An Intrinsic Geometric Origin for the Michelson-Morley Null Result

A New Model Where Phase Evolves Internally, Independent of External Motion

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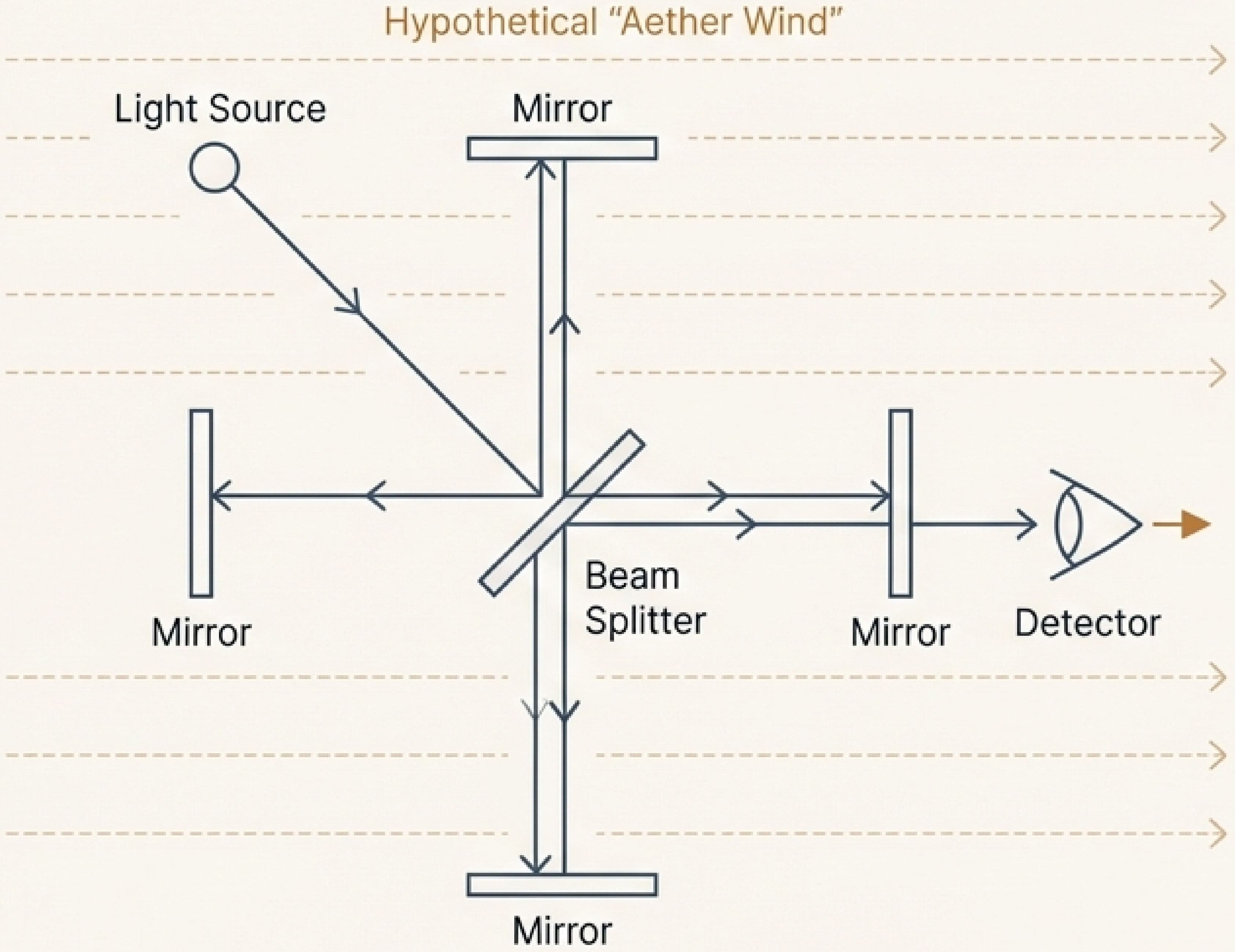
In 1887, an Experiment Was Designed to Detect Earth's Motion Through a Postulated "Aether"

The Michelson-Morley experiment used an interferometer to measure the speed of light in different directions. The prevailing "aether wind" theory predicted that light traveling with the wind would have a different speed than light traveling against it, causing a measurable shift in the interference fringe pattern when the apparatus was rotated.



