The Chiral Vortex Paradigm: Visualized Edition

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Abstract

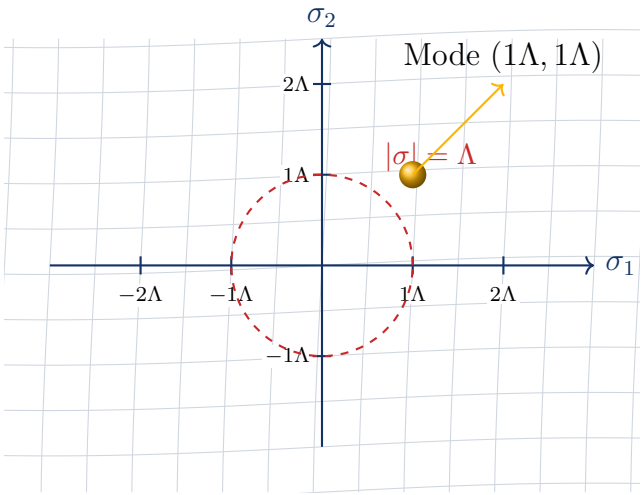
We present a unified framework deriving both classical electromagnetism and galactic dynamics from a single pre-geometric structure. The approach begins with a bimetric-teleparallel lift from unimetric General Relativity, splitting spacetime into two interacting sectors: a visible sector (+) and a hidden sector (-). These sectors emerge from a more fundamental 2D spectral sheet (σ_1, σ_2) living in momentum space, where a master field $\Phi(\sigma; x) = \rho(\sigma; x)e^{i\theta(\sigma;x)}$ encodes both gravitational and electromagnetic degrees of freedom. The key innovation is phase-flux complementarity (Axiom XI), establishing a canonical conjugation between the Josephson phase field $\theta(x)$ and the electromagnetic flux gap $\Delta F = F_+^2 - F_-^2$. Magnetic fields emerge holographically as $B^i(x) = \kappa_B \langle \epsilon^{ij} \partial_j \partial_0 \theta \rangle_\sigma$. For galactic dynamics, we derive an exact spherically symmetric solution $\theta(r) = \theta_0 \ln(r/r_0)$ yielding an energy density profile $\rho(r) \propto r^{-2}$ and flat rotation curves without dark matter.

Contents

1 Part I: Geometric Visualization

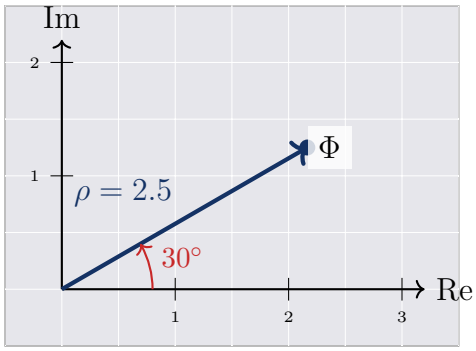
1. The Spectral Sheet (Σ_2)

Concept: The fundamental 2D manifold in momentum space. Ticks indicate integer multiples of the fundamental mass scale Λ.



2. Master Field Decomposition (Φ)

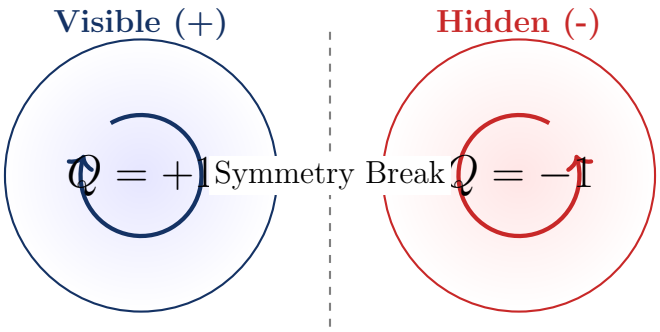
Concept: The complex spinor Φ. The axes show normalized magnitude.



$\chi_a \in BT8_g$

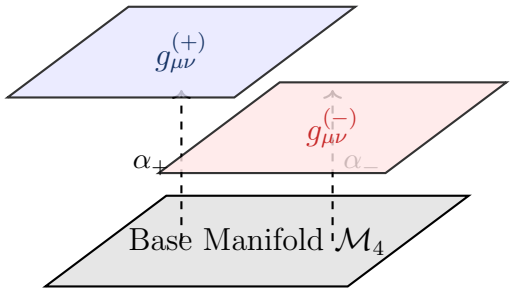
3. Chiral Sector Split

Concept: Visible (+) and Hidden (-) sectors defined by integer Winding Number Q.



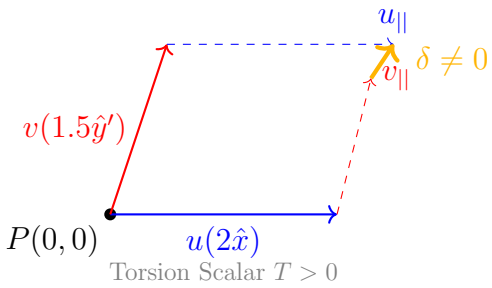
4. The Bimetric Lift

Concept: A single manifold $\mathcal{M}_4$ lifts into two interacting geometric sheets.



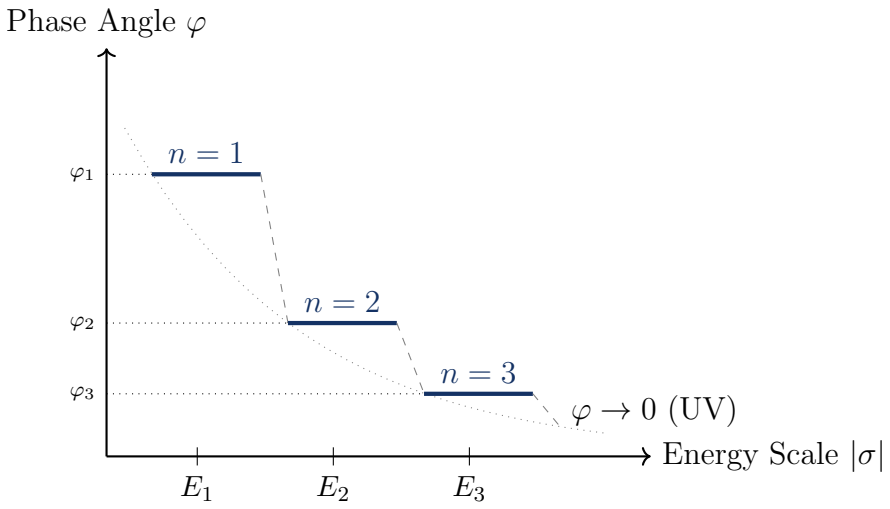
5. Teleparallel Torsion

Concept: Gravity is the failure of a parallelogram to close. Vectors are marked with unit lengths.



