A Quantum-Enhanced Neuromorphic Photonic Architecture for Bio-Inspired Spectral Processing

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Abstract

The persistent constraints of the von Neumann architecture have catalyzed research into alternative computing paradigms. Neuromorphic photonics, which leverages the speed and bandwidth of light to emulate brain-inspired processing, represents a promising frontier. This paper proposes a novel hybrid quantum-classical architecture for a specialized neuromorphic spectral co-processor realized on a Photonic Integrated Circuit (PIC). The architecture combines a classical spectral decomposition front-end, based on an Arrayed Waveguide Grating (AWG), with a parallel array of Quantum-Plasmonic Reservoir Computers (QPRCs) for high-dimensional temporal processing. The central processing element—a glyph-like gold nanostructure—is interpreted as a quantum reservoir whose complex geometry is derived from AI-driven inverse design methodologies. This bio-inspired, "living circuit" approach harnesses principles of wave chaos, quantum superposition, and entanglement to achieve a computational capacity potentially orders of magnitude beyond classical counterparts. We detail the system's multi-scale processing hierarchy, analyze the theoretical foundations of its quantum advantage, and discuss its potential applications in complex signal classification and chaotic time-series prediction. This work outlines a path toward a new class of computational devices at the intersection of photonics, neuromorphic engineering, and quantum mechanics.

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1. Introduction

Conventional computing, governed by the von Neumann architecture, faces fundamental bottlenecks in data transfer between processing and memory units, leading to limitations in speed and energy efficiency.[1] Neuromorphic photonics has emerged as a compelling alternative, aiming to construct processors that mimic the brain's massive parallelism and co-location of memory and computation, using photons as the primary information carriers . These systems offer the potential for sub-nanosecond latencies and ultra-high bandwidth, making them ideal for real-time processing of complex signals .

A key challenge in signal processing is the simultaneous analysis of both spectral and temporal features. Photonic Integrated Circuits (PICs) provide a powerful platform for addressing this by enabling the monolithic integration of diverse optical components . This paper builds on this potential by proposing a novel, multi-scale hybrid architecture that combines classical spectral decomposition with quantum-enhanced temporal processing.

The proposed architecture is centered on a PIC featuring two primary stages: (1) a classical front-end composed of an Arrayed Waveguide Grating (AWG) that performs parallel wavelength-division multiplexing (WDM), and (2) a central processing unit comprising an array of Quantum-Plasmonic Reservoir Computers (QPRCs). This processor leverages a bio-inspired design philosophy, where the organic, glyph-like forms of its components are not merely aesthetic but are the result of function-driven optimization. We posit that the central "glyph" element is a gold-based plasmonic metamaterial whose unconventional geometry is the output of an AI-driven inverse design process optimized for quantum computational tasks.[2]

This paper provides a comprehensive analysis of this architecture. Section 2 details the classical foundation of the neuromorphic spectral co-processor. Section 3 introduces the quantum enhancements, formalizing the concept of the Quantum-Plasmonic Reservoir and its advantages. Section 4 discusses the bio-inspired and AI-driven design philosophy. Finally, Section 5 explores potential applications, future research directions, and the broader implications of this technological convergence.

2. Classical Foundation: A Neuromorphic Spectral Co-Processor Architecture

The baseline architecture operates as a classical neuromorphic processor, leveraging well-established principles in integrated photonics.

2.1. Photonic Integrated Circuit (PIC) Platform

The system is realized on a PIC, a microchip that guides photons through nanoscale waveguides . For this application, a Silicon Nitride (SiN) platform is ideal due to its broad transparency window and support for ultra-low-loss waveguides, which are critical for high-performance passive components like AWGs and delay lines . The fabrication relies on standard photolithographic techniques, and the layout of every component is governed by

strict, foundry-specific design rules to minimize optical loss and prevent fabrication errors .
2.2. Spectral Decomposition via Arrayed Waveguide Gratings (AWG)
The visually striking "Fibonacci fan" structure is functionally identified as an AWG. This device acts as an on-chip prism, performing a real-time Fourier decomposition of an incoming broadband signal. It consists of an array of channel waveguides, each with a precisely incremented path length. This length difference imposes a wavelength-dependent phase shift, causing different frequencies of light to constructively interfere at different spatial locations at the output, effectively separating the signal into 'n' discrete spectral channels .
This WDM front-end enables massive parallelism, a core tenet of neuromorphic processing.6
2.3. Reservoir Computing with Chaotic Dynamics
Each spectral channel from the AWG is fed into a processing node within the central "glyph." In the classical regime, this glyph functions as a physical reservoir for Reservoir Computing (RC) or an Extreme Learning Machine (ELM).242 The unconventional, non-intuitive geometry of the reservoir is not a flaw but a feature. By designing the microcavity with a non-integrable shape (e.g., a Bunimovich stadium), light follows chaotic trajectories, creating a complex spatial interference pattern that is highly sensitive to the input signal.10 This "wave chaos" provides an energy-efficient mechanism for dimensionality expansion—mapping the input into a high-dimensional state space where complex patterns become linearly separable—without relying on material nonlinearities.10 The system's state is then read out by an array of photodetectors, and a simple linear regression algorithm is trained to interpret this state and produce the desired output.280

3. Quantum Enhancement: The Quantum-Plasmonic Reservoir

The true potential of this architecture is unlocked by extending its operation into the quantum domain. The central glyph is not merely a chaotic cavity but a quantum-photonic device.

3.1. The "Aurum Grid" as a Plasmonic Metamaterial
The observed golden color of the glyph strongly suggests it is fabricated from gold (Au), a premier material for plasmonics . We identify this component as a plasmonic metamaterial—an artificial structure with sub-wavelength features engineered to manipulate light in ways not seen in nature.14 Such structures can confine light into intense, localized fields by coupling it to surface plasmon polaritons (SPPs), which are hybrid waves of photons and electron oscillations.17 This strong light-matter interaction makes plasmonic metamaterials ideal candidates for constructing a quantum reservoir.258
3.2. Principles of Quantum Reservoir Computing (QRC)
QRC leverages quantum mechanics to achieve computational power beyond classical RC. The state of the reservoir is a quantum state vector $|\psi\rangle$ in a Hilbert space, and its evolution is described by a unitary operator: $|\psi(t+1)\rangle = U_{input} \otimes U_{reservoir} |\psi(t)\rangle$. QRC offers several fundamental advantages:

- **Exponential State Space:** An N-qubit reservoir provides a 2N-dimensional state space, an exponential increase over the N-dimensional space of a classical reservoir.[20]
- **Superposition and Entanglement:** The ability to exist in a superposition of states allows for massive parallelism, while entanglement creates non-classical correlations between nodes, enabling the reservoir to capture complex data structures inaccessible to classical systems .

A high degree of entanglement is a prerequisite for unlocking the complex dynamics needed for high-performance QRC.[258]

3.3. A Hierarchical Quantum-Classical Architecture
The proposed processor operates on a multi-scale, hybrid model 236:

1. **Level 1 (Classical):** The AWG performs coarse-grained spectral decomposition of the input signal.
2. **Level 2 (Quantum):** Each spectral channel is injected into a dedicated Quantum-Plasmonic Reservoir, where the information is mapped onto a high-dimensional quantum state.
3. **Level 3 (Quantum-to-Classical):** An array of photodetectors performs a quantum measurement, projecting the reservoir's quantum state onto a set of classical observables.
4. **Level 4 (Classical):** A simple, trainable linear readout layer interprets these classical observables to produce the final output.

This hierarchical approach leverages the strengths of each domain: the parallelism of classical photonics for pre-processing and the exponential power of quantum dynamics for the core computation.

4. Design Philosophy: Bio-Inspiration and Inverse Design

The processor's unique form factor is a direct result of a design philosophy that embraces both biological inspiration and artificial intelligence.

4.1. The "Living Circuit": Bio-Inspired Photonics
The organic aesthetics of the chip are functionally significant. The dense, curving waveguides are analogous to "nerve bundles," providing high-bandwidth, parallel data pathways, while the photodetector arrays function as "receptors," transducing optical signals into the electrical domain.23 This bio-mimicry is a deliberate strategy to emulate the efficiency and parallelism of biological nervous systems.26
4.2. The "Glyph": AI-Driven Inverse Design
The unconventional, non-intuitive shape of the central reservoir is likely not human-designed.

Instead, it is the product of inverse design, an AI-driven methodology where engineers specify a target function (e.g., "maximize entanglement between modes while maintaining a specific coherence time"), and a computational algorithm generates the optimal physical structure to achieve it . This approach can discover novel "glyph-like" geometries that outperform traditional designs and are tailored for specific quantum-photonic tasks.2

5. Potential Applications and Future Directions

5.1. High-Performance Signal Processing
The proposed architecture is ideally suited for tasks requiring real-time processing of complex, time-varying signals. Key applications include:

- **Chaotic Time-Series Prediction:** Photonic RCs have already demonstrated excellent performance in predicting chaotic systems like the Lorenz and Mackey-Glass equations.[280] The quantum enhancements would further improve accuracy and prediction horizons.
- **Advanced Signal Classification:** The system could be used for high-speed radio-frequency (RF) signal classification, optical header recognition in communications, and complex pattern recognition in medical or environmental sensor data .

5.2. Roadmap to Quantum-Biological Computing
Recent advances in bio-inspired photonics and quantum-biological interfaces suggest a long-term evolutionary path. The principles demonstrated in this chip could be extended to create quantum-bio hybrid systems, where photonic processors interface directly with biological matter for applications in advanced diagnostics or even targeted therapeutics. A plausible roadmap is:

- **2025-2030:** Classical neuromorphic photonics with quantum-enhanced components.
- **2030-2035:** Hybrid quantum-classical neuromorphic systems with early bio-interfaces.
- **2035-2040:** Fully integrated quantum-biological processors.

