

# Latent Core

*Dr. Tamás Nagy*

Dr. Tamás Nagy

tamas@thel latent.space

Skeleton

## Abstract

Bridge: Latent Core Eigenvalue Conditioning.

This paper presents 120 machine-verified theorems building on 10 established facts and 24 hypotheses. All results are formally verified in the Platonic proof kernel (136 verification units, 120 proved statements) and exportable to Lean 4.

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## 1. Introduction

## 2. Further Results

**Theorem** (gap\_function\_identity). *Gap Function Identity*. [Platonic: gap\_function\_identity, domain: latent\_core]

**Theorem** (bernstein\_ellipse\_identity). *Bernstein Ellipse Identity*. [Platonic: bernstein\_ellipse\_identity, domain: latent\_core]

**Theorem** (phase\_transition\_equivalence). *Phase Transition Equivalence*. [Platonic: phase\_transition\_equivalence, domain: latent\_core]

**Theorem** (ec\_rate\_is\_latent\_decay). *Ec Rate Is Latent Decay*. [Platonic: ec\_rate\_is\_latent\_decay, domain: latent\_core]

**Theorem** (higher\_rho\_fewer\_modes). *Higher Rho Fewer Modes*. [Platonic: higher\_rho\_fewer\_modes, domain: latent\_core]

**Theorem** (ec\_is\_grade\_two\_projection). *Ec Is Grade Two Projection*. [Platonic: ec\_is\_grade\_two\_projection, domain: latent\_core]

**Theorem** (eckart\_young\_at\_grade\_two). *Eckart Young At Grade Two*. [Platonic: eckart\_young\_at\_grade\_two, domain: latent\_core]

**Theorem** (grade\_collapse\_ec\_complete). *Grade Collapse Ec Complete*. [Platonic: grade\_collapse\_ec\_complete, domain: latent\_core]

**Theorem** (dimension\_free\_equivalence). *Dimension Free Equivalence*. [Platonic: dimension\_free\_equivalence, domain: latent\_core]

**Theorem** (keff\_measures\_latent\_compression). *Keff Measures Latent Compression*. [Platonic: keff\_measures\_latent\_compression, domain: latent\_core]

**Theorem** (ip\_product\_nonneg). *Ip Product Nonneg.* [Platonic: ip\_product\_nonneg, domain: latent\_core]

**Theorem** (symmetry\_square). *Symmetry Square.* [Platonic: symmetry\_square, domain: latent\_core]

**Theorem** (ip\_scaling\_nonneg). *Ip Scaling Nonneg.* [Platonic: ip\_scaling\_nonneg, domain: latent\_core]

**Theorem** (tensor\_ip\_pos\_semidef). *Tensor Ip Pos Semidef.* [Platonic: tensor\_ip\_pos\_semidef, domain: latent\_core]

**Theorem** (tensor\_ip\_symmetric). *Tensor Ip Symmetric.* [Platonic: tensor\_ip\_symmetric, domain: latent\_core]

**Theorem** (tensor\_norm\_multiplicative). *Tensor Norm Multiplicative.* [Platonic: tensor\_norm\_multiplicative, domain: latent\_core]

**Theorem** (gca2\_derived). *Gca2 Derived.* [Platonic: gca2\_derived, domain: latent\_core]

**Theorem** (tensor\_ip\_bilinear). *Tensor Ip Bilinear.* [Platonic: tensor\_ip\_bilinear, domain: latent\_core]

**Theorem** (gca\_closure\_triple). *Gca Closure Triple.* [Platonic: gca\_closure\_triple, domain: latent\_core]

**Theorem** (positive\_strip\_implies\_rho\_gt\_one). *Positive Strip Implies Rho Gt One.* [Platonic: positive\_strip\_implies\_rho\_gt\_one, domain: latent\_core]

**Theorem** (duality\_derived). *Duality Derived.* [Platonic: duality\_derived, domain: latent\_core]

**Theorem** (duality\_preserves\_gap). *Duality Preserves Gap.* [Platonic: duality\_preserves\_gap, domain: latent\_core]

**Theorem** (duality\_preserves\_nstar). *Duality Preserves Nstar.* [Platonic: duality\_preserves\_nstar, domain: latent\_core]

**Theorem** (strip\_monotone). *Strip Monotone.* [Platonic: strip\_monotone, domain: latent\_core]

**Theorem** (ns\_semigroup\_grade\_preserving). *Ns Semigroup Grade Preserving.* [Platonic: ns\_semigroup\_grade\_preserving, domain: latent\_core]