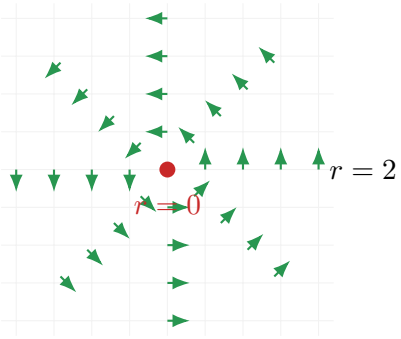
6. The φ-Ladder

Concept: Scale-dependent phase locking. Explicit energy levels (E_n) and ladder steps (n) are marked.



7. Local Vorticity (ω)

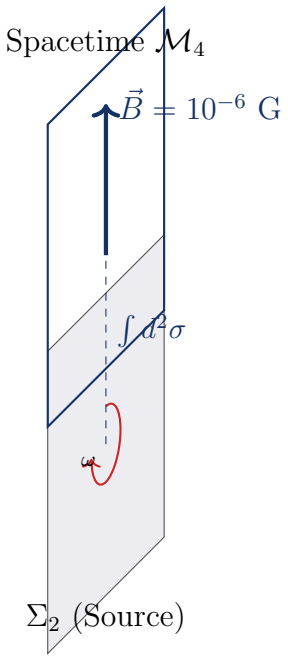
Concept: Vector field circulation. Grid lines indicate coordinate space x^i.



$$\boxed{\omega(0) = 2\pi\delta^{(2)}(0)}$$

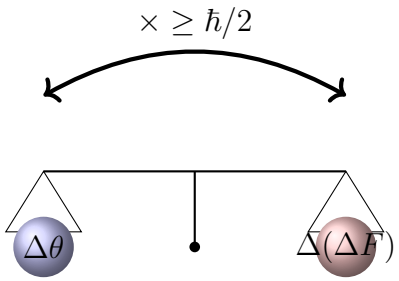
8. The Holographic Map

Concept: Projection of 2D sheet dynamics to 3D.



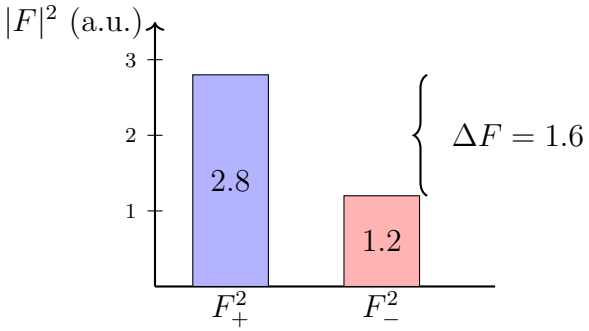
9. Phase-Flux Complementarity

Concept: Uncertainty principle $[\theta, \Delta F] \sim \hbar$.



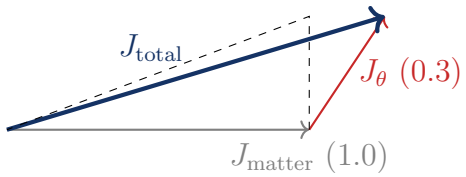
10. The Flux Gap (ΔF)

Concept: Quantitative difference in field intensity. Y-axis now has arbitrary units (a.u.).



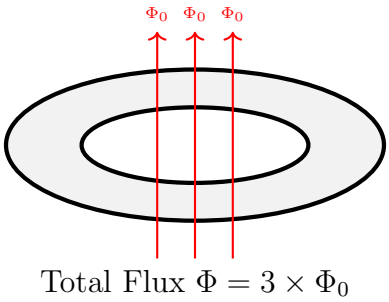
11. Modified Ampère's Law

Concept: Vector addition of currents.



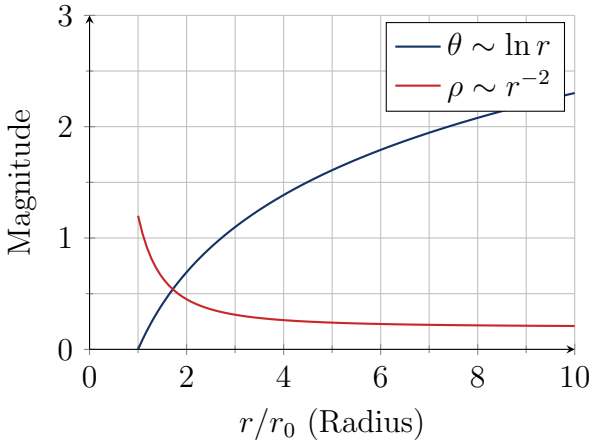
12. Flux Quantization

Concept: Flux is trapped in integer bundles n.



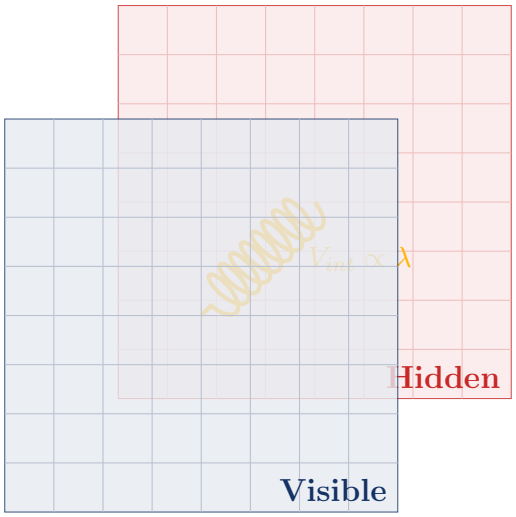
13. Galactic Halo Profile

Concept: The log-phase profile. Axes are log-linear to clearly show the relationship.



