Unified Time Dilation Formula in the Vortex Æther Model

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Abstract

We present a unified time dilation formula derived from the Vortex Æther Model (VAM), a fluid-dynamic reformulation of gravitation and mass-energy interactions. Unlike General Relativity, where mass and curvature govern clock rates, VAM attributes gravitational phenomena to quantized vorticity, æther circulation, and swirl-induced pressure gradients. The proposed equation replaces the Schwarzschild and Kerr metric terms with vortex core tangential velocities, swirl angular frequencies, and an effective mass derived from exponentially decaying æther density. A hybridization mechanism smoothly interpolates between vortex-scale gravity and classical Newtonian coupling at macroscopic distances. The final expression captures six physical effects within one coherent framework: (1) vortex-induced mass generation via circulation and helicity, (2) bubble-like volume expansion due to internal irrotational flow, (3) acceleration of this flow under compression, (4) thermal-like energy response from swirl speedup, (5) relativistic time dilation from æther puncture during motion, and (6) swirl-based core-local time. The result is a mathematically robust, numerically testable model that unifies quantum vortex dynamics with gravitational time effects and remains non-singular across all radial domains.

1 Unified Time Dilation Formula in the Vortex Æther Model

Introduction

In General Relativity (GR), time dilation is sourced by mass and rotation via the Schwarzschild and Kerr metrics, respectively. The Vortex æther Model (VAM) replaces these with swirl-induced vorticity, æther density gradients, and circulation fields. We derive and present a unified time dilation expression that incorporates:

- Vortex-induced mass formation,
- Frame-dragging via swirl angular velocity,
- Bubble swelling dynamics mimicking thermodynamic gas laws,
- Exponential decay of æther vorticity with distance,
- Hybridization to classical GR at large r.

1.1 Final VAM Time Dilation Equation

The unified time dilation equation in VAM becomes:

$$\boxed{t_{\text{adjusted}} = \Delta t \cdot \sqrt{1 - \frac{2G_{\text{hybrid}}(r)M_{\text{hybrid}}(r)}{rc^2} - \frac{C_e^2}{c^2}e^{-r/r_c} - \frac{C_e^2}{r_c^2 c^2}e^{-r/r_c}}} \tag{1}$$

1.2 Explanation of Terms

1. The first term $\frac{2G_{\text{hybrid}}M_{\text{hybrid}}}{rc^2}$ generalizes Newtonian gravity using hybrid interpolation.
2. The second term $\frac{C_e^2}{c^2}e^{-r/r_c}$ accounts for tangential swirl effects.
3. The third term $\frac{C_e^2}{r_c^2 c^2}e^{-r/r_c}$ models rotational energy frame-dragging.

1.3 Hybridization of Gravitational Coupling

To reconcile predictions for macroscopic systems, we define:

$$\mu(r) = \exp\left(-\frac{r^2}{R_0^2}\right), \quad R_0 \sim 10^{-12}\,\text{m}$$

$$G_{\text{hybrid}}(r) = \mu(r)\, G_{\text{swirl}} + (1 - \mu(r))\, G$$
$$M_{\text{hybrid}}(r) = \mu(r)\, M_{\text{eff}}^{\text{VAM}}(r) + (1 - \mu(r))\, M$$

1.4 Effective VAM Mass

Assuming an exponentially decaying æther density:

$$\rho_{æ}(r) = \rho_0 e^{-r/r_c}$$

The effective mass becomes:

$$M_{\text{eff}}^{\text{VAM}}(r) = 4\pi\rho_0 r_c^3 \left(2 - \left(2 + \frac{r}{r_c}\right)e^{-r/r_c}\right)$$

Symbol	Meaning	Value / Expression	Units
$G_{\text{hybrid}}(r)$	Hybrid gravitational constant (VAM/GR)	$\mu(r)G_{\text{swirl}} + (1-\mu(r))G$	$\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$
$\mu(r)$	Vortex-to-classical transition function	e^{-r^2/R_0^2}, $R_0 = 1.0\times10^{-12}\,\text{m}$	unitless
G	Newtonian gravitational constant	6.67430×10^{-11}	$\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$
G_{swirl}	Swirl-induced gravitational constant	$\dfrac{C_e c^5 t_p^2}{2F_{\max} r_c^2}$	$\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$
$M_{\text{hybrid}}(r)$	Hybrid effective mass	$\mu(r)M_{\text{eff}}^{\text{VAM}}(r) + (1-\mu(r))M$	kg
$M_{\text{eff}}^{\text{VAM}}(r)$	Vortex effective mass	$4\pi\rho_{æ} r_c^3\left[2-(2+\frac{r}{r_c})e^{-r/r_c}\right]$	kg
$\rho_{æ}$	Æther density	3.89343583×10^{18}	$\text{kg}\cdot\text{m}^{-3}$
r_c	Core radius (Coulomb scale)	1.40897017×10^{-15}	m
C_e	Core tangential velocity	1.09384563×10^{6}	$\text{m}\cdot\text{s}^{-1}$
t_p	Planck time	5.391247×10^{-44}	s
$F_{\max}$	Maximum force	29.053507	N
$\left(\frac{C_e}{r_c}\right)^2$	Squared swirl angular frequency (Ω^2)	6.02367430×10^{42}	s^{-2}
c	Speed of light	2.99792458×10^{8}	$\text{m}\cdot\text{s}^{-1}$

Table 1: Key symbols and constants in the VAM time dilation equation.

1.5 Constants and Variables

Conclusion

This equation synthesizes all prior VAM elements: vortex helicity, bubble boundaries, circulation-induced gravity, and exponential suppression of short-range fields. It remains finite, matches classical predictions at macroscopic scales, and enables numerical probing at quantum scales.

References

Symbol	Meaning	Description	Value (if constant)
Δt	Reference time	Clock far from gravitating body	–
t_{adjusted}	Local time	Time experienced near the vortex structure	–
r	Radial coordinate	Distance from the vortex core	m
r_c	Vortex core radius	Characteristic decay scale	$1.40897017 \times 10^{-15}$ m
C_e	Vortex tangential velocity	Maximal edge swirl velocity	1.09384563×10^{6} m/s
$\rho_{\text{æ}}$	Æther density	Fluid density of the æther	$\sim 3.89 \times 10^{18}$ kg/m^3
c	Speed of light	Vacuum light speed	2.99792458×10^{8} m/s
G	Newton's constant	Classical gravity	6.67430×10^{-11} m^3/kg/s^2
$F_{\max}$	Max force	From Planck-scale dynamics	29.053507 N
t_p	Planck time	Quantum gravity scale	5.391247×10^{-44} s
G_{swirl}	Vortex gravity coupling	$C_e c^5 t_p^2/(2F_{\max} r_c^2)$	–
M	Macroscopic mass	Classical object mass (e.g., proton mass)	$1.67262192 \times 10^{-27}$ kg
$M_{\text{eff}}^{\text{VAM}}(r)$	VAM mass	Mass from vorticity energy	derived
$M_{\text{hybrid}}(r)$	Hybrid mass	Smooth transition between VAM and GR	–
$G_{\text{hybrid}}(r)$	Hybrid gravity constant	Smooth transition between G and G_{swirl}	–
$\mu(r)$	Hybrid blending function	$\mu(r) = \exp\left(-\frac{r^2}{R_0^2}\right),\ R_0 \sim 10^{-12}$ m	dimensionless
e^{-r/r_c}	Vorticity decay	Exponential suppression term	–

Table 2: Explanation of variables in Equation 1.