The Vortex Æther Model: Time Dilation from Vortex Dynamics

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I. TIME DILATION IN THE ÆTHER-VORTEX MODEL

We consider an inviscid, irrotational superfluid æther with stable topological vortex knots. The Æther experiences absolute time t_{abs}, but local clocks experience slowed rates due to pressure gradients and knot energetics. The Vortex Æther Model posits that the rate at which time flows in the local frame (near the knot) depends on the internal angular frequency Ω_k. In this section, we derive time dilation analogues inspired by the predictions of general relativity (GR), based solely on pressure and vorticity gradients in the fluid.

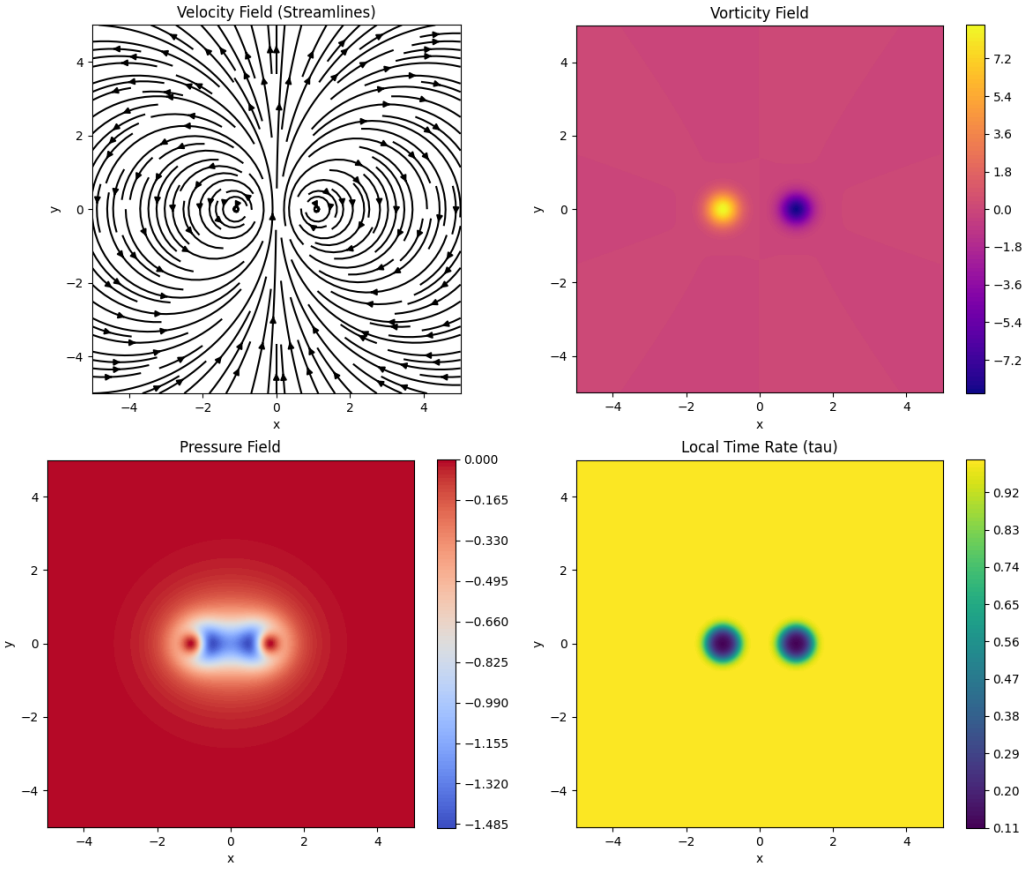

FIG. 1: Velocity streamlines, vorticity, pressure, and local time rate τ for a simulated vortex pair. The pressure minimum and time slow-down clearly align with the regions of high vorticity. This directly illustrates the æther model's central claim: time dilation follows from vortex energetics and pressure depletion.

