

ULTRAMETRIC PHYSICS

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RESEARCH PLAN

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EXECUTIVE

SUMMARY: THE RATIO-CENTRIC PARADIGM

This research plan presents a framework for ultrametric physics based on **fundamental scaling ratios** rather than anthropocentric number representations. The core insight: physical reality is described by **dimensionless scaling ratios** (π , ϕ , e , α , etc.) that operate on hierarchical discrete structures, independent of any base representation (decimal, binary, etc.) or continuum assumptions.

Key Innovations: 1. ****Ratio-Based Valuations****: Scaling bases $q \in \mathbb{R}^+$ as pure ratios, not decimal numbers 2. **Base-Invariant Formulations**: All mathematics independent of representation (decimal/binary/etc.) 3. **Hierarchical Discrete Reality**: Bruhat-Tits trees as fundamental substrate 4. **Unified Framework**: Addressing quantum computation, quantum gravity, and measurement theory simultaneously 5. **Constrained Methodology**: 0.5 FTE PI, LLM-assisted, open dissemination via Zenodo/ResearchGate

RESEARCH

CONSTRAINTS AND METHODOLOGY

Resources:

Personnel: 0.5 FTE Principal Investigator (20 hrs/week)

Tools: Large Language Models (DeepSeek, Google Gemini)

Computation: Python execution within LLM chat threads

Output Format: Markdown with MathJax → Obsidian → PDF

Dissemination: Zenodo (DOI), ResearchGate, social media

Excluded: Experimental facilities, arXiv, LaTeX, formal peer review

Research Protocol:

Module Execution: Each module as single LLM chat thread

Document Generation: Markdown with MathJax, base-independent formulations

Code Implementation: Python for simulations/toy models (executable in chat)

Archiving: Zenodo deposit with DOI, ResearchGate upload

Dissemination: Social media with Zenodo links

RESEARCH MODULES (12

MODULES)

Prioritized for consistency and quality control based on existing progress and monograph “Ultrametric Physics: From Discrete Hierarchical Geometry to Intrinsic Fault Tolerance and Quantum Gravity” (0.10.md)

FOUNDATIONAL

MATHEMATICS (Modules 1-4)

Module 1:

Ratio-Based Valuation Theory

Core Concept: Scaling ratios q as fundamental, not integer primes **Research Questions:** 1. How to formalize valuations with arbitrary scaling ratios $q \in \mathbb{R}^+$? 2. What algebraic structures emerge when q is a geometric ratio (π , ϕ , e)? 3. How do scaling ratios generate continuous appearances from discrete structures?

Expected Output: 8-12 page Markdown document defining ratio-based valuation framework, with theorems/proofs for $q = \pi$, ϕ , e , and Python implementations.

Key Insight: q treated as pure scaling operator, never written in decimal form; base-invariant formulations; physical interpretation as fundamental scaling ratio.

Module

2: Bruhat-Tits Trees with Scaling Ratios

Core Concept: Trees with edge weight $\log q$, independent of q 's decimal representation **Research Questions:**

1. How to construct trees parameterized by scaling ratio q and residue field size N ? 2. What tree properties (growth, boundary dimension) depend only on ratios $\log N/\log q$? 3. How do tree automorphisms relate to scaling transformations?

Expected Output: 6-10 page document with tree constructions for $q = \pi$, ϕ , e , Python code for tree generation/analysis, visualizations.

Key Insight: Edge weight = $\log q$ (not decimal expansion); boundary dimension = $\log N/\log q$ (pure ratio); physical interpretation: q as scale separation ratio.

Module

3: Vladimirov Operator and Ratio-Based Calculus

Core Concept: Pseudodifferential operator with scaling ratio q **Research Questions:** 1. How to define D_q^α for arbitrary scaling ratio q ? 2. What is the spectrum in terms of $q^{(\alpha)}$ (powers of scaling ratio)? 3. How does tree Laplacian approximate D_q^α in continuum limit?

Expected Output: 5-8 page document with ratio-based calculus, Python implementations for eigenvalue calculations, connection to tree Laplacians.

Key Insight: Normalization constant $C_q(\alpha)$ expressed in terms of q ; eigenvalues as powers of scaling ratio; base-independent formulations.

