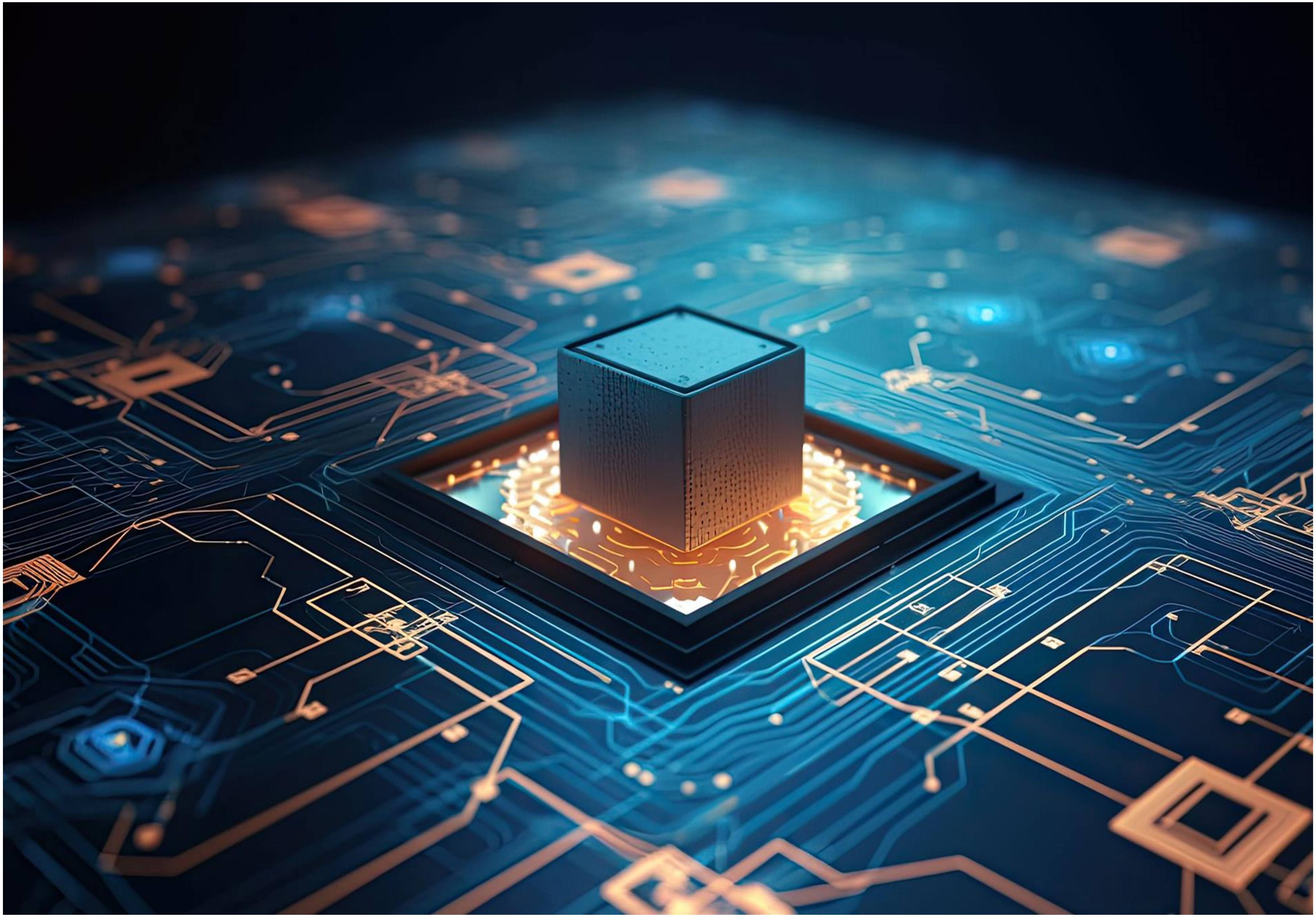
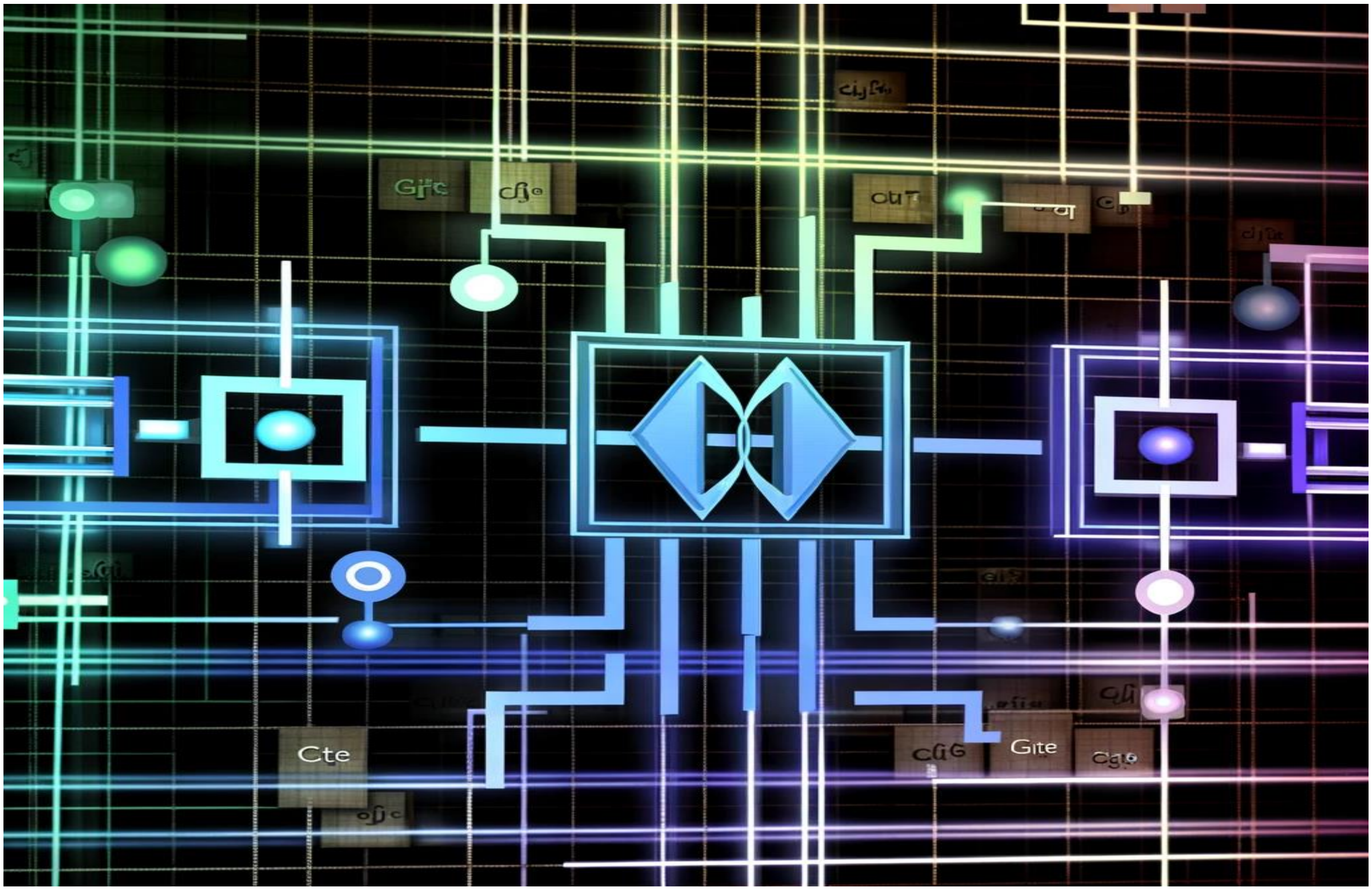