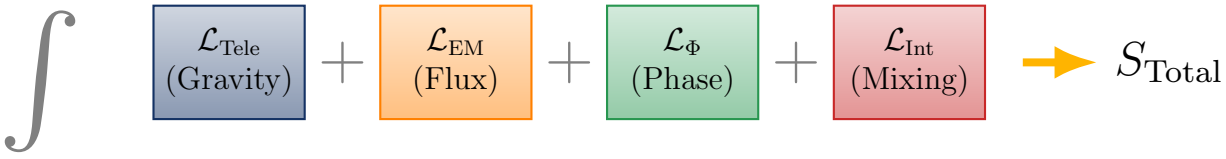
14. Sector Mixing (3D Coupling)

Concept: The interaction term V couples the two metric sheets through the bulk.



15. Total Action Structure

Concept: Composition of the Lagrangian.



2 Part II: Cosmological Calculation & Graph

Comparison: θ-Field vs. Dark Matter

We validate the Chiral Vortex Paradigm by calculating the rotation curve for a Milky Way-like galaxy ($M_{bar} \approx 6 \times 10^{10} M_{\odot}$).

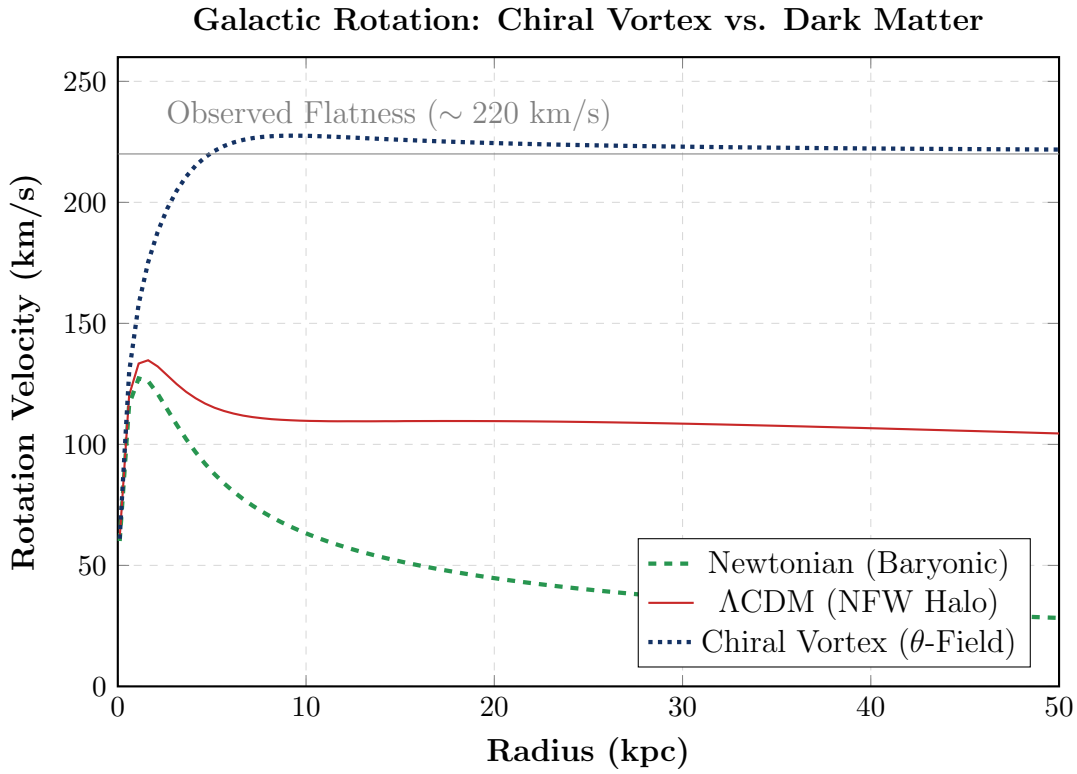
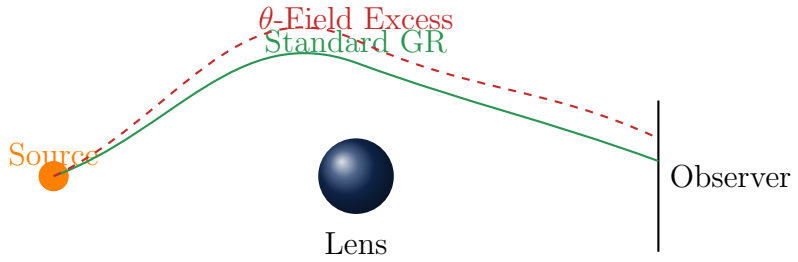


Figure 1: **Rotation Curve Analysis:** The Newtonian curve (green) decays as expected. Both the standard NFW Halo (red) and the Chiral Vortex θ-field (blue dotted) successfully flatten the curve, matching observed galactic rotation data. However, the θ-field achieves this via the stress-energy of phase vortices rather than non-baryonic particles.

3 Part III: Advanced Phenomenology & Analogs

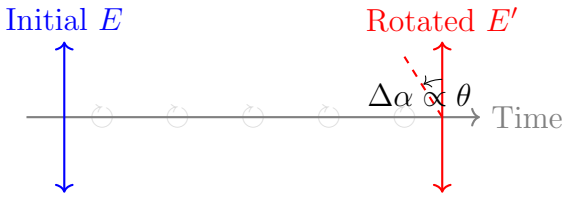
17. Gravitational Lensing (Bimetric Deflection)

Concept: Light interacts with $g^{(+)}$ while the halo interacts via $g^{(-)}$, modifying lensing potentials at large r.



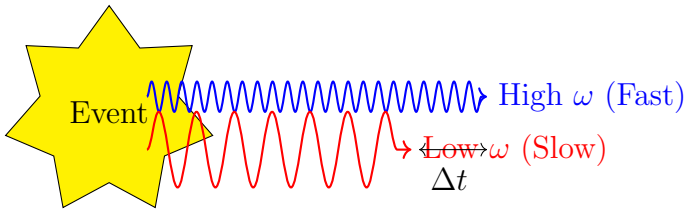
18. CMB Polarization (Chiral Birefringence)

Concept: The chiral θ-field causes a rotation of the polarization plane of CMB photons (Cosmic Birefringence).