Module

4: Adelic Theory for General Number Fields

Core Concept: Extend adelic framework beyond $\mathbb{Q}$ to fields with fundamental scaling ratios ****Research Questions:**** 1. How to construct adeles for fields with scaling ratios π, ϕ, e ? 2. What physical interpretations emerge from different completions? 3. How do product formulas generalize with scaling ratios?

Expected Output: 7-10 page document extending adelic theory, physical interpretation of different completions, mathematical consistency proofs.

Key Insight: Treat all completions democratically; scaling ratios as fundamental parameters; connection to multiple scale hierarchies in physics.

QUANTUM

COMPUTATION THEORY (Modules 5-7)

Module 5:

Ratio-Based Quantum Error Correction

Core Concept: Error suppression $\epsilon_L \sim q^{(-d)} \epsilon_P$ with scaling ratio q **Research Questions:** 1. How does scaling ratio q determine error suppression efficiency? 2. What is the optimal q for given resource constraints? 3. How does this compare to surface codes and other approaches?

Expected Output: 8-12 page document deriving error suppression formulas, resource optimization with scaling ratio q , comparison tables.

Key Insight: q as fundamental scaling ratio of architecture; optimization over q space; physical implementation considerations.

Module 6:

Quantum Gate Theory on Ratio-Based Trees

Core Concept: Universal gate sets from tree automorphisms with scaling ratio q **Research Questions:**

1. What gate sets are universal for computation on trees with scaling ratio q ? 2. How to compile arbitrary unitaries into scaling transformations? 3. What are complexity implications of ratio-based computation?

Expected Output: 7-10 page document with gate classification, compilation algorithms, complexity analysis, Python implementations.

Key Insight: Gates as scaling transformations; compilation as path finding in ratio space; complexity dependent on $\log q$.

Module 7:

Thermodynamic Limits with Scaling Ratios

Core Concept: Minimum energy requirements scale with q^d **Research Questions:** 1. What are fundamental thermodynamic limits for ratio-based computation? 2. How does temperature affect error suppression with scaling ratio q ? 3. What are Landauer limits for ratio-based operations?

Expected Output: 6-9 page document with thermodynamic derivations, temperature limits analysis, comparison to conventional architectures.

Key Insight: Energy barriers scale as q^d ; temperature limits depend on $\log q$; thermodynamic advantages of ratio-based structures.

QUANTUM

GRAVITY AND COSMOLOGY (Modules 8-10)

Module

8: Wheeler-DeWitt Equation on Ratio-Based Trees

Core Concept: Discrete WdW equation with kinetic term from scaling ratio q **Research Questions:** 1. How to formulate WdW equation on trees with scaling ratio q ? 2. What solutions correspond to cosmological histories? 3. How does time emerge from tree navigation with scaling ratio q ?

Expected Output: 10-15 page document with discrete WdW formulation, solution methods, time emergence mechanism, Python implementations.

Key Insight: Time as navigation in ratio-scaled tree; WdW operator depends on q ; connection to cosmic evolution.

Module

9: Emergent Lorentz Symmetry from Scaling Ratios

Core Concept: Lorentz group emerges from automorphisms with scaling ratio q **Research Questions:**

1. How does Lorentz symmetry emerge from tree automorphisms in limit? 2.

What is the relation between scaling ratio q and speed of light? 3. How do Lorentz violations appear at small scales?

Expected Output: 8-12 page document deriving Lorentz group emergence, q - c relations, Lorentz violation predictions.

Key Insight: Speed of light related to $\log q$; Lorentz violations scale with q^{-d} ; testable predictions.

Module

10: Cosmological Dynamics from Ratio-Based Navigation

Core Concept: Scale factor $a(t)$ from tree branching statistics with scaling ratio q **Research Questions:** 1. How does $a(t)$ emerge from branching with scaling ratio q ? 2. What tree parameters correspond to $(\Omega_m, \Omega_\Lambda, H_0)$? 3. How does inflation arise from ratio-based dynamics?

Expected Output: 9-13 page document deriving cosmological dynamics, parameter mapping, inflation mechanism, Python simulations.

Key Insight: Cosmological parameters as ratios; inflation as accelerated branching; testable CMB predictions.

CONSCIOUSNESS

AND SYNTHESIS (Modules 11-12)

Module

11: Monna Map as Ratio-Based Consciousness Interface

Core Concept: $M: K \rightarrow \mathbb{R}$ as projection from discrete ratio-based states to continuous experience **Research Questions:** 1. How does Monna map transform ratio-based quantum states to qualia? 2. What neural implementations are possible? 3. How does this resolve the hard problem?