A. Bernoulli-Based Local Time Modulation

In high-vorticity regions, Bernoulli's principle implies a drop in pressure near vortex cores:

$$\frac{1}{2}\rho_{æ}v^2 + p = p_0 \Rightarrow p = p_0 - \frac{1}{2}\rho_{æ}v^2 \tag{1}$$

Assuming that the local physical clock rate is proportional to pressure:

$$\frac{t_{\text{local}}}{t_0} = \left(1 - \frac{\rho_{æ}v^2}{2p_0}\right)^{-1} \tag{2}$$

For circular vortex flow where $v = \Omega r$:

$$\frac{t_{\text{local}}}{t_0} \approx 1 + \frac{\rho_{æ}\Omega^2 r^2}{2p_0} \tag{3}$$

This reduces time rate locally with higher knot rotation, modeling time modulation without relativity, where $\rho_{æ}/p_0 \sim 1/c^2$.

B. Heuristic Time Modulation by Knot Rotation

Let Ω_k be the average angular velocity of a vortex knot:

$$\frac{t_{\text{local}}}{t_{\text{abs}}} = \left(1 + \alpha\Omega_k^2\right)^{-1} \tag{4}$$

For small Ω_k:

$$\frac{t_{\text{local}}}{t_{\text{abs}}} \approx 1 - \alpha\Omega_k^2 + \mathcal{O}(\Omega_k^4) \tag{5}$$

This matches special relativistic time dilation:

$$\frac{t_{\text{moving}}}{t_{\text{rest}}} \approx 1 - \frac{v^2}{2c^2} \tag{6}$$

This heuristic expression generalizes the local effect of rotational energy into a topological time-modulation law, consistent with the Bernoulli-derived expansion in the low-vorticity limit.

C. Vorticity-Induced Gravitational Time Dilation

In the æther-vortex framework, gravity emerges from pressure gradients induced by localized vorticity. Let $\Phi(\vec{r})$ be a scalar potential analogous to the Newtonian gravitational potential:

$$\Phi(\vec{r}) = \gamma \int \frac{|\vec{\omega}(\vec{r}')|^2}{|\vec{r} - \vec{r}'|}\, d^3r' \tag{7}$$

