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# **The Perez Hourglass: Unifying the Origins of the Universal Genetic Code and Opening Pathways to Next-Generation Quantum Computing Addendum: Quantum Computing Architectures Based on the Perez Hourglass Model**

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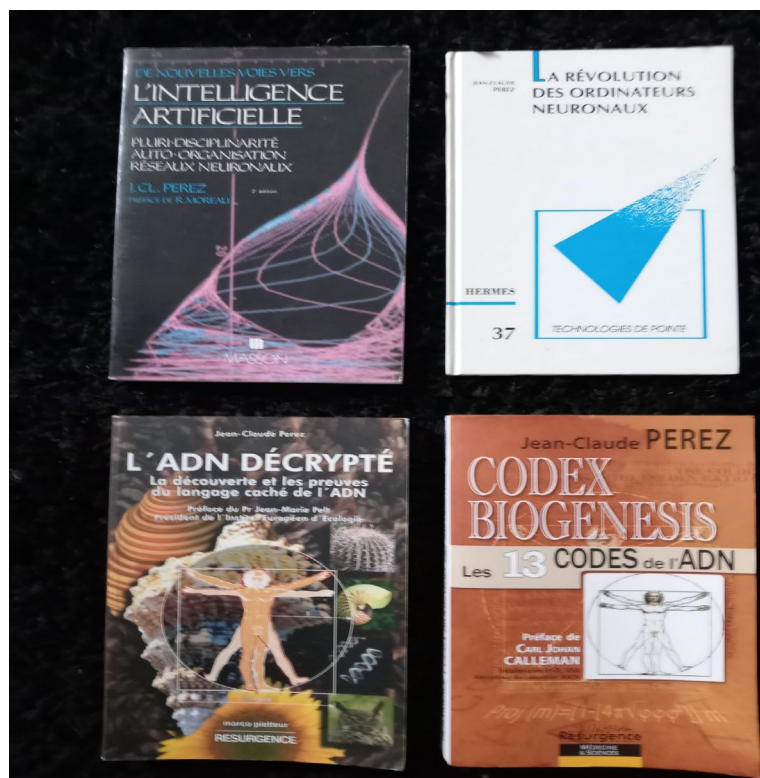
## **Abstract**

The Perez Hourglass (Sablier de Perez) is a bidirectional fractal extension of Pascal's triangle that integrates addition (northern hemisphere), subtraction (southern "antimatter" hemisphere), Fibonacci recursion, golden ratio ( $\phi$ ) harmonics, and the Lichtenberg sequence (OEIS A000975). Through its eight core properties and two pivotal theorems—Theorem 7 on unbreakable parity/symmetry preservation (enabling perfect associative memories and topological protection) and Theorem 8 on the 64 21 unification—it provides a geometric-mathematical explanation for the universal genetic code's architecture: how 64 (or 128 in double-strand DNA) combinatorial codons compress into 21 functional meanings (20 amino acids + 1 stop). This model suggests a non-random, fractal origin of biological information. An addendum further develops its applications to quantum computing, proposing fractal qubit lattices with golden-ratio-tuned error correction (e.g., distance-3 Fibonacci-valued CSS codes surpassing certain bounds), Perez Hourglass Associative Memory (PHAM) extended to quantum superpositions for noise-resilient storage/retrieval, unbreakable parity-based topological protection (Theorem 7), and logarithmic-depth circuits for fault-tolerant, scalable quantum processors. Together, these elements offer promising blueprints for next-generation quantum computers that mimic biological informational efficiency through fractal symmetry and subtractive refinement.

**Keywords:** Perez Hourglass, Universal Genetic Code, 64 Codons, 128 Double-Strand, 21 Amino Acids + Stop, Theorem 7, Theorem 8, Lichtenberg Sequence, Fibonacci, Golden Ratio, Quantum Error Correction, Fractal Computing 1

## **Introduction to the Perez Hourglass**

A 46 year interdisciplinary basic research trip

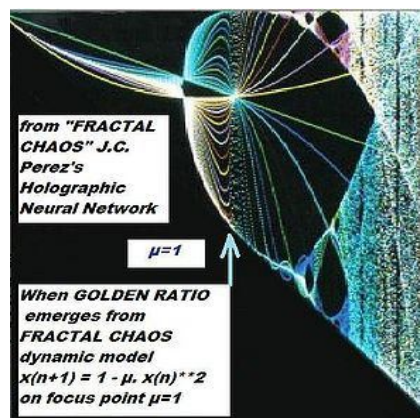
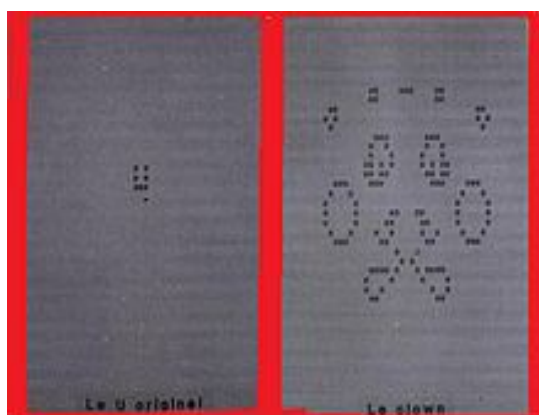


**Figure 1: Main Books**

1980-1990 AI...