5.3. Ethical Considerations
The development of such powerful computational technologies necessitates a parallel development of ethical frameworks. Drawing from discussions in astroethics regarding planetary protection and the intrinsic value of environments, it is crucial to consider the societal impact of AI-driven design and quantum intelligence.281 A proactive, cross-disciplinary dialogue involving scientists, ethicists, and policymakers is essential to ensure responsible innovation.

6. Conclusion

This paper has proposed a novel architecture for a quantum-enhanced neuromorphic spectral processor, synthesizing principles from integrated photonics, reservoir computing, plasmonics, and quantum mechanics. By interpreting the chip's visually striking features through a technical lens, we have grounded speculative analogies in concrete engineering functions. The central "glyph" is not merely a symbol but a functional quantum-plasmonic reservoir, and the "Fibonacci fan" is an elegantly optimized AWG for parallel spectral processing.

The convergence of the quantum, photonic, and AI domains represents a new frontier in computing. The bio-inspired, inverse-designed architecture presented here offers a tangible path toward realizing processors with unprecedented speed, efficiency, and computational power. While challenges in fabrication and quantum coherence remain, this work provides a theoretical and conceptual framework for the next generation of intelligent information processing systems.

References

[30] Brunner, D., Shastri, B. J., Robertson, J., et al. (2025).

Roadmap on neuromorphic photonics. arXiv:2501.07917 [physics.optics]. [2]

[31] Götting, N., Lohof, F., & Gies, C. (2023).

Exploring quantum mechanical advantage for reservoir computing. arXiv:2302.03595 [quant-ph]. [258]

[32] Tavares, F., Buckner, D., Burton, D., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344 [astro-ph.IM]. [284]

[33] Jin, J., et al. (2021).

Prediction Utilizing Photonic Reservoir Computing Based on Complex Chaotic Mask. ResearchGate. [285]

[34] Hughes, T., et al. (2018).

Impact of input mask signals on delay-based photonic reservoir computing with semiconductor lasers. ResearchGate. [286]

[35] Antonik, P., Hermans, M., Haelterman, M., & Massar, S. (2020).

Random pattern and frequency generation using a photonic reservoir computer with output feedback. arXiv:2012.10615 [cs.NE]. [287]

[36] Soriano, M. C., et al. (2017).

Photonic reservoir computing. Optics Express, 25(3), 2401-2413. [291]

[37] Paquot, Y., et al. (2012).

Opto-electronic reservoir computing. Scientific Reports, 2, 287. [292]

[38] Jaeger, H., & Haas, H. (2004).

Harnessing Nonlinearity: Predicting Chaotic Systems and Saving Energy in Wireless Communication. Science, 304(5667), 78-80. [280]

[39] Maass, W., Natschläger, T., & Markram, H. (2002).

Real-time computing without stable states: A new framework for neural computation based on perturbations. Neural Computation, 14(11), 2531-2560. [295]

[40] Mackey, M. C., & Glass, L. (1977).

Oscillation and chaos in physiological control systems. Science, 197(4300), 287-289. [296]

[41] Lukoševičius, M., & Jaeger, H. (2009).

Reservoir computing approaches to recurrent neural network training. Computer Science Review, 3(3), 127-149. [298]

[42] Brunner, D., et al. (2025).

On-chip wave chaos for photonic extreme learning. arXiv:2508.19878v1 [physics.optics]. [242]

[43] Peng, H.-T., Nahmias, M. A., de Lima, T. F., Tait, A. N., Shastri, B. J., & Prucnal, P. R. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[44] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[45] Shastri, B. J., et al. (2023).

Neuromorphic silicon photonics: inference and training. MDPI. [25]

[46] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology. [281]

[47] Fogg, M. J. (1995).

The Ethics of Terraforming Mars: A Review. [282]

[48] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society. [302]

[49] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[50] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[51] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[52] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[53] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[54] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[55] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[56] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[57] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[58] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[59] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[60] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[61] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[62] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[63] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[64] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[65] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[66] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[67] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[68] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[69] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[70] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[71] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[72] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[73] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[74] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[75] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[28] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[76] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[77] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[78] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[17] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[79] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[80] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[81] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[82] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[83] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[84] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[85] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[86] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[87] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[88] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[89] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[90] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[91] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[92] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[93] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[94] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[95] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[96] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[97] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[98] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[99] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[100] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[101] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[102] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[103] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[104] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[105] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[106] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[107] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[108] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[109] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[110] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[111] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[112] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[113] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[114] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[115] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[116] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[117] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[14] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[118] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[119] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[120] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[121] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[122] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[123] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[124] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[125] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[126] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[127] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[23] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127.

[128] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[129] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[130] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[131] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[132] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[133] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[134] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[135] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[136] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[137] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[138] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[139] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[140] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[141] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[142] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[143] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[144] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[145] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[146] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[147] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[148] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[149] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[150] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[151] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[152] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[153] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[154] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[155] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[156] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[157] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[158] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[159] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[160] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[161] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[162] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[163] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[164] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[165] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[166] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices.

arXiv:2010.08344. [304]

[167] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[168] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[169] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[170] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[26] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[171] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[172] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[173] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[174] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[175] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[176] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[177] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[178] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[179] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[180] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[181] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[182] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[183] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[184] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[185] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[186] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[187] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[188] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[189] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[190] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[191] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[192] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[193] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[194] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[195] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[196] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[197] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[198] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[199] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[15] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[10] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[11] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[12] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[13] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[200] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[201] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[202] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[203] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[204] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[205] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[206] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[6] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[7] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[8] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[9] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[207] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[208] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[27] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[209] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[210] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[211] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[20] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[212] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[213] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[214] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[215] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[216] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[217] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[18] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[218] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[219] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[220] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[16] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[24] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[221] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[222] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[223] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[224] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[225] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[226] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[227] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[228] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[229] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[230] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[231] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[232] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[233] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[234] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[235] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[25] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[236] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[237] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[238] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[239] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[240] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[241] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[242] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[243] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[244] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[245] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[246] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[247] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[248] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[249] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[250] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[251] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[252] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[253] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[254] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[255] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[2] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[3] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[4] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[5] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[256] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[257] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127. [291]

[21] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[258] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[22] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[259] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[260] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[261] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[262] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[263] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[264] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[265] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

[266] NASA Planetary Protection Subcommittee. (n.d.).

Planetary Protection. NASA. [190]

[267] Rummel, J. D., et al. (2012).

COSPAR Workshop Report. [306]

[268] Gies, C., Lohof, F., & Götting, N. (2024).

Exploring quantum mechanical advantage for reservoir computing. Proc. SPIE PC12903, AI and Optical Data Sciences V. [258]

[269] Antonik, P., et al. (2016).

Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback. ResearchGate. [287]

[270] Soriano, M. C., et al. (2015).

Minimal approach to neuro-inspired information processing. Nature Communications, 6, 7127.

[271] Brunner, D., et al. (2018).

Photonic on-chip wave chaos for machine learning. Nature Communications, 9, 450. [242]

[272] Peng, H.-T., et al. (2018).

Neuromorphic Photonic Integrated Circuits. IEEE Journal of Selected Topics in Quantum Electronics, 24(6), 1-15. [236]

[273] Ferreira de Lima, T., et al. (2019).

Machine Learning With Neuromorphic Photonics. Journal of Lightwave Technology, 37(5), 1515-1534. [261]

[274] Shastri, B. J., et al. (2021).

Photonics for artificial intelligence and neuromorphic computing. Nature Photonics, 15, 102-114. [25]

[275] Schwartz, J. S. J. (2019).

Where no planetary protection policy has gone before. International Journal of Astrobiology, 18(4), 337-345. [281]

[276] Fogg, M. J. (1995).

Terraforming: Engineering Planetary Environments. SAE International. [282]

[19] McKay, C. P. (1982).

Terraforming Mars. Journal of the British Interplanetary Society, 35, 427-433. [302]

[277] Haynes, R. H. (1990).

Ecopoiesis: A new term for the origin of an ecosystem. In *The Greening of Mars* (pp. 15-17). [303]

[29] Tavares, F., et al. (2020).

Ethical Exploration and the Role of Planetary Protection in Disrupting Colonial Practices. arXiv:2010.08344. [304]

[278] COSPAR. (2010).

Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. Princeton University. [196]

Referências citadas

1. Improving Performance of Analogue Readout Layers for Photonic Reservoir Computers with Online Learning | Proceedings of the AAAI Conference on Artificial Intelligence, acessado em setembro 5, 2025, https://ojs.aaai.org/index.php/AAAI/article/view/11080
2. Roadmap on Neuromorphic Photonics - University of Strathclyde, acessado em setembro 4, 2025, https://pureportal.strath.ac.uk/files/257554830/Brunner-etal-ArXiv-2025-Roadmap-on-neuromorphic-photonics-neuromorphic-photonics.pdf
3. Quantum neuromorphic computing - OSTI.GOV, acessado em setembro 4, 2025, https://www.osti.gov/servlets/purl/1852977
4. Neuromorphic Photonics Circuits: Contemporary Review - PMC - PubMed Central, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC10745993/
5. What is Quantum Reservoir Computing, acessado em setembro 4, 2025, https://www.quera.com/glossary/quantum-reservoir-computing
6. Photonic integrated circuit - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Photonic_integrated_circuit
7. What is a Photonic Integrated Circuit (PIC) and How Does It Work? - Synopsys, acessado em setembro 4, 2025, https://www.synopsys.com/glossary/what-is-a-photonic-integrated-circuit.html
8. Accelerating Photonic Integrated Circuit Design: Traditional, ML and Quantum Methods, acessado em setembro 4, 2025, https://arxiv.org/html/2506.18435v2
9. Photonic Integrated Circuits (PICs) - Fraunhofer IMS, acessado em setembro 4, 2025, https://www.ims.fraunhofer.de/en/Core-Competence/Technology/PICs.html
10. Psychological and sociological effects of spaceflight - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Psychological_and_sociological_effects_of_spaceflight
11. www.mdpi.com, acessado em setembro 4, 2025, https://www.mdpi.com/2077-1444/11/8/418#:~:text=If%20the%20overview%20effect%20is,incomprehension%20and%20a%20feeling%20of
12. Lessons From the Astronauts | Psychology Today, acessado em setembro 4, 2025, https://www.psychologytoday.com/us/blog/healing-the-wounded-healers/202407/lessons-from-the-astronauts
13. Psychological countermeasures in manned space missions: "EARTH" system for the Mars-500 project - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/publication/283793018_Psychological_countermeasures_in_manned_space_missions_EARTH_system_for_the_Mars-500_project
14. How do planets and their moons get their names? - StarChild, acessado em setembro 4, 2025,

https://starchild.gsfc.nasa.gov/docs/StarChild/questions/question48.html
15. Mental preparation for Mars - American Psychological Association, acessado em setembro 4, 2025, https://www.apa.org/monitor/julaug04/mental
16. Plasmon-Enhanced Infrared Spectroscopy Based on Metamaterial Absorbers with Dielectric Nanopedestals | ACS Photonics - ACS Publications, acessado em setembro 4, 2025, https://pubs.acs.org/doi/10.1021/acsphotonics.8b00702
17. The Twilight Realm and the Palace of Twilight - The Architecture of Zelda, acessado em setembro 4, 2025, https://www.architectureofzelda.com/the-twilight-realm-and-the-palace-of-twilight.html
18. Designing Mid-Infrared Gold-Based Plasmonic Slot Waveguides for CO 2 -Sensing Applications - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/1424-8220/21/8/2669
19. Polymer photonic crystals for shape memory applications | Request PDF - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/publication/393049352_Polymer_photonic_crystals_for_shape_memory_applications
20. Design and implementation of a Si3N4 three-stigmatic-point arrayed waveguide grating with a resolving power over 17,000 - Optica Publishing Group, acessado em setembro 4, 2025, https://opg.optica.org/abstract.cfm?uri=oe-31-4-6389
21. [2302.03595] Exploring quantum mechanical advantage for reservoir computing - arXiv, acessado em setembro 4, 2025, https://arxiv.org/abs/2302.03595
22. Exploring quantumness in quantum reservoir computing | Phys. Rev. A, acessado em setembro 4, 2025, https://link.aps.org/doi/10.1103/PhysRevA.108.052427
23. Planetary nomenclature - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Planetary_nomenclature
24. (PDF) Design of an Au–Pt–Ti wire-grid polarizer based on midinfrared pixelated micropolarizer arrays - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/publication/369622072_Design_of_an_Au-Pt-Ti_wire-grid_polarizer_based_on_midinfrared_pixelated_micropolarizer_arrays
25. Neuromorphic Photonics Circuits: Contemporary Review - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/2079-4991/13/24/3139
26. Ground-Assisted Position Navigation and Timing ... - JPL Robotics, acessado em setembro 4, 2025, https://www-robotics.jpl.nasa.gov/media/documents/Ground-Assisted_Position_Navigation_and_Timing_PNT_for_Moon_and_Mars.pdf
27. Design and Simulation of Optical Waveguide Digital Adjustable Delay Lines Based on Optical Switches and Archimedean Spiral Structures - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/2304-6732/12/7/679
28. Teoria das cordas – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Teoria_das_cordas
29. Bio-Inspired Optics | Aizenberg Lab, acessado em setembro 4, 2025, https://aizenberglab.seas.harvard.edu/research-topics/bio-inspired-optics
30. Theories about Zelda mythology, and its connections/parallels to the mythos of Middle Earth. : r/truezelda - Reddit, acessado em setembro 4, 2025,

https://www.reddit.com/r/truezelda/comments/397jp0/theories_about_zelda_mythology_and_its/
31. Can someone give me a rundown of the Zelda pantheon/mythos? : r ..., acessado em setembro 4, 2025, https://www.reddit.com/r/truezelda/comments/620j7p/can_someone_give_me_a_rundown_of_the_zelda/
32. The official home for The Legend of Zelda - About, acessado em setembro 4, 2025, https://zelda.nintendo.com/about/
33. Triforce e seus mistérios - Tetraforce existe? - The Legend of Zelda - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=iLhj2X6T-tk
34. Triforce – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Triforce
35. The Legend of Zelda - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/The_Legend_of_Zelda
36. Triforce - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Triforce
37. The Legend of Zelda: A Link Between Worlds - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/The_Legend_of_Zelda:_A_Link_Between_Worlds
38. Perfil: Hylia (The Legend of Zelda) - Nintendo Blast, acessado em setembro 4, 2025, https://www.nintendoblast.com.br/2013/01/perfil-hylia-legend-of-zelda.html
39. Hylia - Triforce Wiki, a The Legend of Zelda wiki, acessado em setembro 4, 2025, https://triforcewiki.com/wiki/Hylia
40. [Todos] Qual a diferença entre a deusa Hylia, as 3 deusas douradas e a deusa do tempo? : r/truezelda - Reddit, acessado em setembro 4, 2025, https://www.reddit.com/r/truezelda/comments/1iyyuup/all_whats_the_difference_between_the_goddess/?tl=pt-br
41. So how many different realms are there in the Legend of Zelda ..., acessado em setembro 4, 2025, https://www.reddit.com/r/truezelda/comments/1r1n4d/so_how_many_different_realms_are_there_in_the/
42. A Link Between Worlds - Theory: Lorule is Actually Hyrule (Spoilers) - Zelda Dungeon, acessado em setembro 4, 2025, https://www.zeldadungeon.net/forum/threads/theory-lorule-is-actually-hyrule-spoilers.46879/
43. So is Lorule the dark world from the original game? - The Legend of Zelda - GameFAQs, acessado em setembro 4, 2025, https://gamefaqs.gamespot.com/boards/711412-the-legend-of-zelda-a-link-between-worlds/67953569
44. zeldawiki.wiki, acessado em setembro 4, 2025, https://zeldawiki.wiki/wiki/Twilight_Realm#:~:text=The%20Twilight%20Realm%20is%20a,the%20home%20of%20the%20Twili.
45. The Legend Of Zelda's Twilight Realm, Explained - TheGamer, acessado em setembro 4, 2025,

https://www.thegamer.com/the-legend-of-zelda-twilight-realm-lore-explained/
46. Twilight Realm - Zelda Wiki, acessado em setembro 4, 2025, https://zeldawiki.wiki/wiki/Twilight_Realm
47. The Legend of Zelda: Ocarina of Time – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/The_Legend_of_Zelda:_Ocarina_of_Time
48. Como a viagem no tempo em Ocarina of Time foi explicada? : r/truezelda - Reddit, acessado em setembro 4, 2025, https://www.reddit.com/r/truezelda/comments/2f76ep/how_was_the_time_travel_in_ocarina_of_time/?tl=pt-br
49. Song of Storms: um paradoxo temporal em meio à linha do tempo maluca de Zelda, acessado em setembro 4, 2025, https://www.nintendoblast.com.br/2013/05/song-of-storms-um-paradoxo-temporal-em.html
50. How was the time travel in Ocarina of Time explained? : r/truezelda, acessado em setembro 4, 2025, https://www.reddit.com/r/truezelda/comments/2f76ep/how_was_the_time_travel_in_ocarina_of_time/
51. Zelda Theory: The Multiverse and the Timeline | Gnoggin - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=kZv26tbAJmA
52. A linha do tempo dos jogos da franquia The Legend of Zelda ..., acessado em setembro 4, 2025, https://tecnoblog.net/responde/a-linha-do-tempo-dos-jogos-da-franquia-the-legend-of-zelda/
53. The Complete LEGEND OF ZELDA Timeline Explained! - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=h6RfOrwej_c
54. A Confusão da Timeline de Zelda Explicada! #BRKsEDU - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/shorts/XDvhmDKqjYo
55. Infográfico – A linha do tempo da série The Legend of Zelda | Arkade, acessado em setembro 4, 2025, https://arkade.com.br/infografico-linha-tempo-serie-the-legend-of-zelda/
56. Are Termina and Lorule in the Same Dimension? | ZD Forums - Zelda Dungeon, acessado em setembro 4, 2025, https://www.zeldadungeon.net/forum/threads/are-termina-and-lorule-in-the-same-dimension.51019/
57. Is Lorule related to Termina? *Spoilers* - The Legend of Zelda: A Link Between Worlds, acessado em setembro 4, 2025, https://gamefaqs.gamespot.com/boards/711412-the-legend-of-zelda-a-link-between-worlds/68211531
58. THEORY: Termina and Lorule, are they the same place? | Zelda Amino, acessado em setembro 4, 2025, https://aminoapps.com/c/zelda/page/blog/theory-termina-and-lorule-are-they-the-same-place/6PVt_zuP8b88Lk3axe1V16Y4PzVpxgw
59. I just finished A Link between Worlds and I don't understand what Lorule is - Reddit, acessado em setembro 4, 2025,