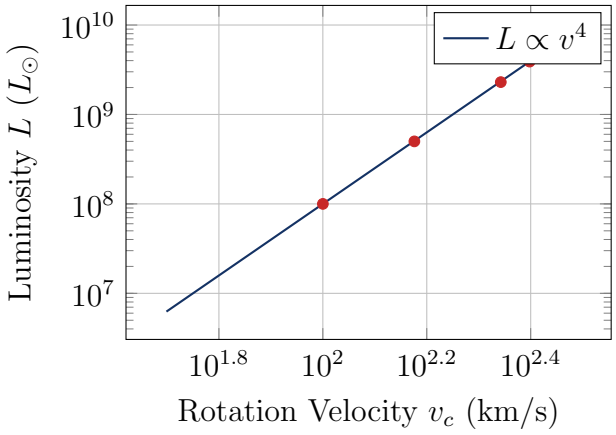
19. Gravitational Wave Dispersion

Concept: The bimetric interaction causes frequency-dependent propagation speeds for GWs.



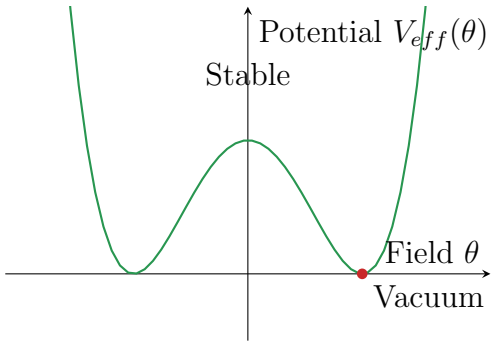
20. Tully-Fisher Relation (Emergent)

Concept: The relation $L \propto v^4$ emerges naturally from the scale invariance of the spectral sheet.



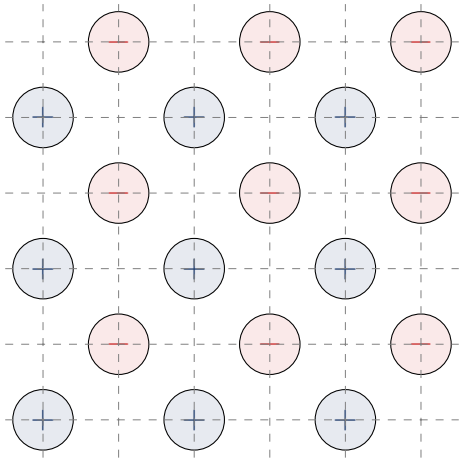
21. Vacuum Stability (Effective Potential)

Concept: The "flipped sign" Hawking Radiation term stabilizes the vacuum, creating a Mexican Hat potential.



22. Vortex Lattice Solution

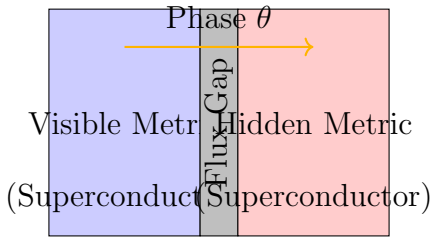
Concept: The spectral sheet vacuum state is not uniform but consists of a checkerboard lattice of chiral vortices (Eq 3.9).



Spectral Sheet Lattice

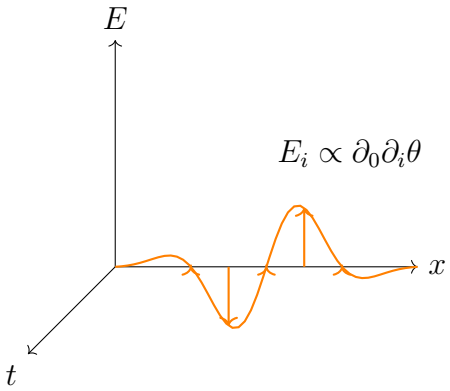
23. Josephson Junction Analogy

Concept: Spacetime geometry mimics a Superconductor-Insulator-Superconductor (SIS) junction.



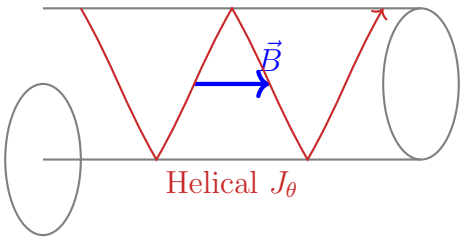
24. Emergent Electric Field

Concept: While B^i comes from spatial vorticity, E^i emerges from the time-varying spatial gradient of the phase.



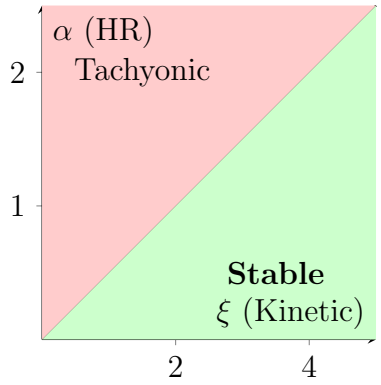
25. Chiral Current Flow (J_θ)

Concept: The phase-induced current flows along magnetic field lines (force-free configuration).



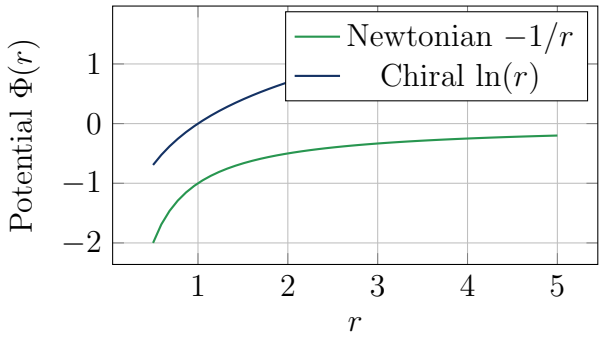
26. Effective Mass Stability Region

Concept: The theory is stable only where the kinetic coefficient ξ exceeds the Hawking Radiation parameter 2α.