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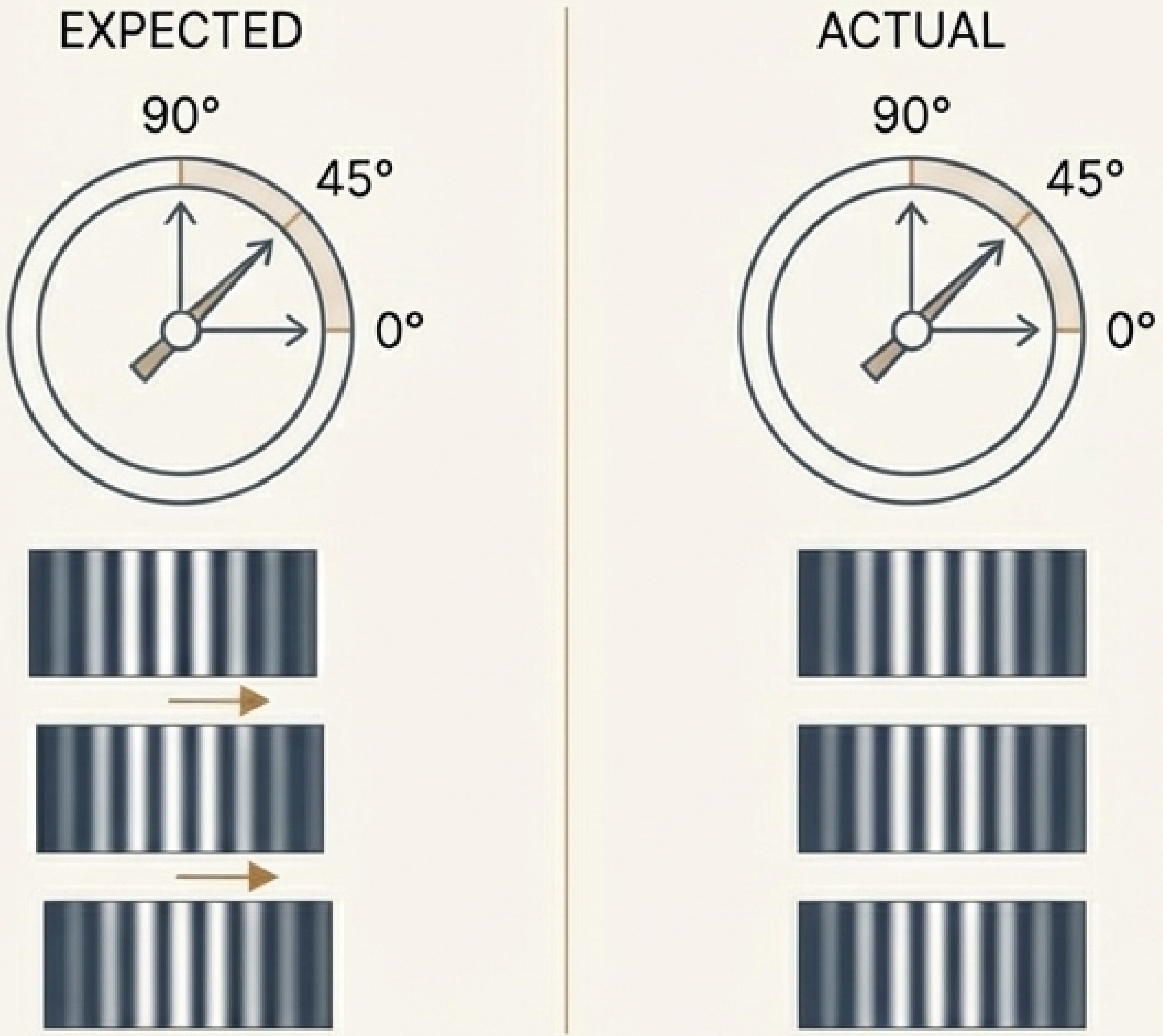
The Experiment Famously Produced a “Null Result,” Challenging the Foundations of Classical Physics

No matter the orientation of the apparatus or the time of day, the expected fringe shift was never observed remained stubbornly static. This profound discrepancy between theory and observation meant that the concept of a stationary aether was incorrect, demanding a new understanding of how light, space, and motion are related.



