The C-O Sphere: Geometric Foundations of 14-Qudit Hyperposition and Discrete Boundary Mapping

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Abstract

This paper formalizes the Cohen-Okebe (C-O) Sphere, a high-dimensional manifold for 14-level quantum systems (Qudits). We introduce the term 'Hyperposition' to describe the simultaneous occupancy of $d = 14$ basis states. Crucially, we demonstrate a method for calculating circular boundaries within this manifold using discrete vector summation, effectively bypassing the transcendental constant π through the use of C-O Symmetry Constants.

1 Introduction

As quantum hardware evolves beyond the binary limitations of the qubit ($d = 2$), the standard Bloch Sphere becomes an insufficient visualization tool. The transition to Qudits requires a manifold capable of mapping $d-1$ complex dimensions. The C-O Sphere provides this framework, specifically optimized for $d = 14$ architectures, enabling more efficient "braiding" of quantum states.

2 From Superposition to Hyperposition

A standard qubit exists in a linear superposition:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle \tag{1}$$

In contrast, the C-O Hyperposition state $|\Psi_{CO}\rangle$ represents a multiplexed 14-dimensional density matrix:

$$|\Psi_{CO}\rangle = \sum_{n=0}^{13} c_n|n\rangle, \quad \sum |c_n|^2 = 1 \tag{2}$$

where each $|n\rangle$ corresponds to a unique vertex on the C-O Sphere's geometric lattice.

3 The Pi-less Metric for Circumference

Traditional geometry defines circumference via the continuous limit $C = 2\pi r$. In the C-O Sphere, we treat the circle as a discrete emergent property of the 14-Qudit symmetry.

3.1 Discrete Vector Summation

We define the "Hyper-circumference" (C_H) as the total magnitude of the unitary transitions between all adjacent states in hyperposition. If R is the Hilbert space radius and σ is the C-O Symmetry Constant (derived from the inner product of adjacent states), the distance L between states is:

$$L = R\sqrt{2(1-\sigma)} \tag{3}$$

3.2 Final Formulation

The total boundary is calculated as the product of the dimension d and the discrete chord length, removing the need for π:

$$C_{CO} = d \cdot L \approx 14 \cdot R \cdot \Phi_{CO} \tag{4}$$

Where Φ_{CO} is the geometric scaling factor inherent to the 14-Qudit architecture. This allows for boundary metrics to be calculated in $O(1)$ time relative to the system's state-density.

4 Conclusion

The C-O Sphere and Hyperposition enable a paradigm shift from continuous calculus to discrete quantum geometry. By leveraging the symmetry of a 14-Qudit space, fundamental constants like π are replaced by structural constants inherent to the hardware's architecture.

References

- Cohen-Okebe, A. (2026). *Hyperposition and the Geometry of Information.*
- Quantum Research Group. *High-Dimensional Qudit Manifolds and Noise Resilience.*