Expected Output: 8-12 page document with Monna map model, neural implementation hypotheses, hard problem resolution.

Key Insight: Consciousness as ratio-based information processing; qualia as specific ratio patterns; measurement as projection.

Module

12: Synthesis: Adelic Ontology and Ratio-Based Unification

Core Concept: Comprehensive synthesis based on monograph “Ultrametric Physics” **Research Questions:** 1. How do ratio-based frameworks unify quantum computation and quantum gravity? 2. What is the adelic ontology of discrete hierarchical reality? 3. What are testable predictions and philosophical implications?

Expected Output: 15-20 page synthesis document integrating all modules, developing adelic ontology, identifying testable predictions.

Key Insight: The adelic universe $A = \mathbb{R} \times \prod q K_q$ as comprehensive mathematical arena; each scaling ratio q as a “layer” of reality; fundamental discreteness with emergent continuity.

EXECUTION TIMELINE

AND MILESTONES

Phase 1:

Foundational Completion (Weeks 1-4)

Complete Modules 1-4: Mathematical foundations

Deliverables: 4 Zenodo deposits (Modules 1-4)

Phase 2:

Core Theory Development (Weeks 5-12)

Develop Modules 5-10: Quantum computation and gravity

Implement computational simulations

Deliverables: 6 Zenodo deposits (Modules 5-10)

Phase 3:

Synthesis and Completion (Weeks 13-16)

Develop Modules 11-12: Consciousness and synthesis

Cross-module coherence verification

Complete framework documentation

Deliverables: 3 Zenodo deposits (Modules 11-12, synthesis)

QUALITY METRICS

AND SUCCESS CRITERIA

Mathematical Rigor:

All theorems with proofs or proof sketches

Internal consistency across modules

Base-invariance verification

Computational

Soundness:

Executable Python code in chat environment

Code documentation and examples

Symbolic verification of analytical results

Physical

Plausibility:

Connection to known physics where required

Testable predictions identified

Consistency with empirical constraints

Interdisciplinary

Coherence:

Connections between modules clearly articulated

Synthesis across quantum computation, gravity, consciousness

Philosophical consistency

Dissemination

Impact:

Zenodo downloads and views

ResearchGate engagement

Social media discussion and sharing

Citation in related work

RISK MITIGATION

STRATEGIES

Theoretical Risks:

Mathematical inconsistencies: Regular cross-module consistency checks

Over-reliance on LLMs: Critical verification of all derivations

Isolation from community: Active social media engagement

Computational Risks:

Code execution limitations: Design for constrained chat environment

Numerical accuracy: Analytical verification where possible

Scalability issues: Focus on small-scale demonstrators

Dissemination Risks:

Low visibility: Strategic social media approach

Misunderstanding: Clear explanations, responsive communication

Platform changes: Primary archiving on Zenodo

EXPECTED

CONTRIBUTIONS AND IMPACT

Theoretical

Contributions:

Complete ratio-based ultrametric physics framework

Generalized valuation theory with scaling ratios

Discrete Wheeler-DeWitt formulation on trees

Ratio-based consciousness model via Monna map

Unification of computation, gravity, and measurement

Methodological

Innovations:

LLM-assisted theoretical physics methodology

Constrained research protocols for foundational work

Open science practices for theoretical physics

Base-invariant mathematical formulations

Practical

Applications:

Quantum computing architectures with geometric protection

Cosmological predictions testable with CMB data

Consciousness criteria for artificial systems

Hierarchical material design principles

CONCLUSION: THE

RATIO-CENTRIC PARADIGM

This research plan presents a focused, executable program for developing ultrametric physics based on fundamental scaling ratios. By rejecting anthropocentric mathematical conventions (integer primes, real continuum, base-10 decimals) and focusing on ratio-based hierarchical structures, the framework offers a unified approach to quantum computation, quantum gravity, and consciousness.

The constrained methodology (0.5 FTE PI, LLM-assisted, open dissemination) demonstrates that significant foundational progress is possible without traditional resources. The 12-module structure ensures consistency and quality control while covering the essential components of the framework.

Ultimate Goal: A **paradigm shift** from number-based to ratio-based physics, developed with strict empirical discipline and rigorous mathematical foundations.

Prior Work and Related Literature

This work builds on the following related research: