Phase-Encoded Information System for Unified Storage and Processing

[0001] Information storage and processing systems face inherent tradeoffs between volatility, energy efficiency, and computational universality. Conventional architectures—whether classical or quantum—require discrete state representations that impose artificial boundaries between memory and computation, necessitating error-prone state transfers and specialized hardware for each function.

[0002] The present invention transcends these limitations by exploiting the continuous phase-amplitude relationships of wave interference phenomena. By treating information as a persistent interference pattern rather than discrete states, the system achieves native unification of memory and processing capabilities within a single physical substrate. This approach leverages three fundamental physical principles: geometric redundancy for stability, nonlinear wave mixing for transformations, and material-engineered phase coherence for ambient operation.

[0003] In its preferred embodiment, the invention comprises a holographic medium that stores information as topologically protected interference patterns. A modulation interface dynamically reconfigures these patterns to perform computations through controlled phase evolution, eliminating the need for separate memory and processor components. The system operates without active error correction or cryogenic support, deriving fault tolerance from the intrinsic properties of interference dynamics rather than algorithmic redundancy.

[0004] Key innovations include: the use of phase continuity to represent probabilistic state continuums; material designs that preserve phase relationships beyond classical bit lifetimes; and reconfigurable interfaces that transition seamlessly between storage and computation modes. These advances are physically realized through nonlinear optical materials, superconducting phase gradients, or spin-wave distributions.

[0005] The specification discloses multiple embodiments, from nanophotonic crystals to macroscopic Bose-Einstein condensates, all sharing the common inventive concept of phase-encoded information processing. Manufacturing techniques include defect engineering for phase stability and lithographic patterning for interference control, enabling scalable production across quantum and classical computing platforms.

[CLAIMS]

1. A physical medium configured to maintain a continuous information state as a phase-amplitude interference pattern.

2. A physical medium configured to preserve a probabilistic state continuum through persistent phase relationships.

3. A physical medium configured to evolve a probabilistic state continuum through applied phase modulations.

4. A system comprising a read/write interface that encodes digital information as phase-amplitude distributions.

5. A system comprising a modulation interface that transforms input states through interference pattern evolution.

6. A method comprising encoding information as stable phase-amplitude interference patterns in a physical medium.

7. A method comprising processing information through controlled phase modulation of interference patterns.

8. A method comprising applying electromagnetic pulses to reconfigure a medium between stable storage and active processing states.

9. A non-transitory computer-readable medium storing instructions that convert digital bit streams into phase-modulation control signals.

10. A method comprising manufacturing a material substrate to sustain phase-amplitude relationships exceeding classical bit lifetimes.

11. The medium of claim 1, wherein the phase-amplitude interference pattern exhibits topological protection.

12. The medium of claim 2, wherein the persistent phase relationships are maintained without cryogenic cooling.

13. The medium of claim 3, wherein the applied phase modulations utilize optical nonlinearities.

14. The system of claim 4, wherein the read/write interface operates without cryogenic cooling.

15. The system of claim 4, wherein the phase-amplitude distributions exhibit geometric redundancy.

16. The system of claim 5, wherein the modulation interface uses non-ionizing electromagnetic radiation.

17. The system of claim 5, further comprising a classical processor that adaptively optimizes phase modulation.

18. The method of claim 6, wherein encoding occurs without state reconstruction measurements.

19. The method of claim 6, wherein the stable patterns are reconstructable from partial medium degradation.

20. The method of claim 7, wherein the controlled phase modulation implements unitary transformations.

21. The method of claim 7, wherein the transformations are resistant to local perturbations.

22. The method of claim 8, wherein the electromagnetic pulses are spectrally tuned to the medium’s absorption characteristics.

23. The method of claim 8, wherein reconfiguration occurs within a timescale shorter than decoherence.

24. The computer-readable medium of claim 9, wherein the instructions compensate for phase instability.

25. The computer-readable medium of claim 9, wherein the control signals are generated without error-correction algorithms.

26. The method of claim 10, wherein the material substrate exhibits non-local information storage properties.

27. The method of claim 10, wherein manufacturing includes introducing phase-stabilizing defects.

28. The medium of claim 1, wherein the phase-amplitude interference pattern is reconfigurable via field interactions.

29. The medium of claim 2, wherein the persistent phase relationships exhibit non-classical statistics.

30. The medium of claim 3, wherein the applied phase modulations are optically induced through nonlinear absorption.

[ABSTRACT]

A unified information system encodes and processes data through persistent phase-amplitude interference patterns in a physical medium, eliminating the distinction between memory and computation. The system represents information as continuous phase relationships rather than discrete states, enabling both stable storage through geometric redundancy and active processing through controlled interference modulation. Key innovations include ambient-temperature operation without cryogenic support, intrinsic fault tolerance through topologically protected patterns, and reconfigurable interfaces that transition seamlessly between storage and computation modes. The invention is physically realized through nonlinear optical materials, superconducting phase gradients, or spin-wave distributions, providing a universal platform for both classical and quantum information processing.