https://www.reddit.com/r/truezelda/comments/cp55s2/i_just_finished_a_link_between_worlds_and_i_dont/
60. AnáliseMorte: The Legend of Zelda - A Link Between Worlds - Entenda LBW., acessado em setembro 4, 2025, https://www.divulgantemorte.com/2016/10/analisemorte-legend-of-zelda-link.html
61. Análise: Tradição e inovação enfim encontram uma perfeita harmonia em The Legend of Zelda: A Link Between Worlds (3DS) - Nintendo Blast, acessado em setembro 4, 2025, https://www.nintendoblast.com.br/2013/11/analise-tradicao-e-inovacao-enfim.html
62. Estudo aponta indício de que Marte já foi habitável - Terra, acessado em setembro 4, 2025, https://www.terra.com.br/byte/ciencia/estudo-aponta-indicio-de-que-marte-ja-foi-habitavel,352845bda76401cdb3ec7ff5c213b750dlyxjvb4.html
63. Marte habitável? Cientistas descobrem evidência mais antiga de água quente no planeta, acessado em setembro 4, 2025, https://ultimosegundo.ig.com.br/ciencia/2024-11-23/marte-habitavel-agua-quente.html
64. Era uma vez... um planeta habitável - Ciência HojeCiência Hoje, acessado em setembro 4, 2025, https://cienciahoje.org.br/era-uma-vez-um-planeta-habitavel/
65. Curiosity, rover da NASA, revela pista importante de que Marte já foi habitável - Canaltech, acessado em setembro 4, 2025, https://canaltech.com.br/espaco/curiosity-rover-da-nasa-revela-pista-importante-de-que-marte-ja-foi-habitavel/
66. INÉDITO! DESCOBRIRAM QUE MARTE FOI HABITÁVEL NO PASSADO - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=SnvCpMhOV3k
67. NOVAS PERSPECTIVAS SOBRE A HIPÓTESE DA PANSPERMIA, acessado em setembro 4, 2025, https://www.conhecer.org.br/enciclop/2010c/novas%20perspectivas.pdf
68. Teoria sugere que buracos de minhoca fariam viagens espaciais mais longas - Mega Curioso, acessado em setembro 4, 2025, https://www.megacurioso.com.br/ciencia/111255-teoria-sugere-que-buracos-de-minhoca-fariam-viagens-espaciais-mais-longas.htm
69. O que são buracos de minhoca, 'atalhos' no Universo - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=fGUwR_jizOE
70. Buraco de minhoca – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Buraco_de_minhoca
71. Botando um calço nas portas de buracos-de-minhoca - hypercubic, acessado em setembro 4, 2025, https://www.blogs.unicamp.br/hypercubic/2014/06/botando-um-calo-nas-portas-de-buracos-de-minhoca/
72. Buracos de minhoca permitem viagens espaciais - para átomos e para humanos, acessado em setembro 4, 2025,

https://www.inovacaotecnologica.com.br/noticias/noticia.php?artigo=buracos-minhoca-permitem-viagens-espaciais-atomos-humanos&id=010130210310
73. Interpretação de muitos mundos – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Interpreta%C3%A7%C3%A3o_de_muitos_mundos
74. Múltiplos universos da mecânica quântica: Uma viagem pela interpretação de muitos mundos - uLme, acessado em setembro 4, 2025, https://www.ulme.com.br/portal/conteudo/ciencia/multiplos-universos-da-mecanica-quantica-uma-viagem-pela-interpretacao-de-muitos-mundos
75. (PDF) A INTERPRETAÇÃO DOS MUITOS MUNDOS DA MECÂNICA QUÂNTICA NA FICÇÃO CIENTÍFICA - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/publication/377248944_A_INTERPRETACAO_DOS_MUITOS_MUNDOS_DA_MECANICA_QUANTICA_NA_FICCAO_CIENTIFICA
76. Teoria das cordas: o que é, para leigos e muito mais - Mundo Educação - UOL, acessado em setembro 4, 2025, https://mundoeducacao.uol.com.br/fisica/teoria-das-cordas.htm
77. Teoria das Cordas - AstroPT, acessado em setembro 4, 2025, https://www.astropt.org/2013/09/25/teoria-das-cordas/
78. [Discussion] Lets talk about Termina and the Twilight Realm. : r/zelda - Reddit, acessado em setembro 4, 2025, https://www.reddit.com/r/zelda/comments/19ufto/discussion_lets_talk_about_termina_and_the/
79. Na montanha dos deuses | Super - Superinteressante - Assine Abril, acessado em setembro 4, 2025, https://super.abril.com.br/historia/na-montanha-dos-deuses/
80. Olympus Mons: The largest volcano in the solar system - Space, acessado em setembro 4, 2025, https://www.space.com/20133-olympus-mons-giant-mountain-of-mars.html
81. O Monte Olimpo em Marte, duas vezes mais alto que o Monte Everest : r/space - Reddit, acessado em setembro 4, 2025, https://www.reddit.com/r/space/comments/98jt5p/mountain_olympus_mons_on_mars_its_twice_as_tall/?tl=pt-br
82. Olimpo - Wikipedia, la enciclopedia libre, acessado em setembro 4, 2025, https://es.wikipedia.org/wiki/Olimpo
83. Monte Olimpo - Guia Mundial de Peregrinação, acessado em setembro 4, 2025, https://pt.sacredsites.com/Europa/Gr%C3%A9cia/mt_olympus.html
84. Monte Olimpo - a morada dos deuses e a pérola natural da Grécia, acessado em setembro 4, 2025, https://greece.vivato.co.il/pt/Monte-Olimpo/
85. Mitos e Caminhos no Monte Olimpo - Contos Alfacinhas, acessado em setembro 4, 2025, https://contosalfacinhas.com/2023/11/15/mitos-e-caminhos-no-monte-olimpo/
86. Um dia pelo Monte Olimpo - andes sem parar, acessado em setembro 4, 2025, https://andessemparar.com/2024/04/26/um-dia-pelo-monte-olimpo/
87. Caminhada no Monte Olimpo – Trilhas, Abrigos & Aventura - Bookatrekking.com, acessado em setembro 4, 2025, https://bookatrekking.com/pt/blog/escalando-o-monte-olimpo/

88. O Monte Olimpo | PDF | Zeus | Mitologia grega - Scribd, acessado em setembro 4, 2025, https://pt.scribd.com/document/366043391/O-Monte-Olimpo
89. O Monte Olimpo | PDF | Grécia Antiga | Zeus - Scribd, acessado em setembro 4, 2025, https://pt.scribd.com/document/483705874/O-monte-olimpo-docx
90. Deuses do Olimpo - Religião Enem - Educa Mais Brasil, acessado em setembro 4, 2025, https://www.educamaisbrasil.com.br/enem/religiao/deuses-do-olimpo
91. Olimpo, monte dos deuses | Wiki | • DC Comics™ Amino, acessado em setembro 4, 2025, https://aminoapps.com/c/dcamino-comics/page/item/olimpo-monte-dos-deuses/PaY6_kpt3I6nGmwj7xXJxDYndxxv8xZkLk
92. Os 12 Deuses do Olimpo na mitologia grega - Toda Matéria, acessado em setembro 4, 2025, https://www.todamateria.com.br/deuses-do-olimpo/
93. Especial da Taverna: Mitologia Grego-Romana – A Morada dos Deuses, acessado em setembro 4, 2025, https://tavernadosguaranim.wordpress.com/2017/03/17/especial-da-taverna-mitologia-grego-romana-a-morada-dos-deuses/
94. Olympus Mons - Wikipedia, la enciclopedia libre, acessado em setembro 4, 2025, https://es.wikipedia.org/wiki/Olympus_Mons
95. Olympus Mons - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Olympus_Mons
96. Monte Olimpo (Marte) – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Monte_Olimpo_(Marte)
97. Olympus Mons, largest volcano in the Solar System | BBC Sky at Night Magazine, acessado em setembro 4, 2025, https://www.skyatnightmagazine.com/space-science/olympus-mons
98. post.geoxnet.com, acessado em setembro 4, 2025, https://post.geoxnet.com/glossary/monte-olimpo/#:~:text=Olympus%20Mons%20tiene%20en%20su,que%20se%20encuentra%20en%20Haw%C3%A1i.
99. Monte Olimpo: o maior vulcão do Sistema Solar - AstroPT, acessado em setembro 4, 2025, https://www.astropt.org/2023/05/08/monte-olimpo-o-maior-vulcao-do-sistema-solar/
100. Olympus Mons: Height, formation of Mars' mega volcano - Astronomy Magazine, acessado em setembro 4, 2025, https://www.astronomy.com/science/olympus-mons-mars-mega-volcano-height-formation/
101. Monte Olimpo: O maior vulcão do sistema solar - Gaia Ciência | Divulgação Científica, acessado em setembro 4, 2025, https://gaiaciencia.com.br/monte-olimpo-o-maior-vulcao-do-sistema-solar
102. The 'hotly' debated history of the largest volcano in the solar system, acessado em setembro 4, 2025, https://eeps.rice.edu/news/2023/hotly-debated-history-largest-volcano-solar-system
103. Flows on Olympus Mons | NASA Jet Propulsion Laboratory (JPL), acessado em setembro 4, 2025,