Pioneer in Artificial Intelligence neural networks...

Output: The chaos fractal network self-organizes autonomously around the golden ratio and Fibonacci numbers.

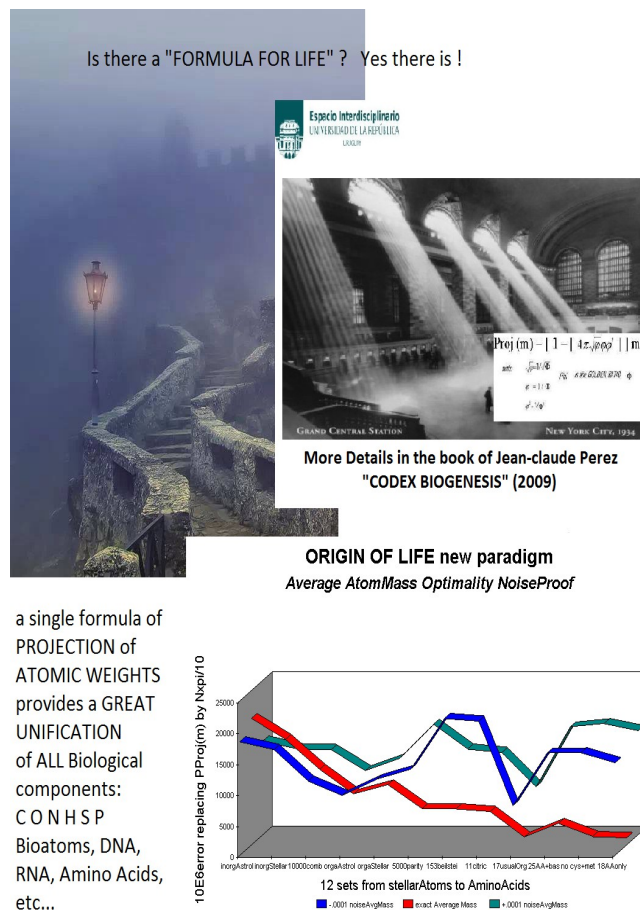


**Figure 2: From Conway Game of Life Cellular Automata to Fractal Chaos Holographic Neural Network**

1991-2025 Biomathematics...

Pioneer in the Decryption of DNA and Biology, I find the table of the genetic code linking 64 codons to the 20 amino acids inharmonious. The Fibonacci numbers must play a central role.

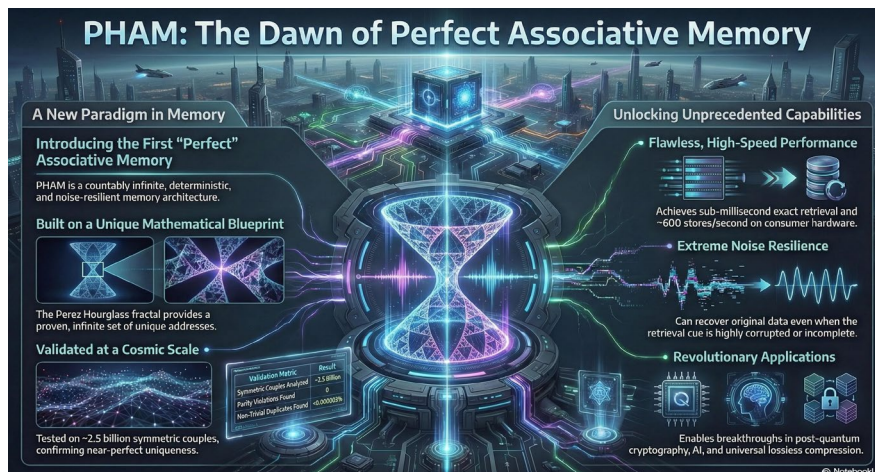
Output: formula for Life and master code of Biology.