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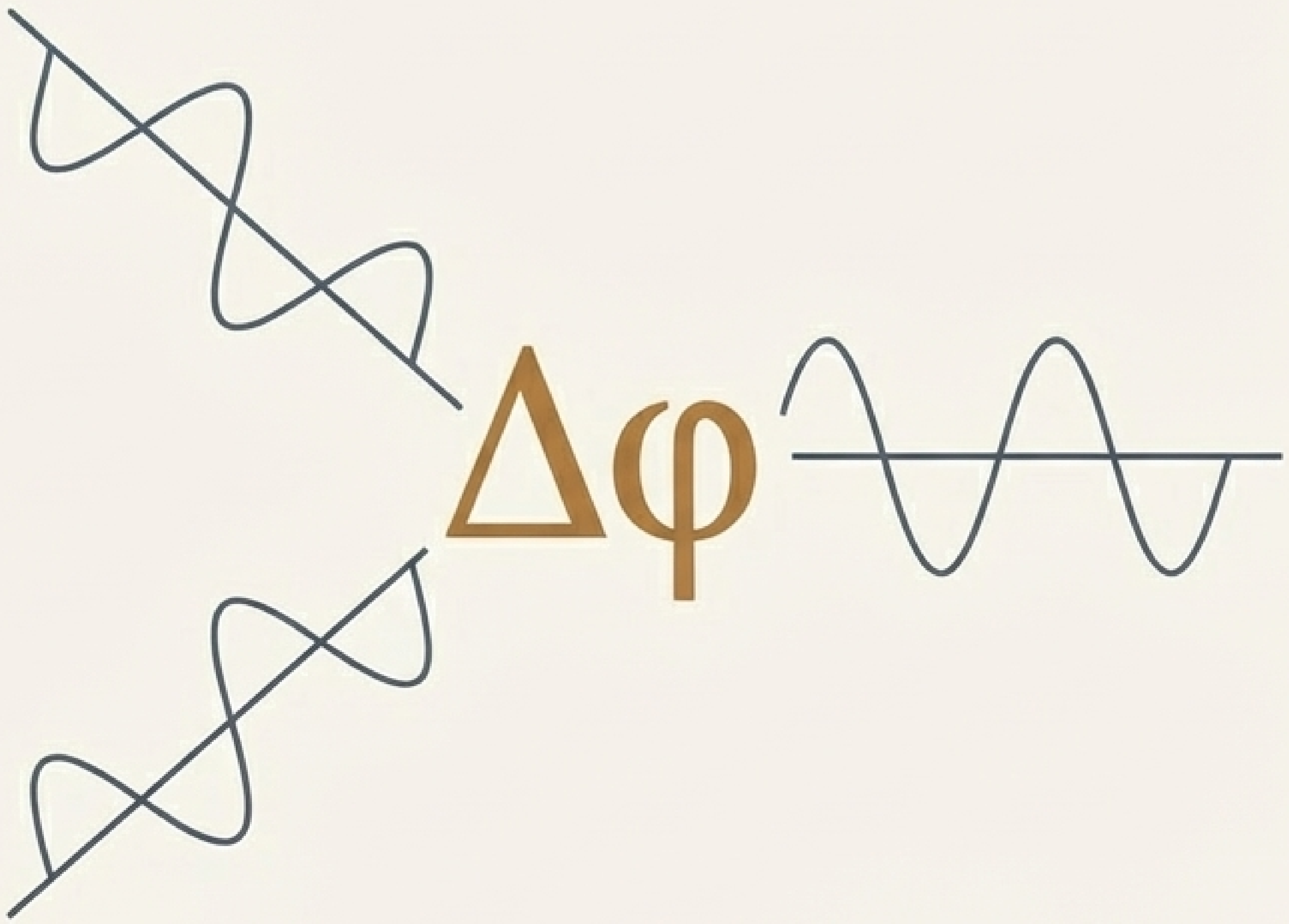
This Poses a Central Question: Why is the Phase Difference Between the Two Arms Constant?

The null result implies that the phase difference ($\Delta\varphi$) between the two light paths is invariant under the rotation of the system. Classical models, reliant on external path differences affected by an aether wind, could not account for this. An explanation must come from the intrinsic properties of the system itself.



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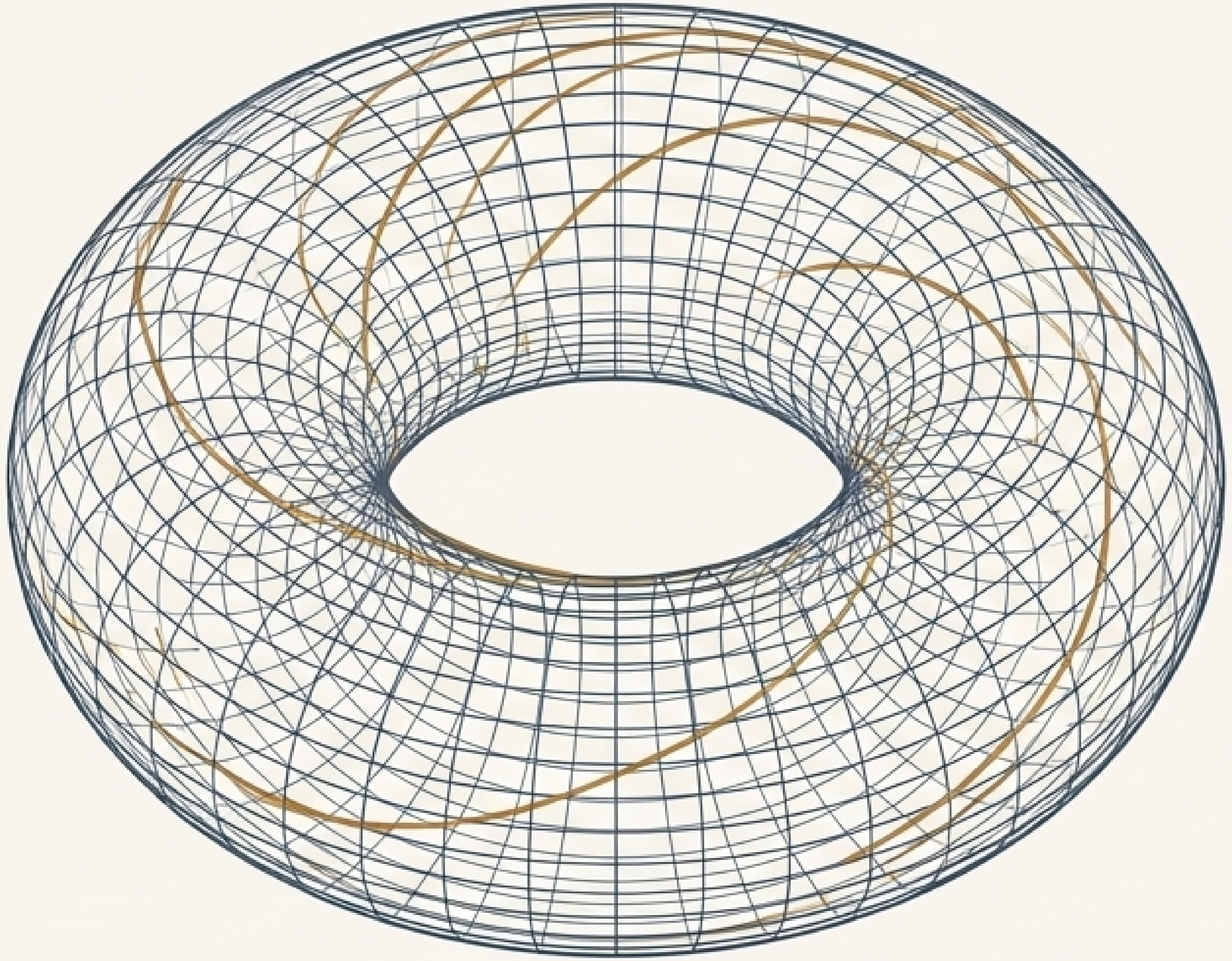
We Propose a New Framework: An Internal Geometric Flow Governs the System's Dynamics