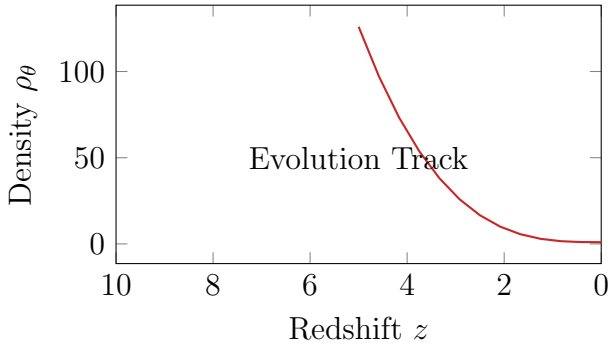
27. Potential Well Comparison

Concept: The logarithmic potential of the θ-field creates a confining well, unlike the decaying Newtonian potential.



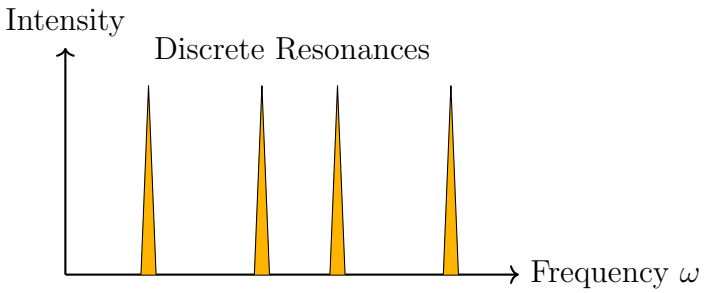
28. Cosmic Phase Evolution

Concept: The energy density of the θ-field evolves with redshift z, influencing structure formation.



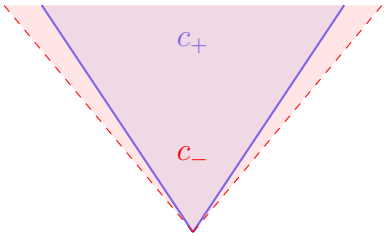
29. Resonance Spectrum (φ-Cascade)

Concept: The discrete ladder steps create resonant absorption lines in the cosmic spectrum.



30. Bimetric Light Cones

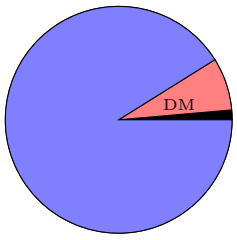
Concept: The Visible and Hidden sectors have slightly different causal structures (light speeds), leading to mixing.



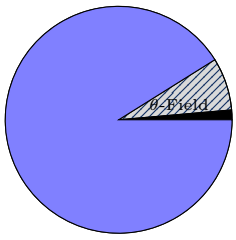
Causal Mixing

31. Cosmological Energy Budget

Concept: Comparing the standard model composition to the Chiral Vortex model where θ-Energy replaces Dark Matter.



Standard ΛCDM

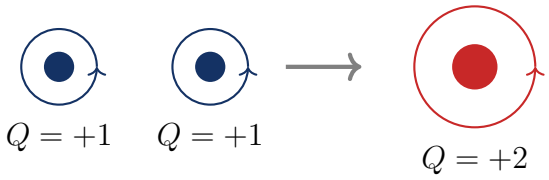


Chiral Vortex Paradigm

4 Part IV: Extended Theoretical Implications

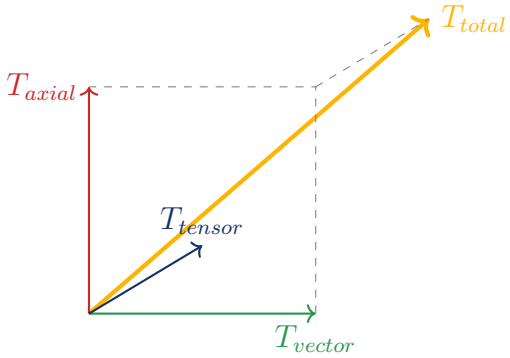
32. Vortex Fusion ($Q_1 + Q_2 \to Q_{final}$)

Concept: Two phase singularities on the spectral sheet merging to form a higher topological charge.



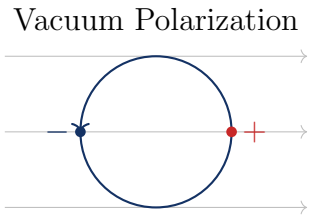
33. Torsion Decomposition

Concept: The torsion vector T^μ decomposes into Axial, Vector, and Tensor components.



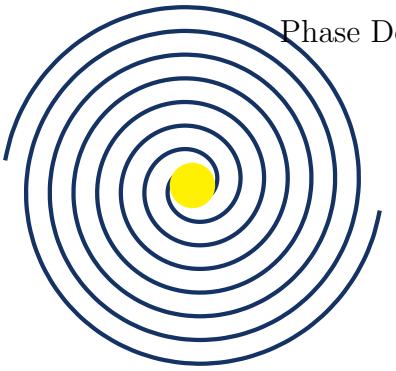
34. Vacuum Polarization Loops

Concept: Virtual θ-field loops induced by the flux gap ΔF, creating vacuum screening.



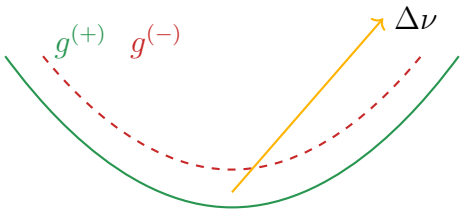
35. Galactic Spiral Waves

Concept: Density waves in the θ-field manifesting as spiral arms.



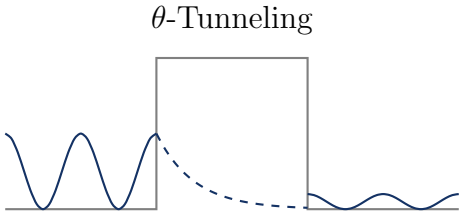
36. Gravitational Redshift (Bimetric)

Concept: A photon climbing out of a dual potential well experiences modified redshift.



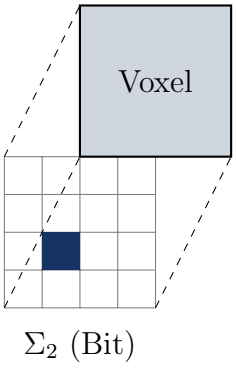
37. Macroscopic Tunneling

Concept: The phase field tunneling through a potential barrier between vacuum states.