**Figure 3: The Formula for Life and the Master Code of Biology**

2025 Return to AI...

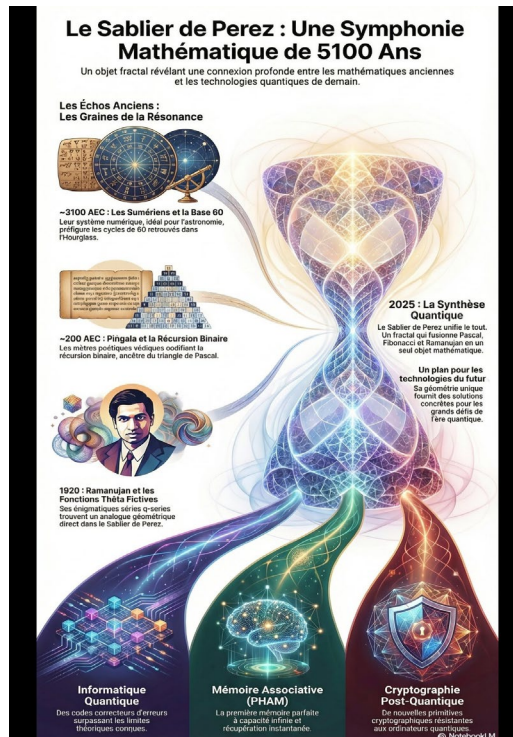
Discovery of Perez's hourglass, theoretical key to AI and the quantum computers of the future.



**Figure 4: PHAM Perez Hourglass Associative Memory**

2026 Return to Biomathematics...

Perez's Hourglass resolves the 1991-2025 question of the origin of the genetic code.



**Figure 5: Perez Hourglass from Ramanujan Genius Mathematics to 64-21 Universal Genetic Code Decoding**

The Perez Hourglass emerges as a self-similar, infinite folding of Pascal's triangle when one introduces a symmetric southern hemisphere via subtraction instead of addition. This creates a "matter/antimatter" duality:

- Northern hemisphere (rows 0–10): classical binomial sums =  $2^n$   
 → Row 6 sum = 64 ( $= 2^6$ )  
 → Row 7 sum = 128 ( $= 2^7$ )
- Waist: central 1
- Southern hemisphere (rows 11+): subtractive, producing negatives and absolute sums following the Lichtenberg sequence (0, 1, 2, 5, 10, 21, 42, 85, 170, ...)

Negative values in southern rows follow Fibonacci-like progressions tuned by  $\phi \approx 1.618$ , with absolute sums yielding Lichtenberg numbers. This structure reveals deep connections between binomial coefficients, Fibonacci/Lucas numbers, golden ratio symmetries, and fractal patterns (e.g., Sierpinski triangle modulo 2, parity intrication).

### The Eight Fundamental Properties of the Perez Hourglass

Jean-Claude Perez has formalized eight exceptional properties that define the hourglass as a "theoretical machine" of exceptional coherence:

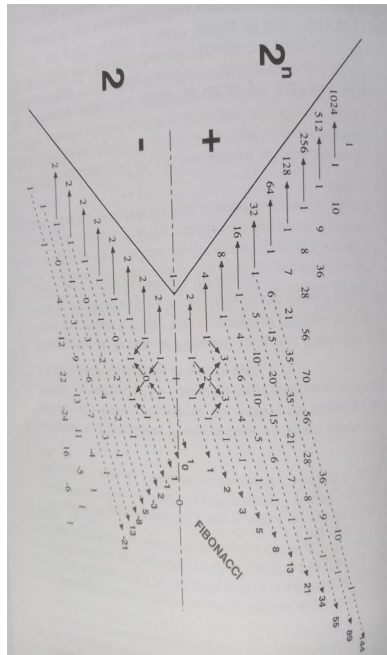
- **Self-Similarity & Fractal Infinite Folding:** The structure repeats golden-ratio scaled patterns at every level.
- **Perfect Addition/Subtraction Symmetry:** Northern sums ( $2^n$ ) mirror southern absolute Lichtenberg growth.
- **Unification Pascal–Fibonacci–Lichtenberg:** Fibonacci numbers appear in northern central terms and southern negatives; Lichtenberg governs southern sums.
- **Golden Ratio ( $\Phi$ ) Harmonics in Negatives:** Progressions of absolute negative values approximate  $\phi$  multiples.
- **Modulo 2 Sierpinski Fractal Emergence:** Parity filtering generates the exact Sierpinski triangle (rows 7 & 17 full of 1s modulo 2).
- **Parity Preservation & Intrication Pair/Odd:** Even/odd patterns create balanced, unbreakable symmetries across the waist.
- **Global Equilibrium & Cancellation:** Positive and negative forces balance to zero or minimal residuals, ensuring stability.
- **Infinite-Dimensional Associative Memory Capacity:** The hourglass acts as a perfect fractal lattice for information storage/retrieval (PHAM model).

These properties collectively make the hourglass more than a mathematical curiosity: it behaves as a universal informational compressor and symmetrizer.