**Theorem** (enstrophy\_nonneg\_contraction). *Enstrophy Nonneg Contraction.* [Platonic: enstrophy\_nonneg\_contraction, domain: latent\_core]

**Theorem** (dissipation\_rate\_negative). *Dissipation Rate Negative.* [Platonic: dissipation\_rate\_negative, domain: latent\_core]

**Theorem** (weyl\_law\_ns). *Weyl Law Ns.* [Platonic: weyl\_law\_ns, domain: latent\_core]

**Theorem** (grade2\_dominance\_safe). *Grade2 Dominance Safe.* [Platonic: grade2\_dominance\_safe, domain: latent\_core]

**Theorem** (poincare\_latent). *Poincare Latent.* [Platonic: poincare\_latent, domain: latent\_core]

**Theorem** (incompressibility\_tracefree). *Incompressibility Tracefree.* [Platonic: incompressibility\_tracefree, domain: latent\_core]

**Theorem** (analyticity\_rate\_duality). *Analyticity Rate Duality*. [Platonic: analyticity\_rate\_duality, domain: latent\_core]

**Theorem** (vr\_exponential\_growth). *Vr Exponential Growth*. [Platonic: vr\_exponential\_growth, domain: latent\_core]

**Theorem** (is\_failure\_rho\_one). *Is Failure Rho One*. [Platonic: is\_failure\_rho\_one, domain: latent\_core]

**Theorem** (eigen\_cos\_factorization). *Eigen Cos Factorization*. [Platonic: eigen\_cos\_factorization, domain: latent\_core]

**Theorem** (vr\_monotone\_in\_rho). *Vr Monotone In Rho*. [Platonic: vr\_monotone\_in\_rho, domain: latent\_core]

**Theorem** (student\_t\_is\_failure). *Student T Is Failure*. [Platonic: student\_t\_is\_failure, domain: latent\_core]

**Theorem** (dual\_face\_identity). *Dual Face Identity*. [Platonic: dual\_face\_identity, domain: latent\_core]

**Theorem** (benchmark\_vr\_quadratic). *Benchmark Vr Quadratic*. [Platonic: benchmark\_vr\_quadratic, domain: latent\_core]

**Theorem** (map\_composition\_associative). *Map Composition Associative*. [Platonic: map\_composition\_associative, domain: latent\_core]

**Theorem** (identity\_map\_neutral). *Identity Map Neutral*. [Platonic: identity\_map\_neutral, domain: latent\_core]

**Theorem** (moment\_map\_growth). *Moment Map Growth*. [Platonic: moment\_map\_growth, domain: latent\_core]

**Theorem** (analyticity\_preservation). *Analyticity Preservation*. [Platonic: analyticity\_preservation, domain: latent\_core]

**Theorem** (analytic\_chain\_preservation). *Analytic Chain Preservation*. [Platonic: analytic\_chain\_preservation, domain: latent\_core]

**Theorem** (moment\_evaluator\_diverges). *Moment Evaluator Diverges*. [Platonic: moment\_evaluator\_diverges, domain: latent\_core]

**Theorem** (toeplitz\_condition\_growth). *Toeplitz Condition Growth*. [Platonic: toeplitz\_condition\_growth, domain: latent\_core]

**Theorem** (fenton\_duality). *Fenton Duality*. [Platonic: fenton\_duality, domain: latent\_core]

**Theorem** (error\_composition\_nonneg). *Error Composition Nonneg*. [Platonic: error\_composition\_nonneg, domain: latent\_core]

**Theorem** (monotone\_improvement). *Monotone Improvement*. [Platonic: monotone\_improvement, domain: latent\_core]

**Theorem** (information\_ratio). *Information Ratio*. [Platonic: information\_ratio, domain: latent\_core]

**Theorem** (three\_body\_2d\_rank). *Three Body 2d Rank*. [Platonic: three\_body\_2d\_rank, domain: latent\_core]

**Theorem** (sv\_pairing). *Sv Pairing*. [Platonic: sv\_pairing, domain: latent\_core]

**Theorem** (scale\_separation). *Scale Separation*. [Platonic: scale\_separation, domain: latent\_core]

**Theorem** (semigroup\_contractive). *Semigroup Contractive*. [Platonic: semigroup\_contractive, domain: latent\_core]

**Theorem** (time\_evolution\_grade\_preserving). *Time Evolution Grade Preserving*. [Platonic: time\_evolution\_grade\_preserving, domain: latent\_core]

**Theorem** (temporal\_meta\_latent\_finite). *Temporal Meta Latent Finite*. [Platonic: temporal\_meta\_latent\_finite, domain: latent\_core]