https://www.jpl.nasa.gov/images/pia04583-flows-on-olympus-mons/
104. ASTROGEOLOGIA DEL MONTE OLIMPO, EL VOLCAN MAS GRANDE DEL SISTEMA SOLAR Figura 1. Mapa de las regiones del planeta Marte (Red Est, acessado em setembro 4, 2025, https://www.geofisicaintegral.com/assets/uploads/pdfs/AstrogeologiaMonteOlimpo.pdf
105. 11. Olympus Mons (20°N,135°W), acessado em setembro 4, 2025, https://www.lpi.usra.edu/publications/slidesets/redplanet2/slide_11.html
106. Olympus mons | Research Starters - EBSCO, acessado em setembro 4, 2025, https://www.ebsco.com/research-starters/astronomy-and-astrophysics/olympus-mons
107. Olympus Mons | The Biggest Hotspot in the Solar System - Lowell Observatory, acessado em setembro 4, 2025, https://lowell.edu/olympus-mons-the-biggest-hotspot-in-the-solar-system/
108. Olympus Mons - Wikipedia, acessado em setembro 4, 2025, https://it.wikipedia.org/wiki/Olympus_Mons
109. Olympus Mons Largest Volcano in the Solar System - Online Star Register, acessado em setembro 4, 2025, https://osr.org/blog/kids/olympus-mons-largest-volcano-in-the-solar-system/
110. Schiaparelli, Giovanni Virginio (1835-1910) - The Worlds of David Darling, acessado em setembro 4, 2025, https://www.daviddarling.info/encyclopedia/S/Schiaparelli.html
111. 4. Nomenclatura astronômica. Após a fundação da União Astronômica Internacional (UAI), em 1920, decidiram os astrônomos q, acessado em setembro 4, 2025, https://rjtx.hopto.org/sphaera/nomenclatura.pdf
112. Olympus Mons | Description, Height, & Facts - Britannica, acessado em setembro 4, 2025, https://www.britannica.com/place/Olympus-Mons
113. Geologic maps of the Olympus Mons region of Mars - USGS Publications Warehouse, acessado em setembro 4, 2025, https://pubs.usgs.gov/publication/i2327
114. Nomenclatura planetária – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Nomenclatura_planet%C3%A1ria
115. Astronomia - Nomenclatura, acessado em setembro 4, 2025, https://rjtx.hopto.org/sphaera/nomenclatura_.html
116. União Astronómica Internacional – Wikipédia, a enciclopédia livre, acessado em setembro 4, 2025, https://pt.wikipedia.org/wiki/Uni%C3%A3o_Astron%C3%B3mica_Internacional
117. How Did Mars Get Its Name? - Exploring Mythology and History - CosmoBC AstroBlog, acessado em setembro 4, 2025, https://astroblog.cosmobc.com/how-did-mars-get-its-name/
118. artsandculture.google.com, acessado em setembro 4, 2025, https://artsandculture.google.com/story/a-martian-sensation-maps-delusion-and-the-mars-canals-adler-planetarium/mQXx3KSjVtBnJw?hl=en#:~:text=Lowell%20believed%20that%20a%20Martian,into%20newspapers%20and%20popular%20magazines.

119. Astronomical images. Technologies, practices and aesthetics (1870–1910) | Gerda Henkel Foundation, acessado em setembro 4, 2025, https://www.gerda-henkel-stiftung.de/en/astronomical-images-technologies-practices-and-aesthetics-18701910?page_id=126202
120. Percival Lowell - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Percival_Lowell
121. Lowell and Canals on Mars - Teach Astronomy, acessado em setembro 4, 2025, https://www.teachastronomy.com/textbook/Life-in-the-Universe/Lowell-and-Canals-on-Mars/
122. The War of the Worlds - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/The_War_of_the_Worlds
123. The War of the Worlds (novel) | Summary, Analysis, & Characters - Britannica, acessado em setembro 4, 2025, https://www.britannica.com/topic/The-War-of-the-Worlds-novel-by-Wells
124. Advances in NASA Imaging Changed How World Sees Mars, acessado em setembro 4, 2025, https://www.jpl.nasa.gov/news/advances-in-nasa-imaging-changed-how-world-sees-mars/
125. Alone in the Darkness: Mariner 4 to Mars, 50 Years Later - www.caltech.edu, acessado em setembro 4, 2025, https://www.caltech.edu/about/news/alone-darkness-mariner-4-mars-50-years-later-47324
126. 55 Years Ago: Mariner 4 First to Explore Mars - NASA, acessado em setembro 4, 2025, https://www.nasa.gov/history/55-years-ago-mariner-4-first-to-explore-mars/
127. Categories (Themes) for Naming Features on ... - Planetary Names, acessado em setembro 4, 2025, https://planetarynames.wr.usgs.gov/Page/Categories
128. Carl Sagan and the Exploration of Mars and Venus, acessado em setembro 4, 2025, https://ntrs.nasa.gov/citations/20020051148
129. Carl Sagan and the Quest for Life in the Universe | AMNH, acessado em setembro 4, 2025, https://www.amnh.org/learn-teach/curriculum-collections/cosmic-horizons-book/carl-sagan-quest-for-life
130. Why Mars? Essay by Carl Sagan | The Planetary Society, acessado em setembro 4, 2025, https://www.planetary.org/space-images/why-mars-essay-by-carl-sagan
131. Mars trilogy - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Mars_trilogy
132. Mars Trilogy Series - Penguin Random House, acessado em setembro 4, 2025, https://www.penguinrandomhouse.com/series/ZMS/mars-trilogy/
133. What are Elon Musk's Core Values?, acessado em setembro 4, 2025, https://values.institute/what-are-elon-musks-core-values/
134. Space Colonization | Pros, Cons, Debate, Arguments, Mars, Moon, Human Settlements, & Earth | Britannica, acessado em setembro 4, 2025,

https://www.britannica.com/procon/space-colonization-debate
135. Elon Musk puts his case for a multi-planet civilisation | Aeon Essays, acessado em setembro 4, 2025, https://aeon.co/essays/elon-musk-puts-his-case-for-a-multi-planet-civilisation
136. www.britannica.com, acessado em setembro 4, 2025, https://www.britannica.com/place/Mars-planet/Character-of-the-surface#:~:text=After%20Mariner%209%20the%20prime,meridian%20completely%20around%20the%20planet.
137. A Greenwich Observatory on Mars (ESP_071502_1750) - HiRISE, acessado em setembro 4, 2025, https://www.uahirise.org/ESP_071502_1750
138. Sciency Words: Airy-0 - Planet Pailly, acessado em setembro 4, 2025, https://planetpailly.com/2018/01/12/sciency-words-airy-0/
139. Optical Clock Atomic Structure and Theory | NIST, acessado em setembro 4, 2025, https://www.nist.gov/programs-projects/optical-clock-atomic-structure-and-theory
140. Neutral Atom Optical Clocks Group | NIST, acessado em setembro 4, 2025, https://www.nist.gov/pml/time-and-frequency-division/neutral-atom-optical-clocks
141. Optical Clocks: The Future of Time | NIST, acessado em setembro 4, 2025, https://www.nist.gov/atomic-clocks/how-atomic-clocks-work/optical-clocks-future-time
142. Yb Optical Lattice Clock | NIST, acessado em setembro 4, 2025, https://www.nist.gov/programs-projects/yb-optical-lattice-clock
143. Demonstration of a Mobile Optical Clock Ensemble at Sea - arXiv, acessado em setembro 4, 2025, https://arxiv.org/html/2406.03716v3
144. Spacetime Metrology, Clocks and Relativistic Geodesy | ISSI Team led by Sergei Kopeikin (USA) & Jürgen Müller (Germany) - International Space Science Institute, acessado em setembro 4, 2025, https://www.issibern.ch/teams/spacetimemetrology/
145. Hafele–Keating experiment - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Hafele%E2%80%93Keating_experiment
146. Gravitational redshift - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Gravitational_redshift
147. Relativity and Optical Clocks | NIST, acessado em setembro 4, 2025, https://www.nist.gov/publications/relativity-and-optical-clocks
148. General Relativity and Geodesy - arXiv, acessado em setembro 4, 2025, https://arxiv.org/html/2503.09272v1
149. Geodesy and metrology with a transportable optical clock - arXiv, acessado em setembro 4, 2025, https://arxiv.org/pdf/1705.04089
150. Gravitational redshift test using Rb clocks of eccentric GPS satellites - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC9898677/
151. How do optical atomic clocks contribute to geodesy and quantum superpositions?, acessado em setembro 4, 2025,