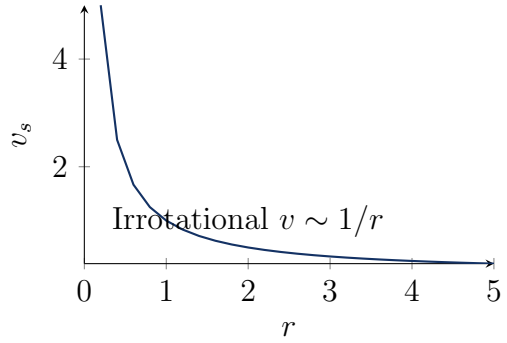
38. Holographic Boundary Bit

Concept: Information on the 2D sheet boundary Σ_2 projecting to a volume voxel in $\mathcal{M}_4$.



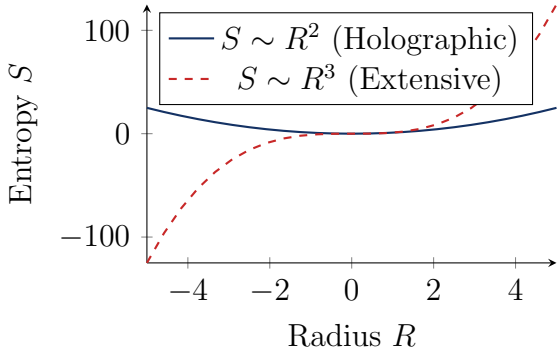
39. Superfluid Velocity Profile

Concept: The velocity of the θ-field superfluid $v_s \sim 1/r$, contrasting with rigid body rotation.



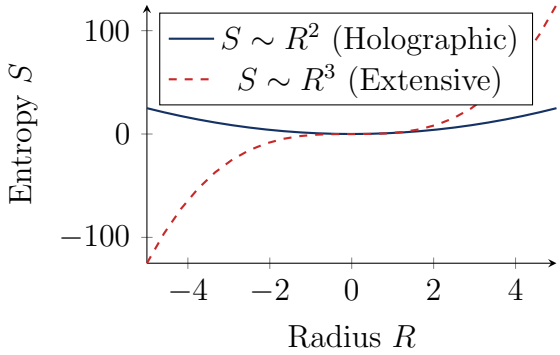
40. Information Entropy Scaling

Concept: Entropy S scales with Area (Holographic) rather than Volume (Extensive).



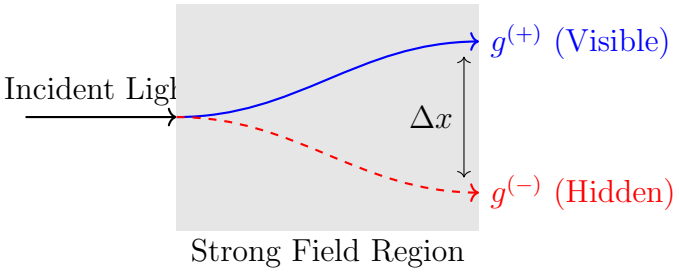
41. Information Entropy Scaling

Concept: Entropy S scales with Area (Holographic) rather than Volume (Extensive).



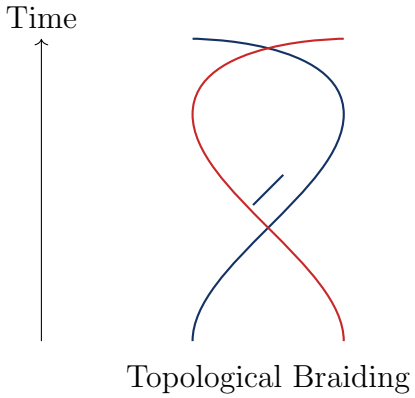
42. Bimetric Geodesic Splitting

Concept: A light ray incident on a strong field region splits into visible ($g^{(+)}$) and hidden ($g^{(-)}$) geodesics due to differing metrics.



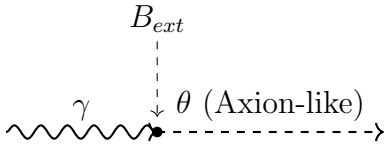
43. Vortex Braiding (Spacetime)

Concept: Worldlines of θ-vortices braiding in spacetime, encoding topological information.



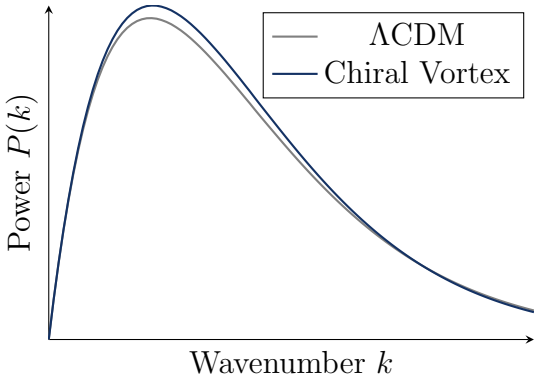
44. Primakoff Conversion ($\gamma \to \theta$)

Concept: A photon converting into a θ-particle (axion-like) in the presence of an external magnetic field.



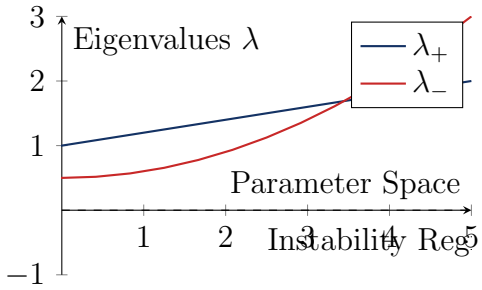
45. Cosmic Power Spectrum Shift

Concept: The presence of the θ-field shifts the acoustic peaks in the matter power spectrum $P(k)$ compared to ΛCDM.



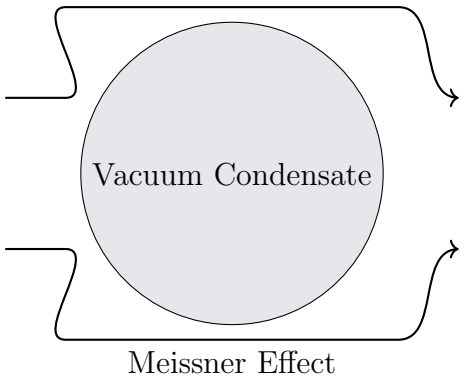
46. Metric Eigenvalues (Stability)

Concept: Stability requires the eigenvalues $\lambda_{\pm}$ of the metric ratio matrix to remain positive.