**Theorem** (geometric\_denominator\_positive). *Geometric Denominator Positive*. [Platonic: geometric\_denominator\_positive, domain: latent\_core]

**Theorem** (truncation\_monotone). *Truncation Monotone*. [Platonic: truncation\_monotone, domain: latent\_core]

**Theorem** (phase\_transition\_rho\_one). *Phase Transition Rho One*. [Platonic: phase\_transition\_rho\_one, domain: latent\_core]

**Theorem** (dimension\_independence). *Dimension Independence*. [Platonic: dimension\_independence, domain: latent\_core]

**Theorem** (basis\_change\_norm\_invariance). *Basis Change Norm Invariance*. [Platonic: basis\_change\_norm\_invariance, domain: latent\_core]

**Theorem** (decay\_exponent\_grows). *Decay Exponent Grows*. [Platonic: decay\_exponent\_grows, domain: latent\_core]

**Theorem** (grade\_norm\_sq\_nonneg). *Grade Norm Sq Nonneg*. [Platonic: grade\_norm\_sq\_nonneg, domain: latent\_core]

**Theorem** (tensor\_grade\_additive). *Tensor Grade Additive*. [Platonic: tensor\_grade\_additive, domain: latent\_core]

**Theorem** (contraction\_grade\_lowering). *Contraction Grade Lowering*. [Platonic: contraction\_grade\_lowering, domain: latent\_core]

**Theorem** (grade\_zero\_scalar). *Grade Zero Scalar*. [Platonic: grade\_zero\_scalar, domain: latent\_core]

**Theorem** (higher\_grade\_interaction\_present). *Higher Grade Interaction Present*. [Platonic: higher\_grade\_interaction\_present, domain: latent\_core]

**Theorem** (projector\_separation). *Projector Separation*. [Platonic: projector\_separation, domain: latent\_core]

**Theorem** (gca2\_inner\_product\_multiplicativity). *Gca2 Inner Product Multiplicativity*. [Platonic: gca2\_inner\_product\_multiplicativity, domain: latent\_core]

**Theorem** (universality\_norm\_preservation). *Universality Norm Preservation*. [Platonic: universality\_norm\_preservation, domain: latent\_core]

**Theorem** (analyticity\_rate\_duality). *Analyticity Rate Duality*. [Platonic: analyticity\_rate\_duality, domain: latent\_core]

**Theorem** (shadow\_detection\_gap). *Shadow Detection Gap*. [Platonic: shadow\_detection\_gap, domain: latent\_core]

**Theorem** (shadow\_calibration\_impossible). *Shadow Calibration Impossible*. [Platonic: shadow\_calibration\_impossible, domain: latent\_core]

**Theorem** (emergence\_is\_cross\_coupling). *Emergence Is Cross Coupling*. [Platonic: emergence\_is\_cross\_coupling, domain: latent\_core]

**Theorem** (eckart\_young\_residual\_improvement). *Eckart Young Residual Improvement*. [Platonic: eckart\_young\_residual\_improvement, domain: latent\_core]

**Theorem** (singular\_value\_ordering). *Singular Value Ordering*. [Platonic: singular\_value\_ordering, domain: latent\_core]

**Theorem** (rank\_k\_residual\_nonneg). *Rank K Residual Nonneg*. [Platonic: rank\_k\_residual\_nonneg, domain: latent\_core]

**Theorem** (three\_body\_3d\_rank). *Three Body 3d Rank*. [Platonic: three\_body\_3d\_rank, domain: latent\_core]

**Theorem** (grade\_collapse\_eigenbasis). *Grade Collapse Eigenbasis*. [Platonic: grade\_collapse\_eigenbasis, domain: latent\_core]

**Theorem** (optimality\_chain\_consistent). *Optimality Chain Consistent*. [Platonic: optimality\_chain\_consistent, domain: latent\_core]

**Theorem** (mismatched\_basis\_diverges). *Mismatched Basis Diverges*. [Platonic: mismatched\_basis\_diverges, domain: latent\_core]

**Theorem** (condition\_number\_gap). *Condition Number Gap*. [Platonic: condition\_number\_gap, domain: latent\_core]

**Theorem** (matching\_completeness\_chain). *Matching Completeness Chain*. [Platonic: matching\_completeness\_chain, domain: latent\_core]

**Theorem** (fourier\_exponential\_decay). *Fourier Exponential Decay*. [Platonic: fourier\_exponential\_decay, domain: latent\_core]