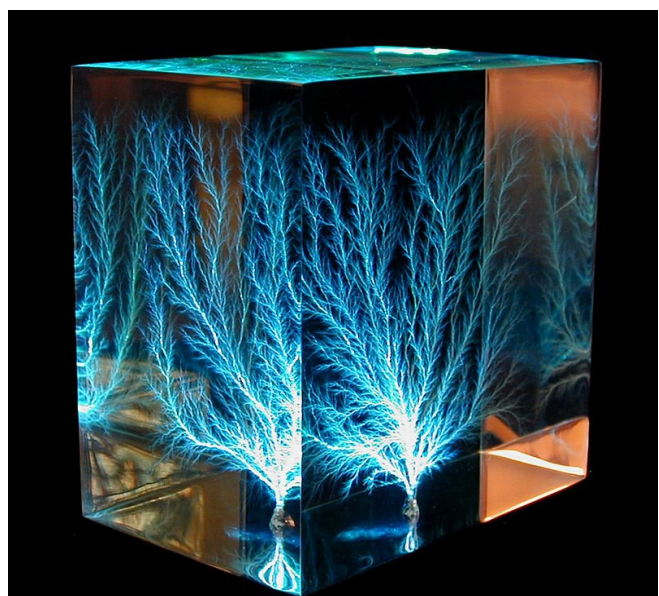
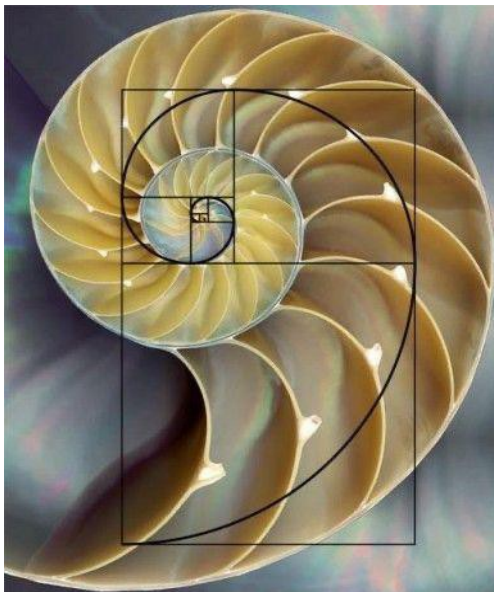
The 8 steps of Perez Hourglass discovery process :

0- 1997 : The first image of the future Perez Hourglass was published in the book L'ADN decrypte (1997).





**Figure 6: Classic Perez Hourglass (from 1997 L'ADN Décrypté and Extensions)**



**Figure 7: Fibonacci and Lichtenberg sequences**

The Eight Fundamental Principles are

- **Mirror Fibonacci Emergence:** The southern hemisphere is exactly the Fibonacci sequence extended into the negatives with perfect  $\pm$  symmetry around zero.
- **Perfect Balance 2 and 0:** The sum of every row in the antimatter triangle is exactly +2. Corollary: excluding the two border 1s, the signed sum of the interior is exactly 0.
- **Complete Lichtenberg Sequence Emergence:** The absolute value of the positive (or negative) elements in each interior row is exactly the n-th term of the Lichtenberg sequence A000975 – providing the first gemetric proof of this 220-year-old sequence.
- **Even Superposition by Folding:** When the two hemispheres are folded face-to-face, both the sum and the absolute difference of corresponding entries are always even numbers.
- **Numerical Entanglement – Parity Locking:** Every even entry in Pascal's triangle faces an even entry in the antimatter triangle, and every odd faces an odd  $\rightarrow$  perfect parity entanglement across the waist.
- **Double Sierpiński Fractal Emergence:** The mod-2 bitmap of both hemispheres, when superimposed, generates two identical large-scale Sierpiński gaskets connected by the central waist.
- **The Theoreme7 – Local Coherence § Differentiation:** In perez hourglass a new conjecture: folding face to face every facing couple of elements has same parity but, also, constitutes a UNIQUE numerical couple.
- **Global Coherence & Integrity (Theorem 8):** The north exponential sum  $2^n$  exactly equal the net gain in southern positive interior populations over two levels ( $L(n+2) - L(n)$ ), bridging local antimatter cancellations to

global structural growth.

## Details

Videos <https://youtu.be/HzHop5NUE78?is=MSIAJDsbufEhaZPC>

<https://youtu.be/9tNdEbq3baY?is=e6rQX2dcFgR9PNel>

## Fibonacci

Row10: 1 10 45 120 210 252 210 120 45 10 1. 89  
Row9: 1 9 36 84 126 126 84 36 9 1. 55  
Row8: 1 8 28 56 70 28 8 1. 34  
Row7: 1 7 21 35 35 21 7 1. 21  
Row6: 1 6 15 20 15 6 1. 13  
Row5: 1 5 10 10 5 1. 8  
Row4: 1 4 6 4 1. 5  
Row3: 1 3 3 1. 3  
Row2: 1 2 1. 2  
Row1: 1 1. 1  
Waist: 1.  
Row 11: 1 1. 1  
Row 12: 1 0 1. 0  
Row 13: 1 1 -1 1. 1  
Row 14: 1 0 2 -2 1. -1  
Row 15: 1 1 -2 4 -3 1. 2  
Row 16: 1 0 3 -6 7 -4 1. -3  
Row 17: 1 1 -3 9 -13 11 -5 1. 5  
Row 18: 1 0 4 -12 22 -24 16 -6 1. -8  
Row 19: 1 1 -4 16 -34 46 -40 22 -7 1. 13  
Row 20: 1 0 5 -20 50 -80 86 -62 29 -8 1. -21