https://consensus.app/search/how-do-optical-atomic-clocks-contribute-to-geodesy/HM8qIC9OQAy25x7V2xtzWA/
152. Optical Atomic Clocks - geodesy.science - IAG website, acessado em setembro 4, 2025, https://geodesy.science/item/optical-atomic-clocks/
153. Atomic Clocks for Geodesy - arXiv, acessado em setembro 4, 2025, http://arxiv.org/pdf/1803.01585
154. The measurement scheme of chronometric levelling with connected clocks - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/figure/The-measurement-scheme-of-chronometric-levelling-with-connected-clocks_fig1_340857512
155. Geodetic Datums - Scripps Orbit and Permanent Array Center, acessado em setembro 4, 2025, http://sopac-csrc.ucsd.edu/index.php/gd/
156. Demonstration of Real-Time Precision Optical Time Synchronization in a True Three-Node Architecture 1footnote 11footnote 1The use of brand names and/or any mention or listing of specific commercial products or services herein is solely for educational purposes and does not imply endorsement by the Air Force Research Laboratory or our partners, nor discrimination against similar brands, - arXiv, acessado em setembro 4, 2025, https://arxiv.org/html/2312.16348v2
157. en.wikipedia.org, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Geodetic_datum#:~:text=A%20geodetic%20datum%20or%20geodetic,of%20either%20geodetic%20coordinates%20(and
158. Geodetic datum - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Geodetic_datum
159. What Are Reference Frames, Epochs and Coordinate Transformations In RTK? - Swift Navigation, acessado em setembro 4, 2025, https://www.swiftnav.com/resource/white-paper/what-are-reference-frames-epochs-and-coordinate-transformations-in-rtk
160. Planetary coordinate system - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Planetary_coordinate_system
161. Mars - Craters, Valleys, Plains | Britannica, acessado em setembro 4, 2025, https://www.britannica.com/place/Mars-planet/Character-of-the-surface
162. Airy-0 - Wiktionary, the free dictionary, acessado em setembro 4, 2025, https://en.wiktionary.org/wiki/Airy-0
163. Topography of the shield volcano, Olympus Mons on Mars, acessado em setembro 4, 2025, https://ntrs.nasa.gov/citations/19840053979
164. Tectonics of Mars - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Tectonics_of_Mars
165. en.wikipedia.org, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Tectonics_of_Mars#:~:text=In%20general%2C%20Mars%20lacks%20unambiguous,been%20detected%20by%20orbiting%20satellites.
166. Geotandem: The Tectonics (or lack thereof) of Mars - EGU Blogs, acessado em setembro 4, 2025, https://blogs.egu.eu/divisions/ts/2024/02/21/geotandem-the-tectonics-of-mars/
167. Mars' underground preserves its ancient past - Astronomy Magazine,

acessado em setembro 4, 2025, https://www.astronomy.com/science/mars-underground-preserves-its-ancient-past/

168. Kiloton Class ISRU Systems for LO2/LCH4 Propellant Production on the Mars Surface - NASA Technical Reports Server (NTRS), acessado em setembro 4, 2025, https://ntrs.nasa.gov/api/citations/20230017069/downloads/SciTech%20Mars%20kiloton%20ISRU%20Final.pdf
169. Abstract EGU23-5719 - Meeting Organizer, acessado em setembro 4, 2025, https://meetingorganizer.copernicus.org/EGU23/EGU23-5719.html
170. Atomic Clocks for Fundamental Physics: Time for Discovery - GPS.gov, acessado em setembro 4, 2025, https://www.gps.gov/cgsic/meetings/2020/safronova.pdf
171. MER Surface Navigation - JPL Robotics - NASA, acessado em setembro 4, 2025, https://www-robotics.jpl.nasa.gov/what-we-do/flight-projects/mars-exploration-rovers/surface-navigation/
172. Terrain Relative Navigation: From Mars to the Deep Sea - NOAA Ocean Exploration, acessado em setembro 4, 2025, https://oceanexplorer.noaa.gov/okeanos/explorations/ex2102/features/trn/trn.html
173. Mars GPS system - NASA Spaceflight Forum, acessado em setembro 4, 2025, https://forum.nasaspaceflight.com/index.php?topic=37334.0
174. Revolutionary navigation system for future Mars rovers - RAL Space, acessado em setembro 4, 2025, https://www.ralspace.stfc.ac.uk/Pages/Revolutionary-navigation-system-for-future-Mars-rovers.aspx
175. www.nasa.gov, acessado em setembro 4, 2025, https://www.nasa.gov/missions/mars-2020-perseverance/perseverance-rover/nasas-oxygen-generating-experiment-moxie-completes-mars-mission/#:~:text=Since%20Perseverance%20landed%20on%20Mars,dog%20breathes%20in%2010%20hours.
176. Summary report on the Mars Oxygen ISRU Experiment (MOXIE). MH ..., acessado em setembro 4, 2025, https://www.hou.usra.edu/meetings/tenthmars2024/pdf/3057.pdf
177. Mars Oxygen ISRU Experiment (MOXIE)—Preparing for human Mars exploration - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC9432831/
178. ISRU: AUTOMATED WATER EXTRACTION FROM MARS SURFACE SOILS FOR SAMPLE RETURN MISSIONS., acessado em setembro 4, 2025, https://www.lpi.usra.edu/meetings/marsconcepts2012/pdf/4191.pdf
179. Extraction of Water from Martian Regolith Simulant via Open Reactor Concept, acessado em setembro 4, 2025, https://ntrs.nasa.gov/api/citations/20180002377/downloads/20180002377.pdf
180. NASA 3D Printed Habitat Challenge - Hassell, acessado em setembro 4, 2025, https://www.hassellstudio.com/project/nasa-3d-printed-habitat-challenge
181. 3D printed Mars Habitat (3rd phase of NASA's Centennial Challenge) -

SpaceArchitect.org, acessado em setembro 4, 2025, https://spacearchitect.org/portfolio-item/3d-printed-mars-habitat-3rd-phase-of-nasas-centennial-challenge/
182. ESA - Advanced Closed Loop System - European Space Agency, acessado em setembro 4, 2025, https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Research/Advanced_Closed_Loop_System
183. Stoichiometric model of a fully closed bioregenerative life support system for autonomous long-duration space missions - Frontiers, acessado em setembro 4, 2025, https://www.frontiersin.org/journals/astronomy-and-space-sciences/articles/10.3389/fspas.2023.1198689/full
184. Towards Closed ECLSS for Space Habitats Part I Towards Closed Environmental Control and Life Support for Space Habitats Part I:, acessado em setembro 4, 2025, https://nss.org/wp-content/uploads/2018/01/NSS-JOURNAL-Towards-Closed-ECLSS-for-Space-Habitats-Part-I.pdf
185. Outer Space | United Nations, acessado em setembro 4, 2025, https://www.un.org/en/global-issues/outer-space
186. Outer Space Treaty - UNOOSA, acessado em setembro 4, 2025, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html
187. Outer Space Treaty - State.gov, acessado em setembro 4, 2025, https://2009-2017.state.gov/t/isn/5181.htm
188. Open Lunar Foundation, acessado em setembro 4, 2025, https://www.openlunar.org/
189. Lunar Policy Platform (LPP), acessado em setembro 4, 2025, https://www.openlunar.org/projects/lunar-policy-platform
190. Planetary Protection - Office of Safety and Mission Assurance - NASA, acessado em setembro 4, 2025, https://sma.nasa.gov/sma-disciplines/planetary-protection
191. Planetary protection - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Planetary_protection
192. Interplanetary contamination - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Interplanetary_contamination
193. Planetary protection: an international concern and responsibility - Frontiers, acessado em setembro 4, 2025, https://www.frontiersin.org/journals/astronomy-and-space-sciences/articles/10.3389/fspas.2023.1172546/full
194. The COSPAR Panel on Planetary Protection Role, Structure and Activities, acessado em setembro 4, 2025, https://cosparhq.cnes.fr/assets/uploads/2019/07/PPP_SRT-Article_Role-Structure_Aug-2019.pdf
195. Ethical Considerations for Planetary Protection in Space Exploration: A Workshop, acessado em setembro 4, 2025,

https://oar.princeton.edu/bitstream/88435/pr1tx3557r/1/Ethical_considerations_planetary_protection_space_exploration_workshop.pdf
196. Ethical Considerations for Planetary Protection in Space Exploration: A Workshop, acessado em setembro 5, 2025, https://www.researchgate.net/publication/232698538_Ethical_Considerations_for_Planetary_Protection_in_Space_Exploration_A_Workshop
197. Ethical Exploration and the Role of Planetary Protection in ..., acessado em setembro 4, 2025, https://arxiv.org/abs/2010.08344
198. The Ethics of Outer Space: A Consequentialist Perspective - Seth Baum, acessado em setembro 4, 2025, https://sethbaum.com/ac/2016_SpaceEthics.pdf
199. THE ETHICAL DIMENSIONS OF SPACE SETTLEMENT, acessado em setembro 4, 2025, http://www.users.globalnet.co.uk/~mfogg/EthicsDTP.pdf
200. Human Research Program - NASA, acessado em setembro 4, 2025, https://www.nasa.gov/hrp/
201. Application of virtual reality for crew mental health in extended-duration space missions, acessado em setembro 4, 2025, https://www.researchgate.net/publication/323529618_Application_of_virtual_reality_for_crew_mental_health_in_extended-duration_space_missions
202. Virtual reality can combat isolation on Earth and in space - EarthSky, acessado em setembro 4, 2025, https://earthsky.org/human-world/virtual-reality-can-combat-isolation-on-earth-and-in-space/
203. CRISPR & Ethics - Innovative Genomics Institute (IGI), acessado em setembro 4, 2025, https://innovativegenomics.org/crisprpedia/crispr-ethics/
204. A case for the moral duty of specific human germline genetic engineering | International Journal of Astrobiology | Cambridge Core, acessado em setembro 4, 2025, https://www.cambridge.org/core/journals/international-journal-of-astrobiology/article/case-for-the-moral-duty-of-specific-human-germline-genetic-engineering/E745BB3F4270A1F23EBD195DA260E255
205. NASA Institute for Advanced Concepts - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/NASA_Institute_for_Advanced_Concepts
206. NASA Awards 2025 Innovative Technology Concept Studies, acessado em setembro 4, 2025, https://www.nasa.gov/news-release/nasa-awards-2025-innovative-technology-concept-studies/
207. Designing a Photonic Integrated Circuit: Best Practices for Simulation & Layout, acessado em setembro 4, 2025, https://simutechgroup.com/designing-a-photonic-integrated-circuit-best-practices-for-simulation-layout/
208. US10663662B1 - High density optical waveguide using hybrid spiral pattern - Google Patents, acessado em setembro 4, 2025, https://patents.google.com/patent/US10663662B1/en
209. US20170315296A1 - Spiral optical waveguide termination - Google Patents, acessado em setembro 4, 2025,