Instead of relying on external factors like an "aether wind," this model posits that the observed behavior is a consequence of an intrinsic geometric process.

The system's state evolves according to a "rotate-lift-damp" operator, which describes the flow internally without reference to an external medium.

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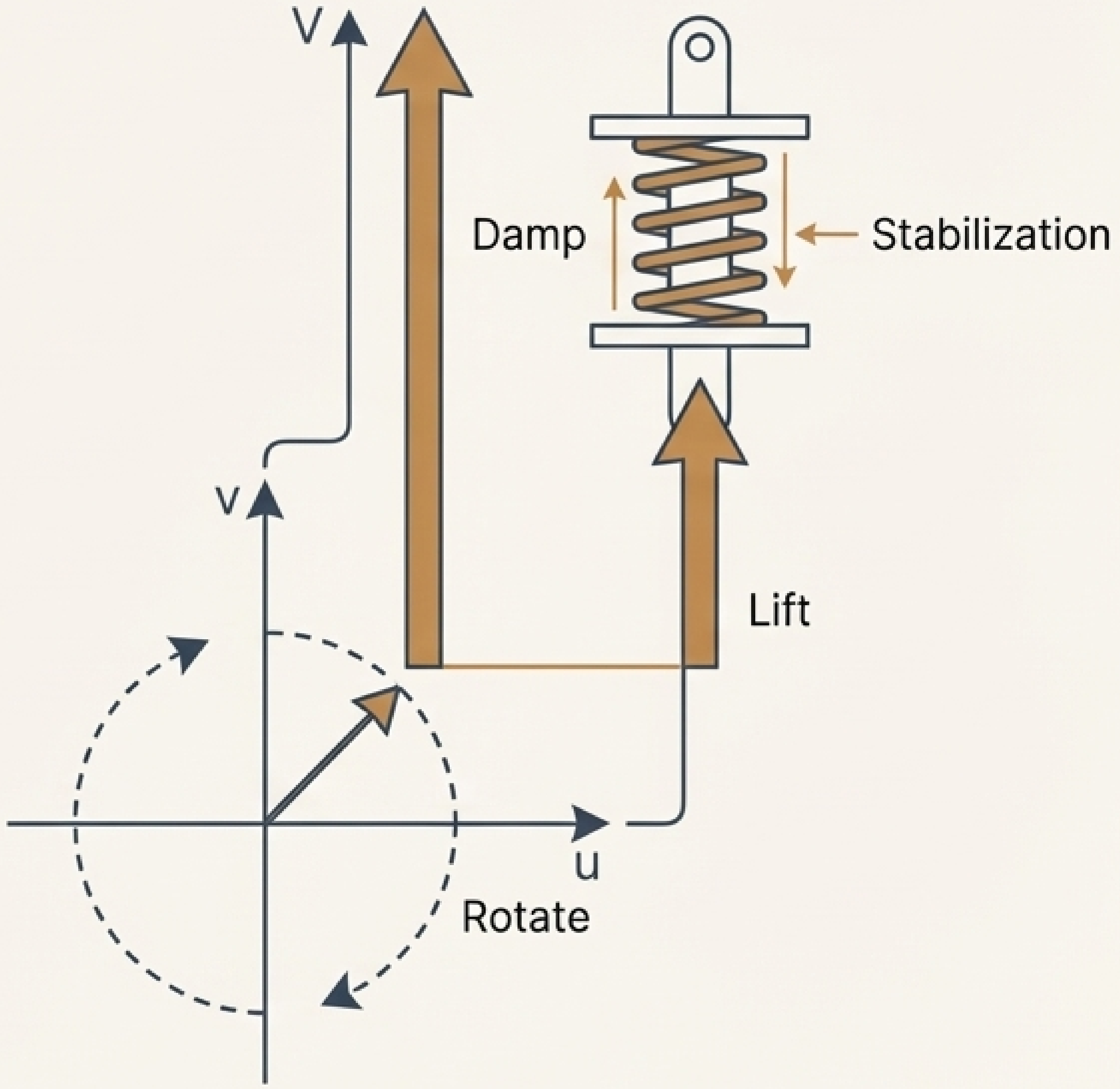
The System's Dynamics are Defined by Three Fundamental Actions

The evolution of the system's state can be understood through three distinct but coupled operations:

1. **Rotation**: A vector in the (u,v) plane rotates at a constant frequency. This preserves its radius.
2. **Lift**: This rotation drives a 'lift' along a third axis (V), proportional to the radius.
3. **Damping**: The lift is stabilized by a damping force, ensuring the system reaches a steady state.