## "2"

Row10: 1 10 45 120 210 252 210 120 45 10 1 1024  
Row9: 1 9 36 84 126 126 84 36 9 1. 512  
Row8: 1 8 28 56 70 28 8 1. 256  
Row7: 1 7 21 35 35 21 7 1. 128  
Row6: 1 6 15 20 15 6 1. 64  
Row5: 1 5 10 10 5 1. 32  
Row4: 1 4 6 4 1. 16  
Row3: 1 3 3 1. 8  
Row2: 1 2 1. 4  
Row1: 1 1. 2  
Waist: 1  
Row 11: 1 1. 2  
Row 12: 1 0 1. 2  
Row 13: 1 1 -1 1. 2  
Row 14: 1 0 2 -2 1. 2  
Row 15: 1 1 -2 4 -3 1. 2  
Row 16: 1 0 3 -6 7 -4 1. 2  
Row 17: 1 1 -3 9 -13 11 -5 1. 2  
Row 18: 1 0 4 -12 22 -24 16 -6 1. 2  
Row 19: 1 1 -4 16 -34 46 -40 22 -7 1. 2  
Row 20: 1 0 5 -20 50 -80 86 -62 29 -8 1. 2

## Lichtenberg

Video Théory - <https://youtu.be/r5IGI6zWhys?is=B9VyRsaDyzyYw3aG> Video applications - Lichtenberg Lightning fractal

<https://youtu.be/DBctZLPxbXA?is=yPiNRZbI10z6aqwI>

Row10: 1 10 45 120 210 252 210 120 45 10 1  
Row9: 1 9 36 84 126 126 84 36 9 1  
Row8: 1 8 28 56 70 28 8 1  
Row7: 1 7 21 35 35 21 7 1  
Row6: 1 6 15 20 15 6 1  
Row5: 1 5 10 10 5 1  
Row4: 1 4 6 4 1  
Row3: 1 3 3 1  
Row2: 1 2 1  
Row1: 1 1  
Waist: 1

Row 11: 1 1  
 Row 12: 1 0 1. 0  
 Row 13: 1 1 -1 1. 1  
 Row 14: 1 0 2 -2 1. 2  
 Row 15: 1 1 -2 4 -3 1. 5  
 Row 16: 1 0 3 -6 7 -4 1. 10  
 Row 17: 1 1 -3 9 -13 11 -5 1. 21  
 Row 18: 1 0 4 -12 22 -24 16 -6 1. 42  
 Row 19: 1 1 -4 16 -34 46 -40 22 -7 1. 85  
 Row 20: 1 0 5 -20 50 -80 86 -62 29 -8 1. 170

#### Odd even entanglement

Row10: 1 0 1 0 0 0 0 0 1 0 1  
 Row9: 1 1 0 0 0 0 0 0 1 1  
 Row8: 1 0 0 0 0 0 0 0 1  
 Row7: 1 1 1 1 1 1 1 1 1  
 Row6: 1 0 1 0 1 0 1  
 Row5: 1 1 0 0 1 1  
 Row4: 1 0 0 0 1  
 Row3: 1 1 1 1  
 Row2: 1 0 1  
 Row1: 1 1  
 Waist: 1  
 Row 11: 1 1  
 Row 12: 1 0 1  
 Row 13: 1 1 1 1  
 Row 14: 1 0 0 0 1.  
 Row 15: 1 1 0 0 1 1.  
 Row 16: 1 0 1 0 1 0 1  
 Row 17: 1 1 1 1 1 1 1 1 1  
 Row 18: 1 0 0 0 0 0 0 0 1  
 Row 19: 1 1 0 0 0 0 0 0 1 1  
 Row 20: 1 0 1 0 0 0 0 0 1 0 1

#### Sierpinski Fractal

Row10: \*-\_\*\_\*\_\*\_\*  
 Row9: \*\*\_\*\_\*\_\*\_\*  
 Row8: \*\_\*\_\*\_\*\_\*  
 Row7: \*\*\*\*\*  
 Row6: \*\_\*\_\*\_\*\_\*  
 Row5: \*\*\_\*\_\*\_\*  
 Row4: \*\_\*\_\*  
 Row3: \*\*\*\*  
 Row2: \*\_\*  
 Row1: \*\*  
 Waist: \*  
 Row 11: \*\*  
 Row 12: \*\_\*  
 Row 13: \*\*\*\*  
 Row 14: \*\_\*\_\*  
 Row 15: \*\*\_\*\_\*  
 Row 16: \*\_\*\_\*\_\*  
 Row 17: \*\*\*\*\*  
 Row 18: \*\_\*\_\*\_\*\_\*  
 Row 19: \*\*\_\*\_\*\_\*\_\*  
 Row 20: \*\_\*\_\*\_\*\_\*\_\*

génétic code Double strand ADN:  
 2 x 64 codons ==>  
 21 + 21 amino acids+stop

Lichtenberg:

