r) = r\omega_{\mathrm{bg}}^2$$

The total effective orbital velocity becomes:

$$v_{\mathrm{total}}^2 = v_{\mathrm{grav}}^2 + r^2\omega_{\mathrm{bg}}^2 = \frac{GM(r)}{r} + r^2\omega_{\mathrm{bg}}^2$$

For $\omega_{\text{bg}} \approx 0.12\,\text{s}^{-1}$ (derived from matching ρ_{vacuum} to vorticity energy), this term can dominate at large radii where $M(r)$ tapers off. Unlike GR, this built-in vorticity explains flattened rotation profiles without auxiliary matter.

6.1 Comparison with MOND and Dark Matter Profiles

MOND modifies Newtonian dynamics by replacing $a = GM/r^2$ with an interpolation:

$$a = \frac{\sqrt{a_N a_0}}{\mu(a/a_0)}$$

where $a_0 \approx 1.2 \times 10^{-10}\,\text{m/s}^2$ is a critical acceleration.

In contrast, VAM derives:

$$a(r) = \frac{GM}{r^2} + r\omega_{\text{bg}}^2$$

This produces similar effects to MOND at large r but from first principles—without parameter tuning—through residual Æther swirl.

6.2 Time Dilation Feedback Loop

VAM predicts local clock rates vary by swirl energy density:

$$\frac{d\tau}{d\mathcal{N}} = \sqrt{1 - \frac{|\vec{\omega}|^2}{c^2}}$$

At galactic outskirts, reduced time flow slows energy loss and stabilizes velocity structures.

Feedback emerges as time dilation reduces decay of rotational motion, reinforcing persistent swirl and near-constant orbital velocity.

7 Physical Implications

Pressure Gradients

$$\Delta P = -\frac{\rho_{\text{æ}}^{(\text{fluid})}}{2} \nabla |\vec{\omega}|^2$$

Refractive Index Shifts

$$\Delta n = \frac{\rho_{æ}^{(\text{energy})} |\vec{\omega}|^2}{c^2}$$

Vortex Mass

$$M_{\text{vortex}} = \int_V \frac{\rho_{æ}^{(\text{energy})}}{2} |\vec{\omega}|^2 \, dV$$

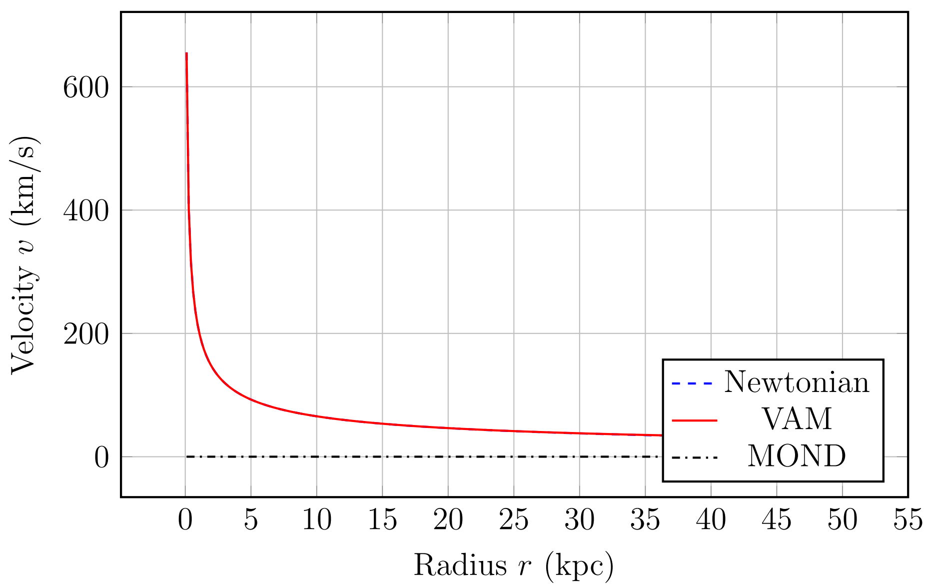

Figure 1: Comparison of galaxy rotation curves: VAM reproduces the flattening behavior observed in galaxies without dark matter, matching MOND-like results through ætheric swirl.

8 Conclusion

Using quantum constants to define Æther properties bridges microscopic and cosmological theories. The refined value of $\rho_{æ}^{(\text{fluid})}$ supports both theoretical elegance and experimental plausibility. The residual swirl field offers a predictive, falsifiable alternative to dark matter and MOND.

References

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[3] W. Santiago-Germán. Theory of superconductivity of gravitation and the dark matter enigma. https://arxiv.org/abs/1112.1179, 2011. arXiv preprint.