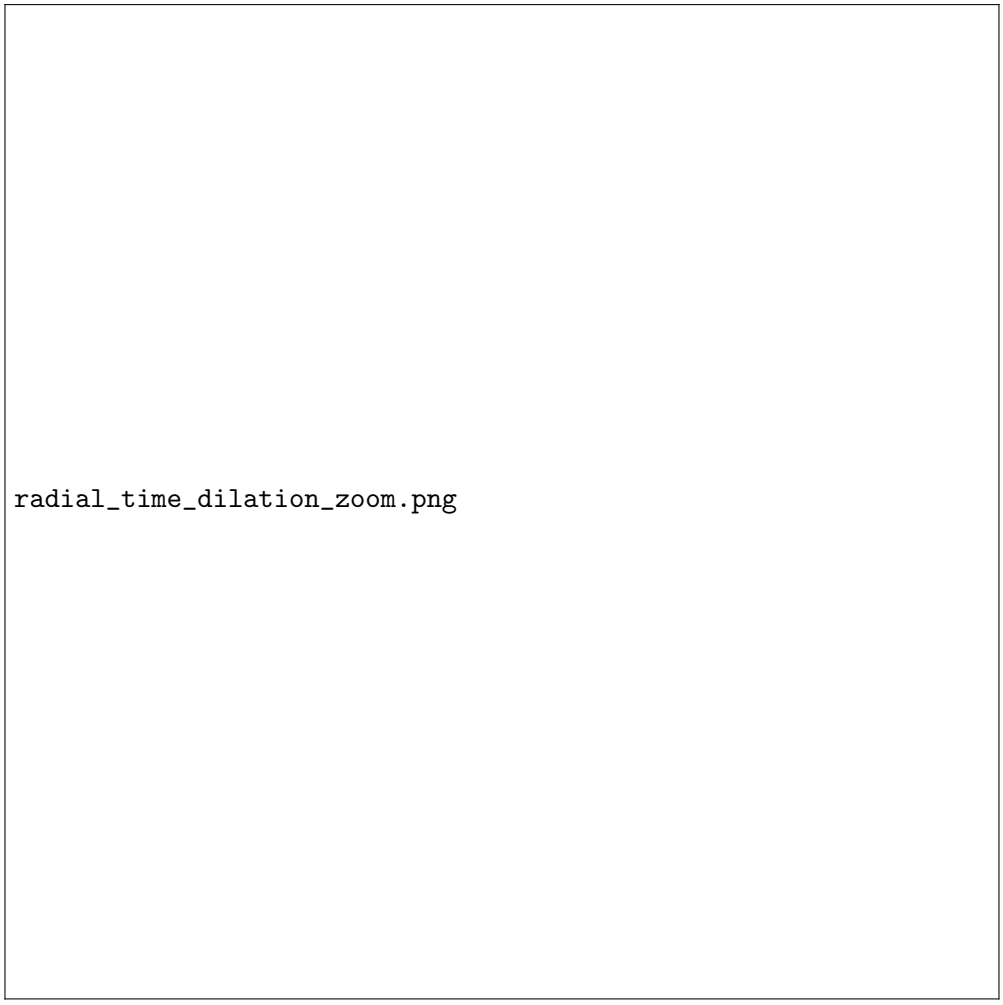

FIG. 2: Radial profile of normalized local time $t_{\text{local}}/t_{\text{abs}}$ as a function of distance r from the vortex core, assuming $\Omega_k \propto 1/r^2$. Time slows significantly near the vortex center and recovers to background values with distance.

Time dilation follows:

$$\frac{t_{\text{local}}}{t_\infty} = \sqrt{1 - \frac{2\Phi(\vec{r})}{c^2}} \tag{8}$$

If the vorticity field is concentrated at a point-like knot:

$$\frac{t_{\text{local}}}{t_\infty} = \sqrt{1 - \frac{2\gamma\omega_0^2}{rc^2}} \tag{9}$$

D. Kerr-Like Time Adjustment

From GR:

$$t_{\text{adjusted}} = \Delta t \cdot \sqrt{1 - \frac{2GM}{rc^2} - \frac{J^2}{r^3c^2}} \tag{10}$$

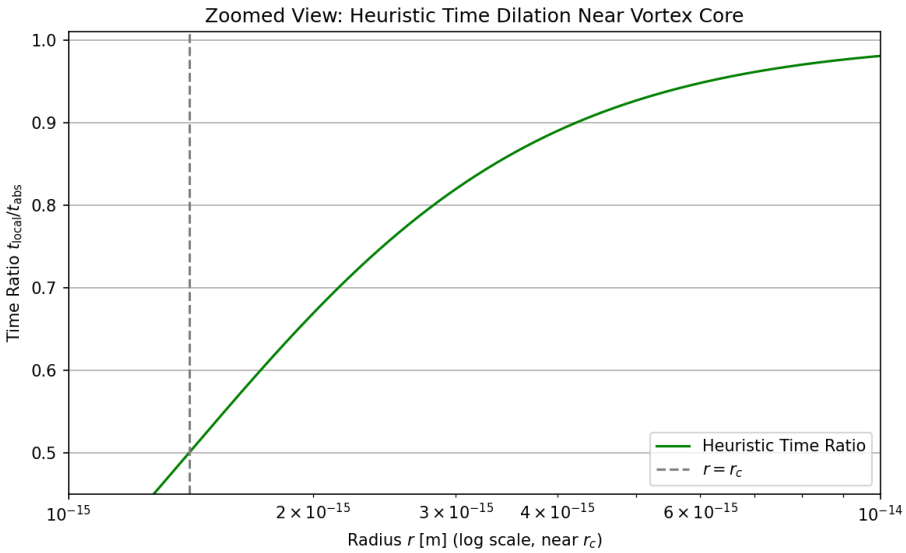

FIG. 3: Zoomed plot of heuristic time dilation near the vortex core. The curve shows time slowing from 1 to 0.5 across $r \sim r_c$, revealing that significant modulation occurs only at or near the core.

In Æther terms:

$$\boxed{t_{\text{adjusted}} = \Delta t \cdot \sqrt{1 - \frac{\gamma \langle \omega^2 \rangle}{rc^2} - \frac{\kappa^2}{r^3 c^2}}} \tag{11}$$

This reproduces gravitational and frame-dragging effects via vorticity and circulation.