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These Three Actions are Encoded in a Minimal Local System of Equations

This minimal, pointwise version of the flow describes the complete dynamics. Each term corresponds directly to one of the geometric actions.

$$\begin{cases} \dot{u} = -\omega v \\ \dot{v} = \omega u \\ \dot{V} = \alpha r - kV \end{cases}$$

Rotation (Preserves radius r) — $\dot{u} = -\omega v$, $\dot{v} = \omega u$

Lift (Additive, driven by radius) — αr

Damping (Stabilizes V) — $-kV$

$$r(t) = \sqrt{u(t)^2 + v(t)^2}$$

The radius is defined as the magnitude in the (u,v) plane.

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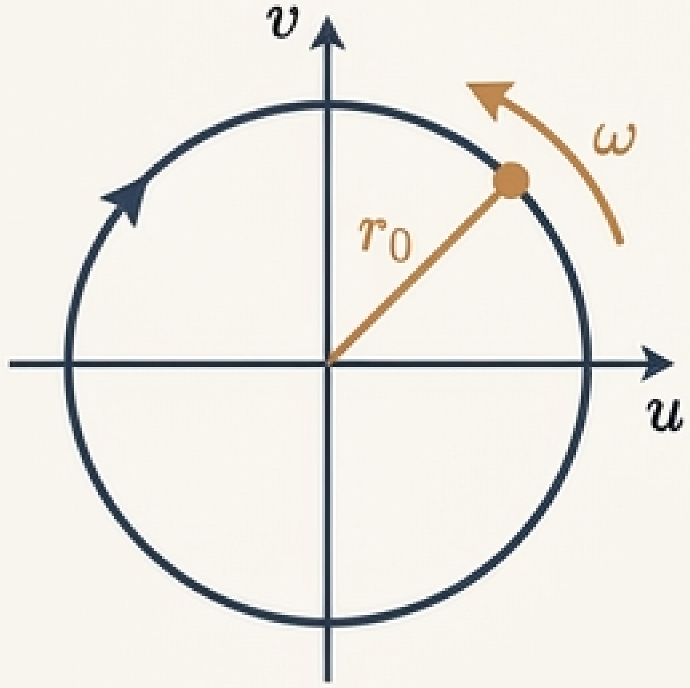
The Solution Describes a Stable System Undergoing Pure Rotation

Solving the system shows that the (u,v) components describe a pure rotation with a constant radius (r_0) and frequency (ω). Simultaneously, the V component evolves to a stable equilibrium value proportional to this radius.

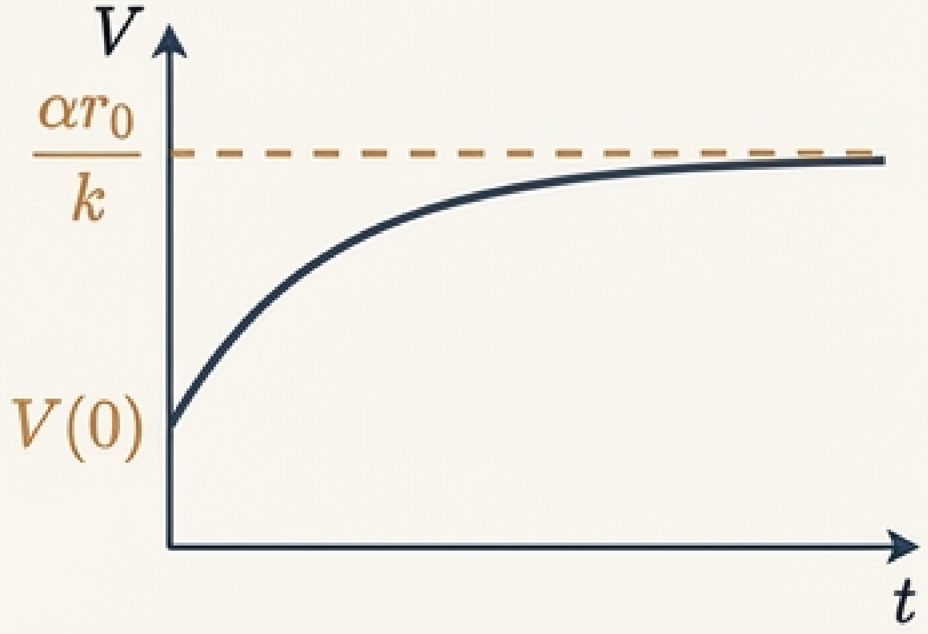
Rotational Solution

$$u(t) = r_0 \cos(\omega t + \phi_0)$$
$$v(t) = r_0 \sin(\omega t + \phi_0)$$



Lift Solution

$$\dot{V} = \alpha r_0 - kV \Rightarrow V(t) = \frac{\alpha r_0}{k} + \left(V(0) - \frac{\alpha r_0}{k}\right) e^{-kt}$$