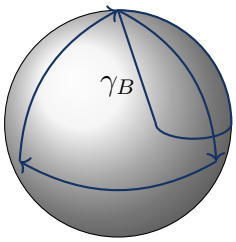
47. Superconducting Vacuum (Meissner Effect)

Concept: The vacuum acts as a superconductor, expelling "hidden" flux lines, confining them to vortices.



48. Berry Phase Holonomy

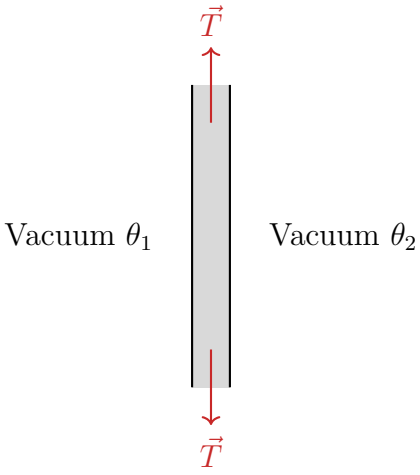
Concept: A closed loop in the spectral sheet's parameter space accumulates a geometric (Berry) phase.



Parameter Space Σ_2

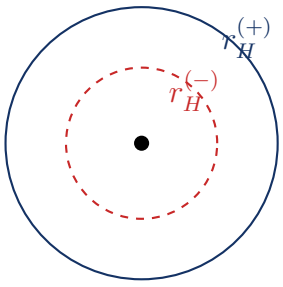
49. Domain Wall Tension

Concept: A phase domain wall separates regions of different vacuum expectation values, held by surface tension σ.



50. Bimetric Black Hole Horizons

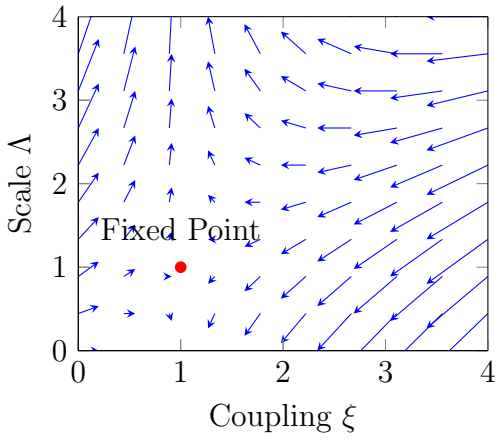
Concept: A black hole in bimetric gravity has two distinct event horizons for the visible and hidden metrics.



Nested Horizons

51. Renormalization Group Flow

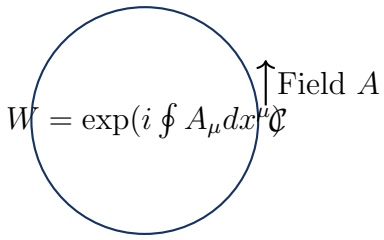
Concept: Coupling constants (ξ, Λ) flow with energy scale, approaching a fixed point.


Fixed Point
Scale Λ
Coupling ξ
0
1
2
3
4

5 Part V: Quantum Topological Extensions

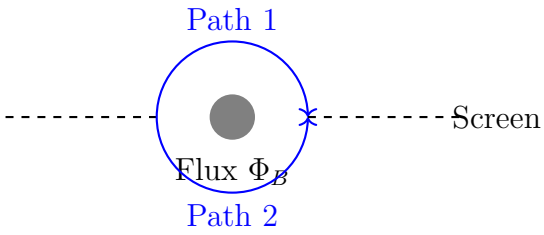
52. Wilson Loop Holonomy

Concept: A closed loop in spacetime measures the gauge field flux, central to the bimetric connection.



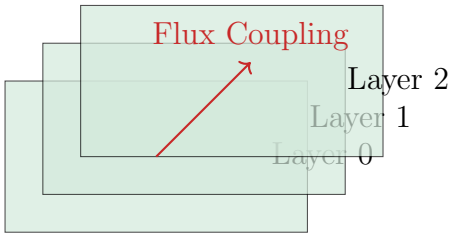
53. Aharonov-Bohm Effect

Concept: An electron path splits around a solenoid, acquiring a topological phase shift $\Delta\phi$ despite $B = 0$ outside.



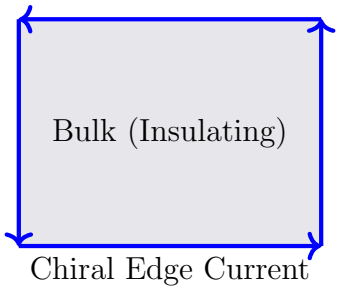
54. Chern-Simons Layering

Concept: Stacked 2D spectral sheets generating a 3D topological mass via the Chern-Simons mechanism.



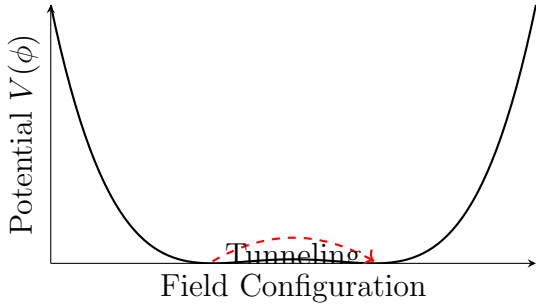
55. Topological Edge States

Concept: Chiral currents flow only on the boundary of the spectral sheet, protected by topology.



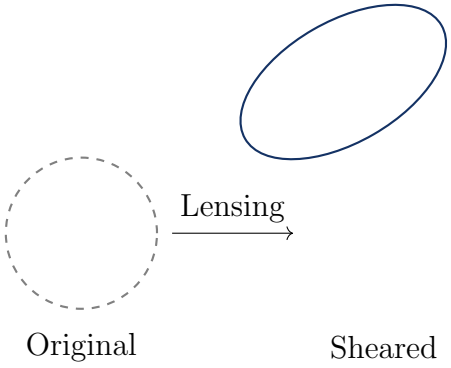
56. Instanton Tunneling

Concept: Non-perturbative tunneling event between two vacua $|0\rangle$ and $|1\rangle$.