**Theorem** (complexification\_strictly\_enriches). *Complexification Strictly Enriches*. [Platonic: complexification\_strictly\_enriches, domain: latent\_core]

**Theorem** (strip\_width\_controls\_decay). *Strip Width Controls Decay*. [Platonic: strip\_width\_controls\_decay, domain: latent\_core]

**Theorem** (euler\_unit\_modulus). *Euler Unit Modulus*. [Platonic: euler\_unit\_modulus, domain: latent\_core]

**Theorem** (fenton\_is\_matching\_instance). *Fenton Is Matching Instance*. [Platonic: fenton\_is\_matching\_instance, domain: latent\_core]

**Theorem** (hermite\_cos\_pipeline). *Hermite Cos Pipeline*. [Platonic: hermite\_cos\_pipeline, domain: latent\_core]

**Theorem** (moment\_mgf\_carleman\_link). *Moment Mgf Carleman Link*. [Platonic: moment\_mgf\_carleman\_link, domain: latent\_core]

**Theorem** (fenton\_resolution\_evaluator\_switch). *Fenton Resolution Evaluator Switch*. [Platonic: fenton\_resolution\_evaluator\_switch, domain: latent\_core]

**Theorem** (distillation\_is\_ey\_truncation). *Distillation Is Ey Truncation*. [Platonic: distillation\_is\_ey\_truncation, domain: latent\_core]

**Theorem** (shrinkage\_reduces\_error). *Shrinkage Reduces Error*. [Platonic: shrinkage\_reduces\_error, domain: latent\_core]

**Theorem** (gca2\_product\_nonneg). *Gca2 Product Nonneg*. [Platonic: gca2\_product\_nonneg, domain: latent\_core]

**Theorem** (tensor\_norm\_multiplicative). *Tensor Norm Multiplicative*. [Platonic: tensor\_norm\_multiplicative, domain: latent\_core]

**Theorem** (tensor\_zero\_absorption). *Tensor Zero Absorption*. [Platonic: tensor\_zero\_absorption, domain: latent\_core]

**Theorem** (bernstein\_cramer\_duality). *Bernstein Cramer Duality*. [Platonic: bernstein\_cramer\_duality, domain: latent\_core]

**Theorem** (duality\_rate\_equivalence). *Duality Rate Equivalence*. [Platonic: duality\_rate\_equivalence, domain: latent\_core]

### 3. Bounds and Estimates

**Theorem** (zero\_strip\_is\_phase\_boundary). *Zero Strip Is Phase Boundary*. [Platonic: zero\_strip\_is\_phase\_boundary, domain: latent\_core]

**Theorem** (bounded\_map\_bounded\_latent). *Bounded Map Bounded Latent*. [Platonic: bounded\_map\_bounded\_latent, domain: latent\_core]

**Theorem** (bounded\_evaluator\_converges). *Bounded Evaluator Converges*. [Platonic: bounded\_evaluator\_converges, domain: latent\_core]

**Theorem** (error\_composition\_bound). *Error Composition Bound*. [Platonic: error\_composition\_bound, domain: latent\_core]

**Theorem** (pipeline\_bound). *Pipeline Bound*. [Platonic: pipeline\_bound, domain: latent\_core]

**Theorem** (grade\_orthogonal\_norm\_bound). *Grade Orthogonal Norm Bound*. [Platonic: grade\_orthogonal\_norm\_bound, domain: latent\_core]

**Theorem** (projection\_subsystem\_bound). *Projection Subsystem Bound*. [Platonic: projection\_subsystem\_bound, domain: latent\_core]

**Theorem** (nbody\_rank\_bound). *Nbody Rank Bound*. [Platonic: nbody\_rank\_bound, domain: latent\_core]

**Theorem** (vr\_collapse\_at\_boundary). *Vr Collapse At Boundary*. [Platonic: vr\_collapse\_at\_boundary, domain: latent\_core]

## 4. Convergence Results

**Theorem** (ec\_convergence\_monotone\_N). *Ec Convergence Monotone N*. [Platonic: ec\_convergence\_monotone\_N, domain: latent\_core]

**Theorem** (cos\_density\_convergence). *Cos Density Convergence*. [Platonic: cos\_density\_convergence, domain: latent\_core]

**Theorem** (matched\_basis\_converges). *Matched Basis Converges*. [Platonic: matched\_basis\_converges, domain: latent\_core]

**Theorem** (cos\_convergence\_monotone). *Cos Convergence Monotone*. [Platonic: cos\_convergence\_monotone, domain: latent\_core]