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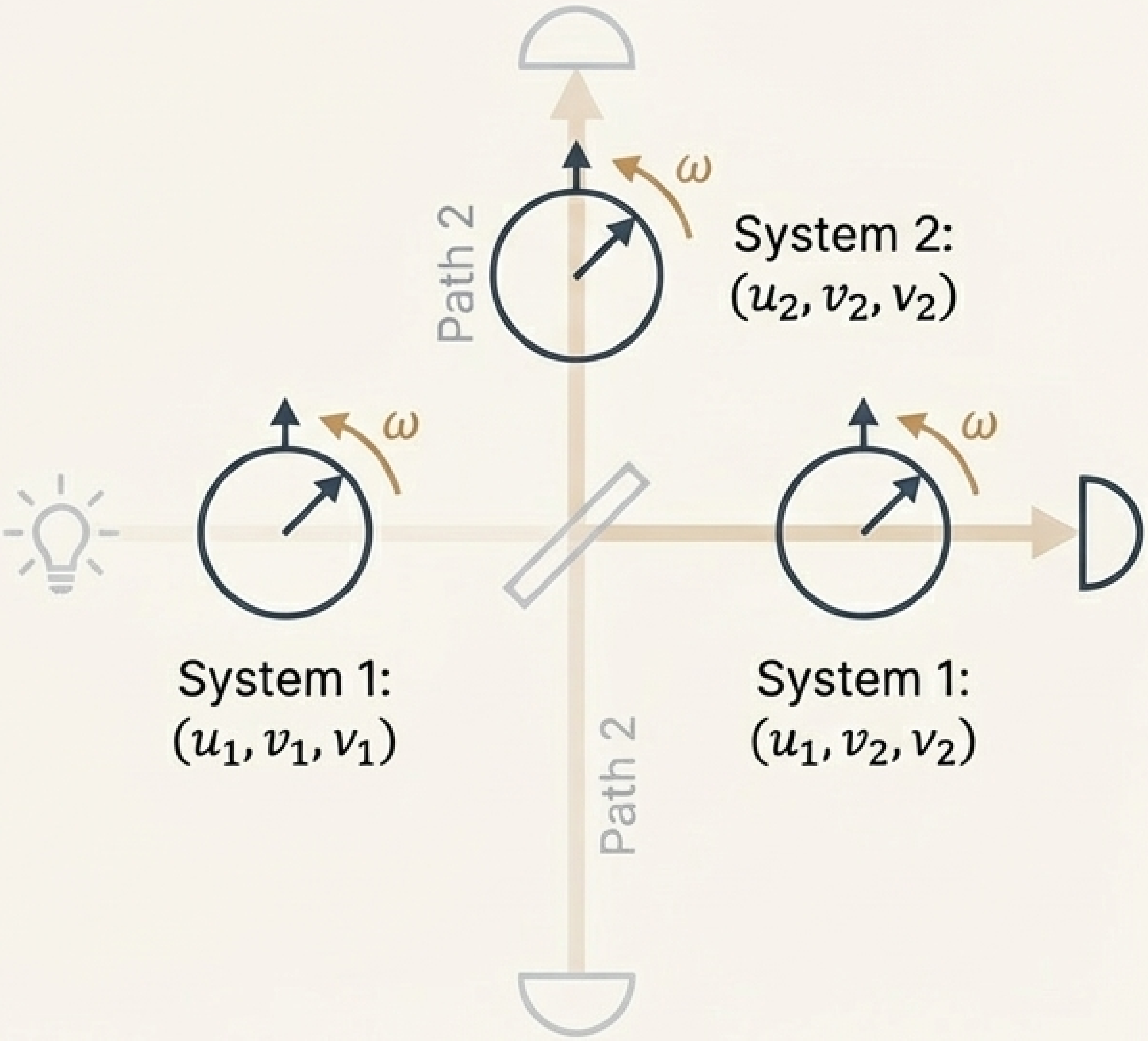
We Now Model Each Arm of the Interferometer as an Independent Internal Flow System

The core insight is to treat each light path in the interferometer not as a passive traveler through an external medium, but as an active system governed by its own instance of the internal geometric flow.

Each arm i has its own state evolving according to the model, defined by (u_i, v_i, v_i).

Crucially, both arms share the same internal rotation frequency ω.