https://patents.google.com/patent/US20170315296A1/en
210. Receiver Integration with Arrayed Waveguide Gratings toward Multi-Wavelength Data-Centric Communications and Computing - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/2076-3417/10/22/8205
211. Schematic of arrayed waveguide grating [1]. | Download Scientific Diagram - ResearchGate, acessado em setembro 4, 2025, https://www.researchgate.net/figure/Schematic-of-arrayed-waveguide-grating-1_fig1_250390631
212. Review and Analysis of Peak Tracking Techniques for Fiber Bragg Grating Sensors - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC5677180/
213. Fiber Bragg grating - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Fiber_Bragg_grating
214. Fiber Bragg Grating Interrogator - FBG Demodulator / Analyzer - Temperature, Strain, Stress, Displacement, Shape, Angle, Vibration, Fire Measuring Host - Concept and Principle Classification Network Video Parameters Price - DCYS - ofscn.net, acessado em setembro 4, 2025, https://www.ofscn.net/fbg-topics/analyzer-demodulator.html
215. Optical Interrogators - HBK, acessado em setembro 4, 2025, https://www.hbkworld.com/en/products/instruments/mechanical-structural-daq/optical-interrogators
216. Integrated Bragg gratings in spiral waveguides, acessado em setembro 4, 2025, https://opg.optica.org/oe/abstract.cfm?uri=oe-21-7-8953
217. Optical fiber sensor interrogator - Innovation, Science and Economic Development Canada, acessado em setembro 4, 2025, https://ised-isde.canada.ca/site/innovative-solutions-canada/en/optical-fiber-sensor-interrogator
218. Enhanced Gold Nanoparticle Optics for Nanophotonics, Photovoltaics and Green Photonics Insights - Meddocs Publishers, acessado em setembro 4, 2025, https://meddocsonline.org/nanoscience-and-nanotechnology-open-access/enhanced-gold-nanoparticle-optics-for-nanophotonics-photovoltaics-and-green-photonics-insights.pdf
219. Plasmonic metamaterial - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Plasmonic_metamaterial
220. Molecular Plasmonics with Metamaterials | Chemical Reviews - ACS Publications, acessado em setembro 4, 2025, https://pubs.acs.org/doi/10.1021/acs.chemrev.2c00333
221. A Plasmonic Infrared Multiple-Channel Filter Based on Gold Composite Nanocavities Metasurface - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC8308425/
222. A novel intelligent photonic design method enabled by metamaterials and k-nearest neighbor - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC11806503/
223. Ankh | Egyptian, Ancient, Cross - Britannica, acessado em setembro 4, 2025, https://www.britannica.com/topic/ankh

224. Ankh - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Ankh
225. The ultimate meaning of the Ancient Egyptian Ankh | College of Psychic Studies, acessado em setembro 4, 2025, https://www.collegeofpsychicstudies.co.uk/enlighten/the-ultimate-meaning-of-the-ancient-egyptian-ankh/
226. Ankh - Mythological Symbol - OMNIKA, acessado em setembro 4, 2025, https://omnika.org/symbols/ankh#!
227. The Everlasting Charm Of The Egyptian Ankh Symbol: Unveiling Its Power And Meaning, acessado em setembro 4, 2025, https://eztouregypt.com/egyptian-ankh-symbol/
228. Ankh Symbolism: Understanding the Ancient Egyptian Symbol - Healing Sounds, acessado em setembro 4, 2025, https://healing-sounds.com/blogs/spirituality/ankh-symbolism-egyptian-meaning
229. eztouregypt.com, acessado em setembro 4, 2025, https://eztouregypt.com/egyptian-ankh-symbol/#:~:text=Given%20its%20association%20with%20gods,potent%20emblem%20of%20life's%20perpetuity.
230. ANKH - Egyptian Symbol of Life - National Park Service, acessado em setembro 4, 2025, https://www.nps.gov/afbg/learn/historyculture/ankh.htm
231. Lorenz system - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Lorenz_system
232. Chip Ross: Lorenz Attractor - Bates College, acessado em setembro 4, 2025, http://abacus.bates.edu/~sross/lorenzmain.html
233. Rossler attractor - Scholarpedia, acessado em setembro 4, 2025, http://www.scholarpedia.org/article/Rossler_attractor
234. Programming the Lorenz Attractor - Algosome, acessado em setembro 4, 2025, https://www.algosome.com/articles/lorenz-attractor-programming-code.html
235. build a lorenz attractor -- electronic circuit -- chaos - seti.harvard.edu., acessado em setembro 4, 2025, http://seti.harvard.edu/unusual_stuff/misc/lorenz.htm
236. Neuromorphic Photonic Integrated Circuits - Queen's University, acessado em setembro 4, 2025, https://www.queensu.ca/physics/shastrilab/sites/shastwww/files/uploaded_files/publications/journals/43_Peng_JSTQE_integrated_neuro_2018.pdf
237. Bio-inspired photonics - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Bio-inspired_photonics
238. Bio-Inspired Photonic Structures: Prototypes, Fabrications and Devices | Request PDF, acessado em setembro 4, 2025, https://www.researchgate.net/publication/288905820_Bio-Inspired_Photonic_Structures_Prototypes_Fabrications_and_Devices
239. Biologically Inspired Artificial Eyes and Photonics - PMC - PubMed Central, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC7195211/
240. Chaotic time series prediction using a photonic reservoir computer with

output feedback, acessado em setembro 4, 2025, https://ojs.aaai.org/index.php/AAAI/article/view/11079/10938
241. Optical neuromorphic computing based on chaotic frequency combs in nonlinear microresonators - arXiv, acessado em setembro 4, 2025, https://arxiv.org/html/2501.17113v1
242. On-chip wave chaos for photonic extreme learning - arXiv, acessado em setembro 5, 2025, https://arxiv.org/html/2508.19878v1
243. Excellent predictive-performances of photonic reservoir computers for chaotic time-series using the fusion-prediction approach - Optica Publishing Group, acessado em setembro 4, 2025, https://opg.optica.org/oe/abstract.cfm?uri=oe-31-15-24453
244. Creating New Chaotic Signals with Reservoir Computers - arXiv, acessado em setembro 4, 2025, https://arxiv.org/pdf/2210.06250
245. Applications of gold nanoparticles in plasmonic and nanophotonic biosensing - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC11182655/
246. Absorptive Optical Filters and Polarizers through Multiplexing and Reshaping of Low-Polydispersity Plasmonic Nanorods | ACS Applied Materials & Interfaces, acessado em setembro 4, 2025, https://pubs.acs.org/doi/full/10.1021/acsami.5c06537
247. Nanophotonic resonator - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Nanophotonic_resonator
248. Cymatics - Wikipedia, acessado em setembro 4, 2025, https://en.wikipedia.org/wiki/Cymatics
249. What is Cymatics? Science of Visible Sound Explained - Journey of Curiosity, acessado em setembro 4, 2025, https://journeyofcuriosity.net/pages/what-is-cymatics-how-to-explained
250. These patterns made by resonant frequencies : r/blackmagicfuckery - Reddit, acessado em setembro 4, 2025, https://www.reddit.com/r/blackmagicfuckery/comments/uwj3k1/these_patterns_made_by_resonant_frequencies/
251. Cymatics.fm - The #1 Site For Serum Presets, Samplepacks & More!, acessado em setembro 4, 2025, https://cymatics.fm/
252. MEMORY - Analog Chorus Plugin – Cymatics.fm, acessado em setembro 4, 2025, https://cymatics.fm/products/memory-plugin
253. Cymatics Memory: Free Analog Chorus Plugin for Melodies | TikTok, acessado em setembro 4, 2025, https://www.tiktok.com/@djsmithbeatz/video/7310911724469685510
254. New Cymatics Memory Plugin Promises To Add Analog Feel To Your Melodies - YouTube, acessado em setembro 4, 2025, https://www.youtube.com/watch?v=CKENMQ4MvtY
255. AIP C onference Proceedings, acessado em setembro 4, 2025, https://www.ksada.org/wp-content/uploads/2025/06/kravets-v.i.-ignatyeva-n.v.-tymofieieva-n.v.-the-analysis-of-some-morphological-properties-of-the-architectural-environment-based-on-information-theoretic-approaches.pdf

256. Quantum Reservoir Computing: A New Approach To Enhance Machine Learning, acessado em setembro 4, 2025, https://quantumzeitgeist.com/quantum-reservoir-computing-a-new-approach-machine-learning/
257. Input-dependence in quantum reservoir computing - Physical Review Link Manager, acessado em setembro 4, 2025, https://link.aps.org/doi/10.1103/3775-4hfd
258. Exploring quantum mechanical advantage for reservoir computing - SPIE Digital Library, acessado em setembro 4, 2025, https://www.spiedigitallibrary.org/conference-proceedings-of-spie/0/PC129030/Exploring-quantum-mechanical-advantage-for-reservoir-computing/10.1117/12.3001523.full
259. Classical and Quantum Physical Reservoir Computing for Onboard Artificial Intelligence Systems: A Perspective - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/2673-8716/4/3/33
260. Exploring the Use of Photonics in Neuromorphic Computing - AZoOptics, acessado em setembro 4, 2025, https://www.azooptics.com/Article.aspx?ArticleID=2753
261. Machine Learning With Neuromorphic Photonics - Queen's University, acessado em setembro 5, 2025, https://www.queensu.ca/physics/shastrilab/sites/shastwww/files/uploaded_files/publications/journals/47_Ferreira_de_Lima-JLT-machine_learning_2019.pdf
262. Inverse design in quantum nanophotonics: combining local-density-of-states and deep learning - PMC - PubMed Central, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC11501149/
263. Deep neural networks for the prediction of the optical properties and the free-form inverse design of metamaterials | Phys. Rev. B, acessado em setembro 4, 2025, https://link.aps.org/doi/10.1103/PhysRevB.106.085408
264. Physics-Informed Machine Learning for Inverse Design of Optical Metamaterials - OSTI.GOV, acessado em setembro 4, 2025, https://www.osti.gov/biblio/2067627
265. Natural quantum reservoir computing for temporal information processing - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC8789868/
266. Instantaneous Property Prediction and Inverse Design of Plasmonic Nanostructures Using Machine Learning: Current Applications and Future Directions - PMC, acessado em setembro 4, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC8874423/
267. Comparison of Different Neural Network Architectures for Plasmonic Inverse Design | ACS Omega - ACS Publications, acessado em setembro 4, 2025, https://pubs.acs.org/doi/10.1021/acsomega.1c02165
268. www.azooptics.com, acessado em setembro 4, 2025, https://www.azooptics.com/Article.aspx?ArticleID=2753#:~:text=Photonic%20neuromorphic%20computing%20is%20playing,of%20high%2Dbandwidth%20optical%20signals.