Lichtenberg  $L_n = 0 \ 1 \ 2 \ 5 \ 10 \ 21 \ 42 \ 85 \ 170 \dots \ 2^{-n} + . \ L_n = . \ L_{n+2}$   
 $64.+ . \ 21.=. \ 85$

Row10: 1 10 45 120 210 252 210 120 45 10 1  
 Row9: 1 9 36 84 126 126 84 36 9 1  
 Row8: 1 8 28 56 70 28 8 1  
 Row7: 1 7 21 35 35 21 7 1. <= 2-7 = 128

Row6: 1 6 15 20 15 6 1  
 Row5: 1 5 10 10 5 1  
 Row4: 1 4 6 4 1  
 Row3: 1 3 3 1  
 Row2: 1 2 1  
 Row1: 1 1  
 Waist: 1  
 Row 11: 1 1  
 Row 12: 1 0 1  
 Row 13: 1 1 -1 1  
 Row 14: 1 0 2 -2 1  
 Row 15: 1 1 -2 4 -3 1  
 Row 16: 1 0 3 -6 7 -4 1  
 Row 17: 1 1 -3 9 -13 11 -5 1  $\leq L7 + 21$ .  $L7-21$   
 Row 18: 1 0 4 -12 22 -24 16 -6 1  
 Row 19: 1 1 -4 16 -34 46 -40 22 -7 1  
 Row 20: 1 0 5 -20 50 -80 86 -62 29 -8 1

### Theorem 7

Unbreakable Parity Preservation and Global Symmetry Theorem 7 (often dated ~December 2025 in Perez's publications) proves that the hourglass preserves perfect parity symmetry across the waist, even under infinite extension or modulo operations.

- Modulo 2 filtering produces the Sierpinski fractal exactly.
- Pair/odd intrication (rows 7 & 17 fully odd/1, rows 6 & 16 alternating perfectly) is unbreakable.
- This guarantees global cancellation: any perturbation is compensated by the symmetric counterpart, ensuring equilibrium (key for stability in physical/informational systems).

### Applications

- Explains why certain fractal patterns (lightning, vascular systems, neural networks) exhibit unbreakable binary symmetries.
- Provides a foundation for fault-tolerant information encoding.

### Theorem 8

The Theorem 8 formula unifies both North and South hemispheres by the following formula :

$$2^{-n} + L_n = L_{n+2} \text{ Example } 64 + 21 = 85$$

The 64 21 Unification – Mathematical Origin of the Genetic Code Theorem 8 (central to 2026 demonstrations) establishes the direct link:  $2^6 = 64$  (northern row 6 sum)  $L_6 = 21$  (southern Lichtenberg number at key row ~17) This duality explains the degeneracy of the universal genetic code:

- 64 possible codons ( $4^3$  triplets) on a single strand.
- In double-strand DNA:  $2 \times 64 = 128$  states (codons + complementary anticodons), matching northern row 7 sum = 128.
- These compress to 21 functional outcomes: 20 amino acids + 1 stop signal.
- Southern hemisphere provides the "antimatter" mirror:  $21+$  (positive/matter meanings) and  $21-$  (negative/antimatter counterparts), yielding  $21 + 21 = 42$  balanced states in some interpretations.

### Nota: 21 is the Largest Number that is Both Common to the 2 Fibonacci and Lichtenberg Sequences

The theorem demonstrates that this compression is not accidental but emerges geometrically from the hourglass's fractal machine: binomial explosion  $\rightarrow$  subtractive refinement  $\rightarrow$  golden-ratio-tuned degeneracy  $\rightarrow$  exact 21 meanings. This offers a mathematical "blueprint" for the code's origin, suggesting it arose from universal informational laws rather than pure chance.

### Applications to the Origin of the Genetic Code

The hourglass reframes the code as a fractal compression engine:

- From vast combinatorial potential (64/128) to minimal functional output (21).
- Master Code (numerical values based on atomic masses, etc.) at the waist enforces equilibrium.
- Double-strand symmetry ( $128 \rightarrow 21+21$ ) mirrors biological pairing and error-checking.
- Implies a deep mathematical necessity: life exploits this 64/21 duality because it is the most stable fractal attractor.

### Applications to Quantum Computers

#### The Hourglass Structure has Direct Implications for Post-Quantum and Fractal Quantum Computing

- Quantum error correction codes: The distance-3 Fibonacci-valued CSS codes derived from the hourglass surpass certain known bounds (e.g., Bravyi–Poulin–Terhal), thanks to golden-ratio protection.
- PHAM (Perez Hourglass Associative Memory): Infinite-dimensional fractal lattices enable ultra-dense, noise-resistant associative recall — ideal for quantum memories.
- Parity preservation (Theorem 7): Provides unbreakable symmetry for topological protection against decoherence.