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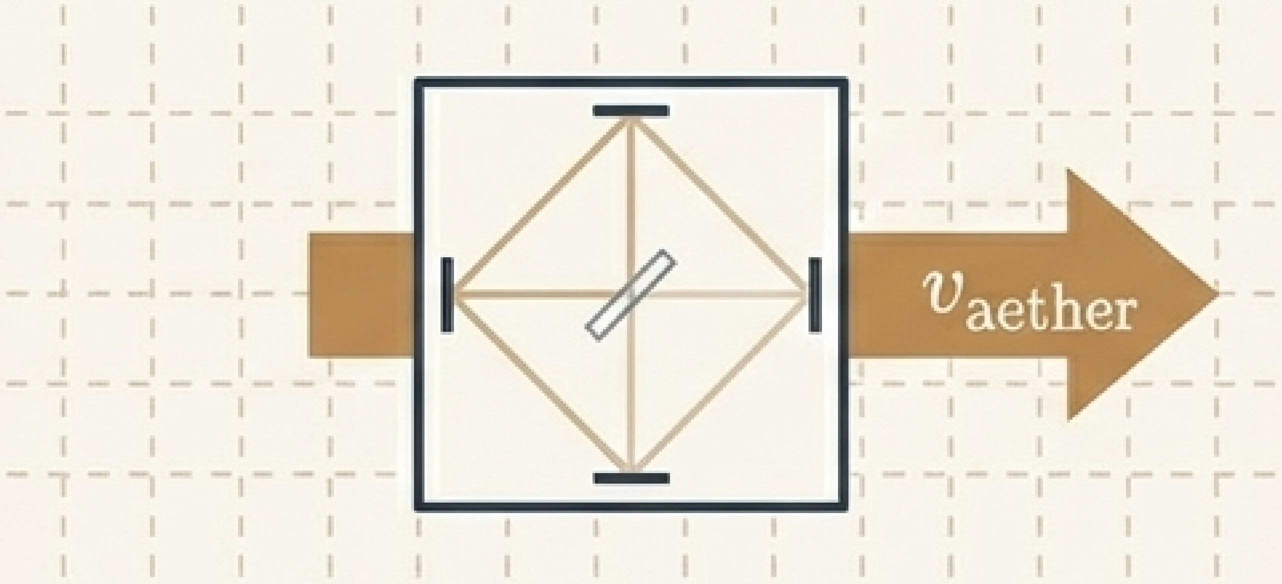
This Creates a Fundamental Distinction Between External and Internal Phase Origins

The “Aether Wind” Expectation

Phase is Relative to External Motion

The phase difference $\Delta\varphi$ is a function of the apparatus’s orientation and its velocity v relative to the aether. Rotation is expected to change the relative path lengths, causing the fringe pattern to shift.

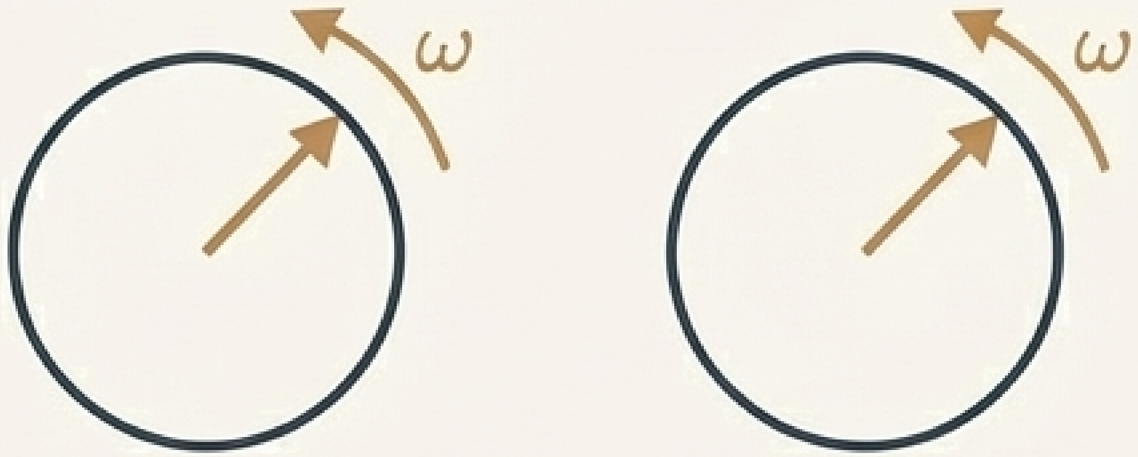


$$\Delta\phi = f(\text{orientation}, v_{\text{aether}})$$

The “Internal Flow” Model

Phase is an Intrinsic Property of the System

The phase φ_i of each arm evolves according to the same internal rotation frequency ω. It is not determined by external path differences but by the system’s own geometry.



$$\dot{\phi}_i = \omega$$

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In the Internal Flow Model, Phase in Both Arms Evolves via the Same Internal Frequency

Because both arms are governed by the same underlying geometric principle, their phases evolve identically. The rate of change of phase for arm 1 ($\dot{\phi}_1$) is simply the internal rotation frequency ω
identically. The rate of change of phase for arm 1 ($\dot{\phi}_1$) is simply the internal rotation frequency ω.
The rate of change of phase for arm 2 ($\dot{\phi}_2$) is also ω. This is the direct result of the rotation component of our governing equations.

$$\dot{\phi}_1 = \omega$$

$$\dot{\phi}_2 = \omega$$

The phase evolution is dictated by the internal geometry, not external travel time.