## 5. Spectral Theory

**Theorem** (stokes\_operator\_is\_grade\_two). *Stokes Operator Is Grade Two*. [Platonic: stokes\_operator\_is\_grade\_two, domain: latent\_core]

**Theorem** (spectral\_gap\_finite\_mixing). *Spectral Gap Finite Mixing*. [Platonic: spectral\_gap\_finite\_mixing, domain: latent\_core]

**Theorem** (weyl\_eigenvalue\_growth). *Weyl Eigenvalue Growth*. [Platonic: weyl\_eigenvalue\_growth, domain: latent\_core]

**Theorem** (spectral\_gap\_positive). *Spectral Gap Positive*. [Platonic: spectral\_gap\_positive, domain: latent\_core]

## 6. Regularity

**Theorem** (energy\_decay\_regularity). *Energy Decay Regularity*. [Platonic: energy\_decay\_regularity, domain: latent\_core]

**Theorem** (regularity\_2d\_quadratic). *Regularity 2d Quadratic*. [Platonic: regularity\_2d\_quadratic, domain: latent\_core]

## 7. Existence and Uniqueness

**Theorem** (meta\_latent\_exists). *Meta Latent Exists*. [Platonic: meta\_latent\_exists, domain: latent\_core]

## 8. Main Theorems

**Theorem** (grade\_truncation\_remainder). *Grade Truncation Remainder*. [Platonic: grade\_truncation\_remainder, domain: latent\_core]

## 9. Cross-Domain Bridges

**Theorem** (latent\_transfer\_cost\_positive). *Latent Transfer Cost Positive*. [Platonic: latent\_transfer\_cost\_positive, domain: latent\_core]

## 10. Formal Framework

### Hypotheses

- $H_{\text{rho\_L\_gt\_one}}$ : Rho L Gt One
- $H_{\text{C\_L\_pos}}$ : C L Pos
- $H_{\text{C\_EC\_pos}}$ : C Ec Pos
- $H_{\text{eps\_pos}}$ : Eps Pos
- $H_{\text{N\_pos}}$ : N Pos
- $H_{\text{keff\_pos}}$ : Keff Pos
- $H_{\text{n\_gt\_keff}}$ : N Gt Keff
- $H_{\text{gamma\_def}}$ : Gamma Def
- $IP1\_a$ : Ip1 A
- $IP1\_b$ : Ip1 B
- $IP3$ : Ip3
- $IP1\_c$ : Ip1 C
- $H_{\text{rho\_kd\_gt\_one}}$ : Rho Kd Gt One
- $H_{\text{eps\_T\_nn}}$ : Eps T Nn
- $H_{\text{eps\_trunc\_nn}}$ : Eps Trunc Nn
- $H_{\text{rho\_gt\_one}}$ : Rho Gt One
- $H_{\text{C1\_pos}}$ : C1 Pos
- $H_{\text{eps\_pos}}$ : Eps Pos
- $H_{\text{N\_pos}}$ : N Pos
- $H_{\text{norm\_0\_nn}}$ : Norm 0 Nn
- $H_{\text{norm\_1\_nn}}$ : Norm 1 Nn
- $H_{\text{norm\_2\_nn}}$ : Norm 2 Nn
- $H_{\text{norm\_3\_nn}}$ : Norm 3 Nn
- $H_{\text{eigenbasis}}$ : Eigenbasis

### Established Facts

- $F_{\text{tensor\_ip\_def}}$ : Tensor Ip Def
- $F_{\text{bernstein\_from\_sigma}}$ : Bernstein From Sigma
- $F_{\text{cramer\_from\_sigma}}$ : Cramer From Sigma
- $F_{\text{exp\_pos\_gt\_one}}$ : Exp Pos Gt One
- $F_{\text{exp\_zero\_one}}$ : Exp Zero One
- $F_{\text{exp\_monotone}}$ : Exp Monotone
- $F_{\text{real\_cancel}}$ : Real Cancel
- $F_{\text{tensor\_ip\_def}}$ : Tensor Ip Def
- $F_{\text{bernstein\_from\_sigma}}$ : Bernstein From Sigma
- $F_{\text{cramer\_from\_sigma}}$ : Cramer From Sigma

## 11. Proof Architecture

All proofs are implemented in the Platonic kernel (elysium/fields/latent\_core/).

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| File                          | Role |
|-------------------------------|------|
| latent_ec_bridge_proof.py     |      |
| gca_algebra_proof.py          |      |
| latent_ns_sf_bridges_proof.py |      |
| latent_applications_proof.py  |      |
| latent_core_proof.py          |      |
| latent_completions_proof.py   |      |

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## 12. Discussion

## References