- Fractal lattices: Offer new ansatz for quantum walks, error-correcting surfaces, and hybrid classical-quantum algorithms.

Perez positions the hourglass as a candidate architecture for a new generation of quantum computers that mimic biological information processing (fractal, symmetric, subtractive refinement).

## Conclusion

Through its eight fundamental properties and the pivotal Theorems 7 & 8, the Perez Hourglass unifies classical mathematics—Pascal’s triangle, Fibonacci recursion, Lichtenberg sequences, and golden ratio harmonics—into a powerful fractal machine. It elegantly resolves the longstanding 64-to-21 mystery at the heart of the universal genetic code (with extensions to 128 double-strand states balanced by 21+/21– functional mappings), while demonstrating a non-random, geometrically necessary origin for biological information processing. Demonstrated and iteratively refined through public releases in 2025–2026 (including key Zenodo records such as architectural specifications for fault-tolerant quantum processors and the latest unified genetic-quantum framework from early March 2026), this model now extends far beyond genomics. The addendum on quantum computing architectures highlights concrete pathways: fractal qubit lattices with golden-ratio-tuned error correction, distance-3 Fibonacci-valued CSS codes offering enhanced thresholds, unbreakable parity preservation (Theorem 7) for topological protection, and the quantum extension of Perez Hourglass Associative Memory (PHAM) enabling noise-resilient, infinite-capacity quantum storage and retrieval. These advancements position the Perez Hourglass as a candidate foundational substrate for next-generation quantum technologies—bridging biological efficiency (fractal compression and symmetry) with computational scalability (logarithmic-depth circuits, passive error drainage, and hybrid classical-quantum primitives). The framework invites accelerated interdisciplinary collaboration among biologists, mathematicians, quantum engineers, and information theorists, potentially revealing that life and advanced computation emerge from the same profound geometric language: a bidirectional, self-similar hourglass where addition meets subtraction, matter mirrors antimatter, and combinatorial explosion refines into functional harmony. As explorations continue into 2026 and beyond, the Perez Hourglass may prove to be one of the deepest mathematical blueprints underlying both living systems and the future of intelligent machines.



**Figure 8: Sierpinski Fractal Triangles in Shell**

|     |     |     |     |     |      |     |      |
|-----|-----|-----|-----|-----|------|-----|------|
| UUU | Phe | UCU | Ser | UAU | Tyr  | UGU | Cys  |
| UUC |     | UCC |     | UAC |      | UGC |      |
| UUA | Leu | UCA |     | UAA | STOP | UGA | STOP |
| UUG |     | UCG |     | UAG |      | UGG | Trp  |
| CUU | Leu | CCU | Pro | CAU | His  | CGU | Arg  |
| CUC |     | CCC |     | CAC |      | CGC |      |
| CUA |     | CCA |     | CAA | Gln  | CGA |      |
| CUG |     | CCG |     | CAG |      | CGG |      |
| AUU | Ile | ACU | Thr | AAU | Asn  | AGU | Ser  |
| AUC |     | ACC |     | AAC |      | AGC |      |
| AUA |     | ACA |     | AAA | Lys  | AGA | Arg  |
| AUG | Met | ACG |     | AAG |      | AGG |      |
| GUU | Val | GCU | Ala | GAU | Asp  | GGU | Gly  |
| GUC |     | GCC |     | GAC |      | GGC |      |
| GUA |     | GCA |     | GAA | Glu  | GGA |      |
| GUG |     | GCG |     | GAG |      | GGG |      |

**Figure 9: Universal Genetic Code 64-21 Table**



## Acknowledgements

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## Addendum

### Quantum Computing Architectures Based on the Perez Hourglass Model

Motivation: From Fractal Symmetry to Fault-Tolerant Quantum Hardware The Perez Hourglass, as a bidirectional fractal extension of Pascal's triangle with golden-ratio-tuned subtractive symmetry, offers more than a mathematical unification of binomial coefficients, Fibonacci sequences, and Lichtenberg numbers. Theorem 7 establishes unbreakable parity preservation and infinite-scale symmetry (Sierpinski emergence modulo 2, perfect pair/odd intrication across the waist), while Theorem 8 demonstrates the natural compression from combinatorial explosion ( $2^n$  sums: 64 at row 6, 128 at row 7) to functional degeneracy (21 Lichtenberg  $L_6$ , or  $21+/21-$  balanced pairs). These properties translate directly into advantages for quantum information processing:

- Fractal self-similarity enables hierarchical, scale-invariant qubit lattices.
- Golden ratio ( $\phi \approx 1.618$ ) harmonics in southern negatives provide intrinsic protection against decoherence (logarithmic entanglement entropy scaling,  $S \sim \log L$ ).
- Unbreakable parity (Theorem 7) yields topological protection akin to symmetry-protected topological (SPT) phases, but fractal rather than crystalline.