II. CONCLUSION AND EXPERIMENTAL OUTLOOK

The Vortex Æther Model replaces spacetime curvature with conserved vorticity in a 3D fluid. Time dilation arises from localized pressure depletion and kinetic energy storage within vortex knots, offering a classical, topological reinterpretation of relativistic effects. Future work includes simulations of vortex clocks and tests using BECs, helium II, or electrohydrodynamic lifters.

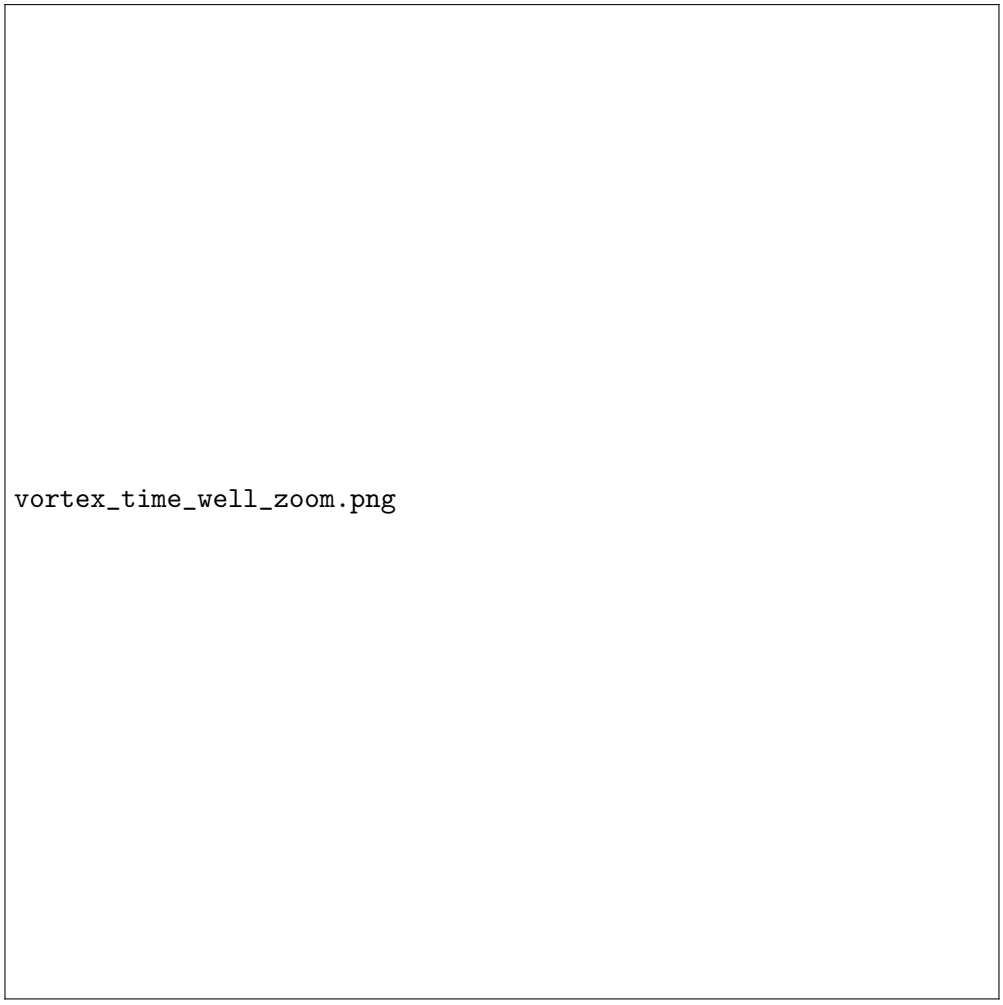

FIG. 4: Schematic of a vortex-induced time well in the æther. Local time $t_{\text{local}}/t_{\text{abs}}$ is shown as a color gradient in 2D space. The central vortex region exhibits the most time slowing due to high Ω_k, forming a well-like structure.