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The Null Result is Therefore an Inevitable Consequence of the System's Geometry

The rate of change of the phase *difference* is the difference between the individual rates of phase change. Since both are evolving at the same frequency ω, this difference is always zero. This means the phase difference $\Delta\phi$ is constant over time, regardless of the apparatus's orientation. The fringe pattern, which depends on $\Delta\phi$, must therefore be static.

$$\frac{d}{dt}(\Delta\phi) = \dot{\phi}_2 - \dot{\phi}_1 = 0$$

$$I(t) = 4r_0^2 \cos^2(\Delta\phi/2)$$

A constant phase difference ($\Delta\phi$ = constant) leads to a stable fringe pattern, perfectly matching the experimental observation.

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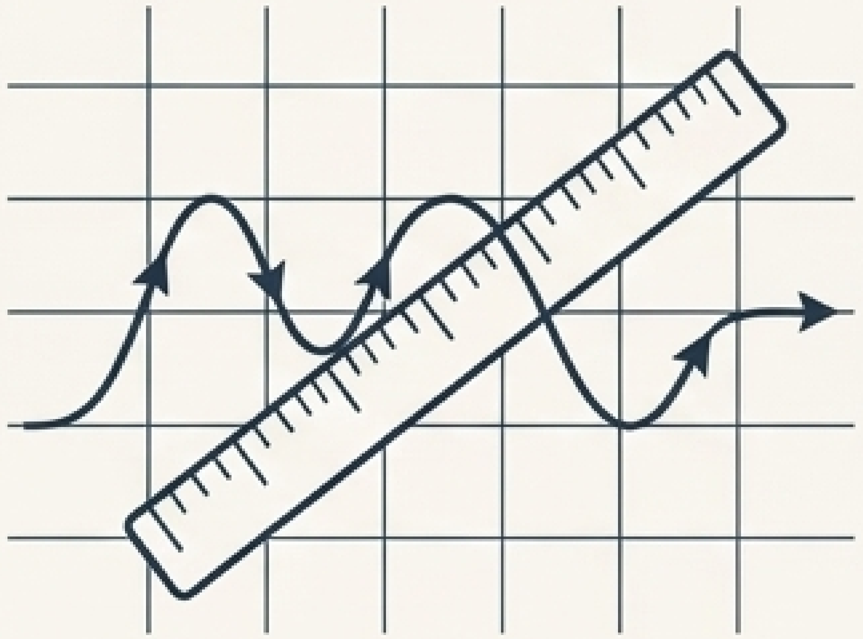
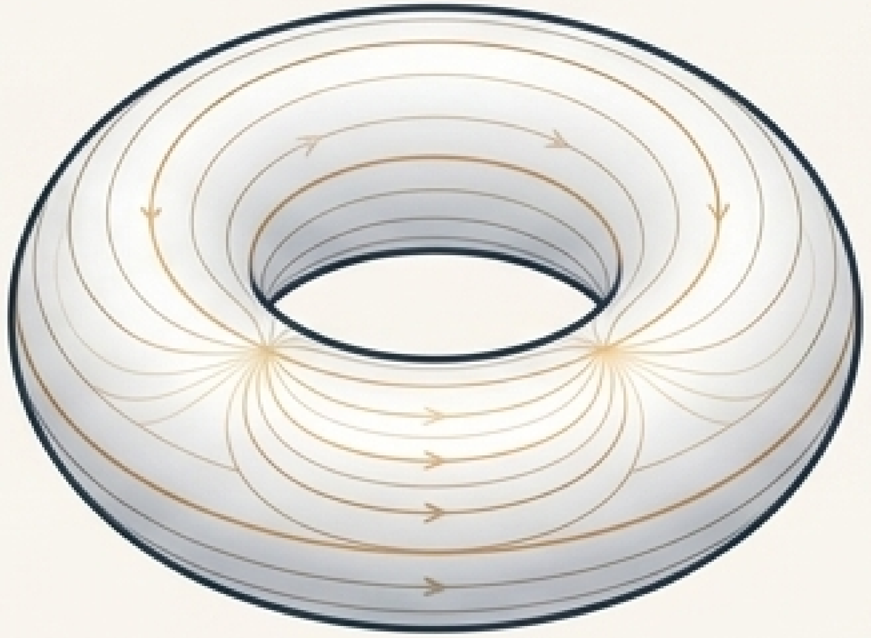
The Conclusion: Phase is an Intrinsic Property, Not a Relative Measurement

The Michelson-Morley null result is not a puzzle to be explained away by contractions of space or time. Instead, it is direct evidence of a deeper principle: the observable phase is an emergent property of a system's internal geometric flow. The fringe pattern is a direct window into this intrinsic, self-contained dynamic, making it immune to the system's motion through external space.

Phase as Extrinsic Path



Phase as Intrinsic Geometry



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This Geometric Framework Offers Avenues for Future Exploration

The pointwise model presented here successfully explains the core phenomenon. This foundational concept can be extended to more complex scenarios:

- Spatial Versions: The model can be applied to fields by using a torus geometry and the Laplace-Beltrami operator, describing how the flow operates over a surface.
- Enhanced Observables: The ‘lift’ component V can be incorporated into a 3-channel intensity signal $I(t) = (u_1 + u_2)^2 + (v_1 + v_2)^2 + (V_1 + V_2)^2$, providing a richer observable to test against more complex experimental setups.

This approach suggests a new mathematical language for describing physical systems where internal structure dictates observable phenomena.

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