The InterferoShell: A Spherical Field-Based Architecture for Matrix Logic Computation via Electromagnetic Interference

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Abstract

This paper introduces the InterferoShell: a spherical, field-driven architecture for logic computation and matrix operations, based on electromagnetic interference rather than traditional lithography. The device uses tessellated emitters arranged on a spherical shell to project phase-controlled light fields into a reactive substrate. We describe how matrix multiplication is encoded as field interaction, and interpret the system using spherical harmonics and group representations of SO(3). Potential applications in reprogrammable logic, semantic computing, and low-power photonic inference are discussed.

1 Introduction

The semiconductor industry has traditionally relied on planar lithographic techniques. We propose a radical departure: a field-native architecture where computation is performed by the spatial and spectral interference of light projected from a tessellated spherical surface.

2 Emitter Geometry and System Architecture

The InterferoShell consists of a spherical array of electromagnetic emitters and/or receivers. Each node is capable of emitting light at a programmable amplitude, frequency, phase, and polarization. The system is designed such that interference patterns within the sphere correspond to desired logic functions or numerical operations.

3 Matrix Multiplication as Interference

Matrix multiplication, particularly in the 2x2 case, can be realized by encoding matrix elements as amplitude-modulated beams intersecting at specific interference zones. The intensity at each zone encodes a dot product of matrix rows and columns. This is extendable to larger arrays using frequency multiplexing and spatial routing.

4 Spherical Harmonics and Functional Decomposition

Spherical harmonics $Y_\ell^m(\theta, \phi)$ form a complete orthonormal basis for functions on the sphere. Each emitter can approximate or synthesize a harmonic component. Matrix operations can be viewed as projections onto these harmonics, and thus interpreted spectrally.

5 Group-Theoretic Interpretation

The symmetry group SO(3) acts naturally on the space of spherical harmonics. Interference patterns under rotations correspond to group actions. This allows us to recast matrix multiplication as the application of a transformation group to angular field modes.

6 Physical Realization

Key physical components include:

- Phase-controlled nanoscale emitters (e.g., metasurface lasers)
- Reactive substrates sensitive to interference thresholds
- Beam alignment and feedback control systems

7 Applications

- Field-programmable gate arrays (FPGAs) without wires
- Optical signal processors
- Semantic computing with field-encoded logic

8 Novelty and Commercial Potential

The InterferoShell is the first proposed spherical, field-based logic engine. It leverages topological coherence, spectral synthesis, and interference control to replace traditional circuit design with dynamic field computation.

9 Future Work

Further development includes modeling full 3D matrix networks, quantum-augmented interference schemes, and experimental validation of substrate sensitivity.