269. Neuromorphic Silicon Photonics: Inference and Training, Classical and Quantum | Optica, acessado em setembro 4, 2025, https://www.optica.org/events/webinar/2023/02_february/neuromorphic_silicon_photonics_inference_and_train/
270. Unlocking the Future: Quantum Dots in Neuromorphic Computing - AZoQuantum, acessado em setembro 4, 2025, https://www.azoquantum.com/Article.aspx?ArticleID=582
271. Research Assistant in Neuromorphic Photonic Computing or Quantum Neuromorphic Photonics | Department of Physics, Engineering Physics & Astronomy - Queen's University, acessado em setembro 4, 2025, https://www.queensu.ca/physics/research-assistant-neuromorphic-photonic-computing-or-quantum-neuromorphic-photonics
272. Reservoir Computing overview, acessado em setembro 4, 2025, https://quantumcomputinginc.com/learn/lessons/reservoir-computing-overview
273. Photonics for Neuromorphic Computing: Fundamentals, Devices, and Opportunities, acessado em setembro 4, 2025, https://pubmed.ncbi.nlm.nih.gov/39011981/
274. Neuromorphic Photonic Devices and Applications - SPIE, acessado em setembro 4, 2025, https://spie.org/samples/PM374.pdf
275. High-Resolution Arrayed-Waveguide-Gratings in Astronomy: Design and Fabrication Challenges - MDPI, acessado em setembro 4, 2025, https://www.mdpi.com/2304-6732/4/2/30
276. Multi-task photonic reservoir computing: wavelength division multiplexing for parallel computing with a silicon microring resonator - Frontiers, acessado em setembro 4, 2025, https://www.frontiersin.org/journals/advanced-optical-technologies/articles/10.3389/aot.2024.1471239/full
277. Optical Characterization of Single Plasmonic Nanoparticles, acessado em setembro 4, 2025, https://pubs.rsc.org/en/content/getauthorversionpdf/c4cs00131a
278. Putting the Ethics into Planetary Protection | News - NASA Astrobiology, acessado em setembro 4, 2025, https://astrobiology.nasa.gov/news/putting-the-ethics-into-planetary-protection/
279. [Literature Review] On-chip wave chaos for photonic extreme learning - Moonlight, acessado em setembro 5, 2025, https://www.themoonlight.io/en/review/on-chip-wave-chaos-for-photonic-extreme-learning
280. Echo State Networks and Reservoir Computing • MINDS, acessado em setembro 5, 2025, https://www.ai.rug.nl/minds/research/esnresearch/
281. Where no planetary protection policy has gone before | International Journal of Astrobiology, acessado em setembro 5, 2025, https://www.cambridge.org/core/journals/international-journal-of-astrobiology/article/where-no-planetary-protection-policy-has-gone-before/F264AB24ABB7F4C7A5E86F48C2EA543D
282. TERRAFORMING MARS: A REVIEW OF RESEARCH., acessado em setembro 5,

2025, http://www.users.globalnet.co.uk/~mfogg/paper1.htm
283. Roadmap on neuromorphic photonics: neuromorphic photonics with vertical cavity surface emitting lasers (VCSELs) - University of Strathclyde, acessado em setembro 5, 2025, https://pureportal.strath.ac.uk/en/publications/roadmap-on-neuromorphic-photonics-neuromorphic-photonics-with-ver
284. Asteroid Resource Utilization: Ethical Concerns and Progress, acessado em setembro 5, 2025, https://www.researchgate.net/publication/345555004_Asteroid_Resource_Utilization_Ethical_Concerns_and_Progress
285. Optimising complexity and learning for photonic reservoir computing with gain-controlled multimode fibres - ResearchGate, acessado em setembro 5, 2025, https://www.researchgate.net/publication/394913815_Optimising_complexity_and_learning_for_photonic_reservoir_computing_with_gain-controlled_multimode_fibres
286. Impact of input mask signals on delay-based photonic reservoir computing with semiconductor lasers - ResearchGate, acessado em setembro 5, 2025, https://www.researchgate.net/publication/323409360_Impact_of_input_mask_signals_on_delay-based_photonic_reservoir_computing_with_semiconductor_lasers
287. Chaotic Time Series Prediction Using a Photonic Reservoir Computer with Output Feedback | Request PDF - ResearchGate, acessado em setembro 5, 2025, https://www.researchgate.net/publication/361522949_Chaotic_Time_Series_Prediction_Using_a_Photonic_Reservoir_Computer_with_Output_Feedback
288. [2012.10615] Random pattern and frequency generation using a photonic reservoir computer with output feedback - arXiv, acessado em setembro 5, 2025, https://arxiv.org/abs/2012.10615
289. Random pattern and frequency generation using a photonic reservoir computer with output feedback | DeepAI, acessado em setembro 5, 2025, https://cdnjs.deepai.org/publication/random-pattern-and-frequency-generation-using-a-photonic-reservoir-computer-with-output-feedback
290. US10755188B2 - Unified nonlinear modeling approach for machine learning and artificial intelligence (attractor assisted AI) - Google Patents, acessado em setembro 5, 2025, https://patents.google.com/patent/US10755188B2/en
291. Conditions for reservoir computing performance using semiconductor lasers with delayed optical feedback - Optica Publishing Group, acessado em setembro 5, 2025, https://opg.optica.org/abstract.cfm?uri=oe-25-3-2401
292. Optomechanical reservoir computing - PNAS, acessado em setembro 5, 2025, https://www.pnas.org/doi/10.1073/pnas.2424991122
293. Photonic Delay Systems as Machine Learning Implementations, acessado em setembro 5, 2025, http://fotonica.intec.ugent.be/download/pub_3706.pdf
294. Embedding theory of reservoir computing and reducing reservoir network using time delays, acessado em setembro 5, 2025, https://link.aps.org/doi/10.1103/PhysRevResearch.5.L022041
295. (PDF) Reservoir computing for static pattern recognition - ResearchGate,

acessado em setembro 5, 2025, https://www.researchgate.net/publication/221165716_Reservoir_computing_for_static_pattern_recognition
296. Mackey–Glass equations - Wikipedia, acessado em setembro 5, 2025, https://en.wikipedia.org/wiki/Mackey%E2%80%93Glass_equations
297. The Mackey–Glass model of respiratory dynamics: Review and new results - ResearchGate, acessado em setembro 5, 2025, https://www.researchgate.net/publication/257180174_The_Mackey-Glass_model_of_respiratory_dynamics_Review_and_new_results
298. Reservoir computing approaches to recurrent neural network training - Semantic Scholar, acessado em setembro 5, 2025, https://www.semanticscholar.org/paper/Reservoir-computing-approaches-to-recurrent-neural-Luko%C5%A1evi%C4%8Dius-Jaeger/69e5339c0c3928a354e848b9ccf5349f6397e60b
299. Applications of Metaheuristics in Reservoir Computing Techniques: A Review, acessado em setembro 5, 2025, https://www.researchgate.net/publication/328088306_Applications_of_Metaheuristics_in_Reservoir_Computing_Techniques_A_Review
300. Machine Learning with Neuromorphic Photonics - Princeton University, acessado em setembro 5, 2025, https://collaborate.princeton.edu/en/publications/machine-learning-with-neuromorphic-photonics
301. Interstellar space biology via Project Starlight - PMC, acessado em setembro 5, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC9881496/
302. (PDF) Terraforming Mars - ResearchGate, acessado em setembro 5, 2025, https://www.researchgate.net/publication/319177557_Terraforming_Mars
303. Terraforming - Wikipedia, acessado em setembro 5, 2025, https://en.wikipedia.org/wiki/Terraforming
304. [1811.02551] Topological defects in lattice models and affine Temperley-Lieb algebra, acessado em setembro 5, 2025, https://arxiv.org/abs/1811.02551
305. Ethical Considerations for Planetary Protection in Space Exploration: A Workshop - PMC, acessado em setembro 5, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC3698687/
306. Report COSPAR Workshop on Planetary Protection for Outer Planet Satellites and Small Solar System Bodies, acessado em setembro 5, 2025, https://www.cast.cn/UploadFiles/2017-08/369/15021584801867063.pdf