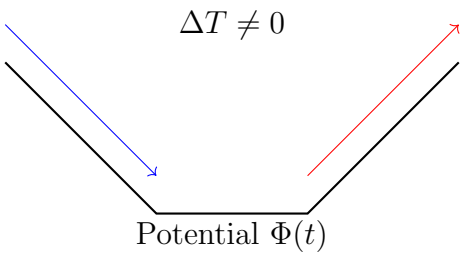
57. Weak Lensing Shear

Concept: A circular background galaxy appears elliptical due to the gravitational shear γ of the θ-halo.



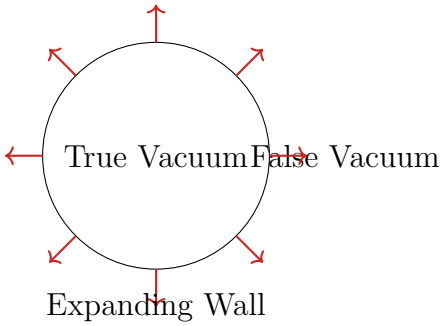
58. Integrated Sachs-Wolfe Effect

Concept: A photon gains energy falling into a potential well and loses it climbing out; time evolution causes a net shift.



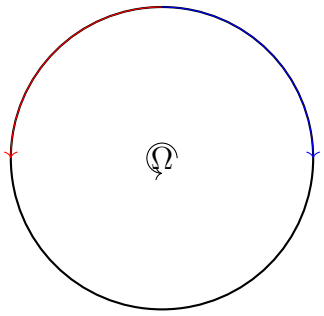
59. Vacuum Bubble Nucleation

Concept: Decay of a false vacuum creates an expanding bubble of true vacuum.



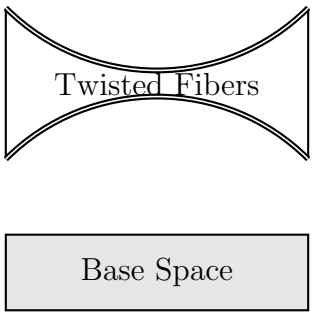
60. Sagnac Effect Interference

Concept: Counter-propagating light beams in a rotating loop acquire a phase difference proportional to rotation Ω.



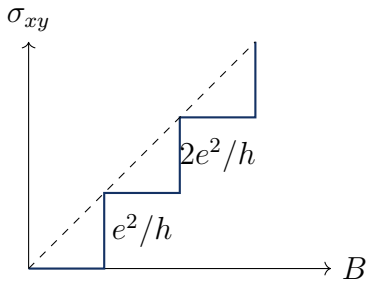
61. Twisted Fiber Bundle

Concept: The global topology of the bimetric lift involves a non-trivial twist in the fiber bundle.



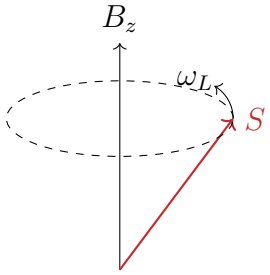
62. Quantum Hall Staircase

Concept: The Hall conductivity σ_{xy} is quantized in integer steps, analogous to the winding number Q.



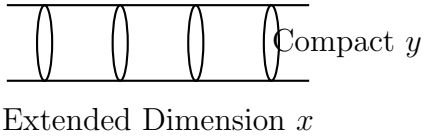
63. Spinor Precession (Larmor)

Concept: A spinor Ψ precesses in a magnetic field, similar to the master field phase evolution.



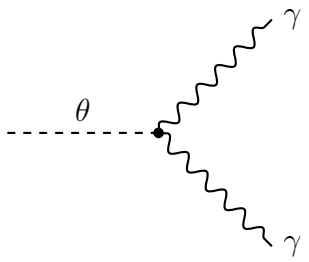
64. Kaluza-Klein Cylinder

Concept: The extra dimension (spectral sheet coordinate) is compactified into a small circle.



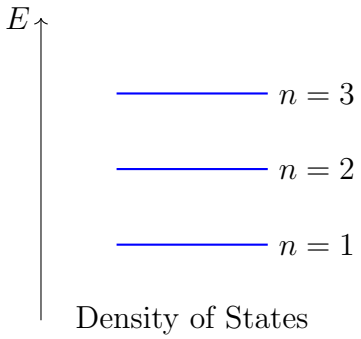
65. Feynman Diagram (Vertex)

Concept: Interaction vertex between the θ-field and two photons ($\theta\gamma\gamma$).



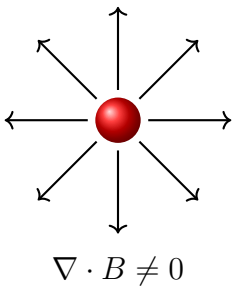
66. Landau Levels

Concept: Discrete energy levels of charged particles in a magnetic field.



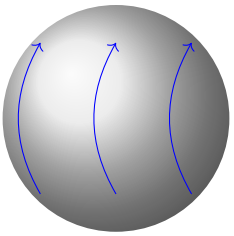
67. Monopole Flux Lines

Concept: Radial field lines emerging from a magnetic monopole singularity.



68. Skyrmion Texture

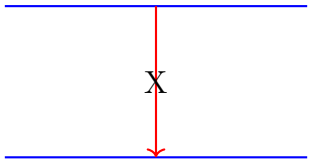
Concept: A topological soliton where vector fields twist into a stable knot.



Skyrmion Core

69. Vortex Reconnection

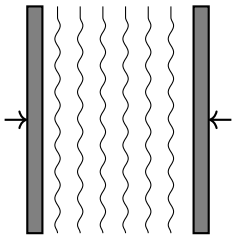
Concept: Two vortex lines colliding, breaking, and reconnecting to change topology.



Reconnection Event

70. Casimir Effect Plates

Concept: Vacuum energy suppression between plates, illustrating vacuum stiffness ρ.



Vacuum Pressure

71. Black Hole Thermodynamics

Concept: Area law relation $S = A/4$ for bimetric horizons.

$S \propto A$