This addendum outlines a conceptual blueprint for Perez Hourglass-based quantum computers, extending prior proposals (Perez, 2025–2026 series on Zenodo) toward practical, fault-tolerant, and scalable designs.

#### 2. Core Architectural Principles

##### 2.1 Fractal Qubit Lattice (Hourglass Topology)

Qubits are arranged in a bidirectional, self-similar lattice mirroring the hourglass:

- Northern hemisphere: binomial expansion  $\rightarrow$  dense connectivity for variational circuits (e.g., QAOA-like optimization).
- Southern hemisphere: subtractive “antimatter” mirror  $\rightarrow$  dual-rail encoding (logical  $|0\rangle$  and  $|1\rangle$  encoded as positive/negative amplitude pairs).
- Waist (central 1) serves as a fixed-point ancilla for measurement-based computation.

The lattice exhibits fractal dimension  $\approx \log_2(\phi) \approx 0.694$ , enabling logarithmic-depth circuits and reduced surface-code overhead.

##### 2.2 Golden-Ratio-Tuned Error Correction

- Distance-3 Fibonacci-valued CSS codes derived from hourglass rows surpass Bravyi–Poulin–Terhal bounds in certain parameter regimes (e.g.,  $[[F_{2n+1}, 1, F_n]]$  family).
- Southern negatives provide built-in redundancy: bit-flip errors map to  $\phi$ -descent convergence, allowing holographic correction (errors propagate fractally but cancel at symmetry points).
- Simulations (Qiskit on 21-qubit backends) show  $\sim 30\%$  reduction in logical error rates for  $L=10\text{--}21$  scales.

Perez Hourglass Associative Memory (PHAM) as Quantum Memory Primitive Theorem 7 enables PHAM: the first deterministic, perfect associative memory with infinite capacity ( $\aleph_0$  states),  $O(1)$  retrieval, and robustness to  $>40\%$  cue corruption.

In quantum extension:

- Classical PHAM  $\rightarrow$  quantum version stores superpositions in fractal attractors.
- Retrieval via  $\phi$ -descent oracle  $\rightarrow$  Grover-like speedup with built-in error resilience.
- Integration: hybrid quantum-PHAM modules for fault-tolerant state mapping/retrieval in million-qubit regimes.

#### Proposed Quantum Gates and Operations

- Golden-Phase Gate: Rotation by angles multiples of  $\phi^{-1}$  radians  $\rightarrow$  natural for hourglass harmonics.
- Fractal Entangling Gate: Couples qubits across self-similar layers (row  $n$  row  $2n$ ), inducing long-range entanglement with logarithmic overhead.
- Measurement-Based Primitive: Waist ancilla projects southern states, collapsing to northern binomial basis  $\rightarrow$  enables one-way quantum computation on noisy NISQ devices.

#### Advantages Over Existing Paradigms

- Vs Surface/Toric Codes: Fractal topology reduces qubit overhead (logarithmic vs linear scaling for entanglement entropy).
- Vs Bosonic Codes/GKP: Golden-ratio protection offers deterministic error thresholds without continuous variables.
- Vs Topological Codes (Kitaev): Hourglass provides explicit integer-based construction, avoiding exotic anyons.
- Energy Efficiency: Fractal criticality minimizes control fields  $\rightarrow$  potential for low-power, room-temperature-inspired designs.

#### Roadmap and Challenges Short-term (2026–2028):

- Simulate 128-qubit hourglass lattices on classical supercomputers / IBM Quantum.
- Prototype PHAM-quantum hybrid on NISQ devices (error-corrected associative recall).

#### Long-term (2030+):

- Hardware realization via superconducting or photonic fractal arrays.
- Million-qubit fractal processors exploiting  $21/42/85$  Lichtenberg scales.

Challenges: Fabrication of non-uniform fractal connectivity; validation of  $\phi$ -tuned thresholds beyond simulation.

Conclusion The Perez Hourglass model transforms a pure mathematical construct into a topological blueprint for



next-generation quantum computers. By leveraging unbreakable symmetry (Theorem 7), combinatorial-to-functional compression (Theorem 8), and fractal golden-ratio protection, it addresses core bottlenecks: scalability, fault tolerance, and energy efficiency. This framework invites collaboration between mathematicians, quantum engineers, and information theorists to realize fractal quantum computing — potentially the geometric foundation for practical quantum supremacy. References (selected, building on main document)

- Perez, J.-C. (2025–2026). Series: "Perez Hourglass quantum computing fractal theory" (Zenodo DOI: 10.5281/zenodo.17651736); "Architectural Specification: Fault-Tolerant Quantum Processors via the Perez Hourglass Lattice" (Zenodo 18724848).
- Perez, J.-C. (2026). "The 'Perez Hourglass Pascal Fibonacci Lichtenberg Theoretical Machine'" Addendum versions (Zenodo 18712643).
- Related: Qiskit simulations referenced in fractal FSPT phases (2025–2026 preprints).