Quantum Logic Gates



Quantum Logic Gates

- Hadamard Gate (H)
- Pauli-X Gate (X)
- Pauli-Y Gate (Y)
- Phase Gate (S)
- T Gate
- Controlled-NOT Gate (CNOT)
- Swap Gate
- Toffoli Gate (CCNOT)
- Fredkin Gate (CSWAP)

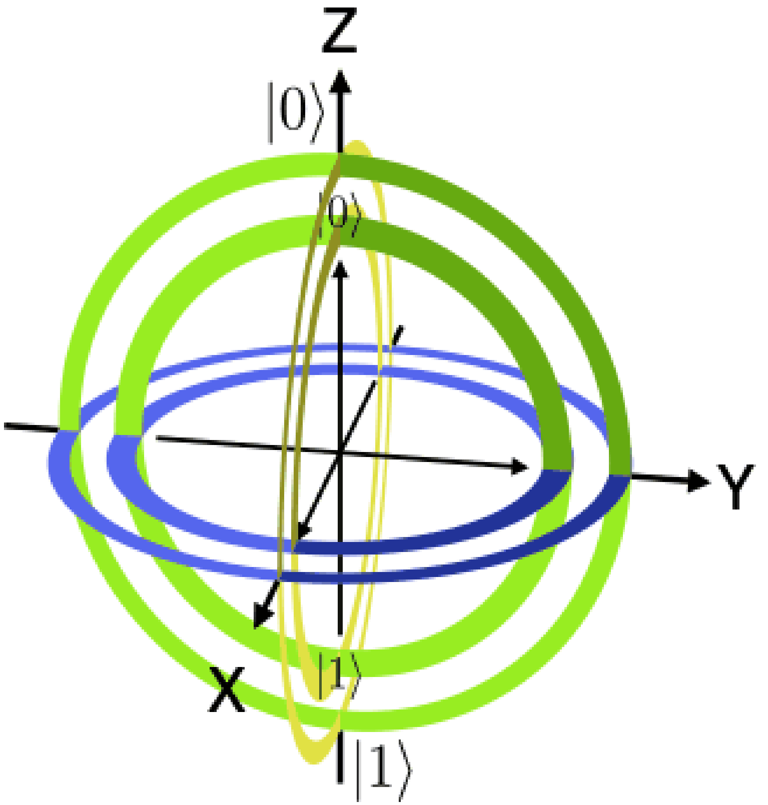
Single-Qubit Gates

1. Pauli-X Gate (X)
2. Pauli-Y Gate (Y)
3. Pauli-Z Gate (Z)
4. Hadamard Gate (H)
5. Phase Gate (S and T)

Two-Qubit Gates

1. Controlled-NOT Gate (CNOT)
2. Controlled-Z Gate (CZ)
3. SWAP Gate
4. Controlled-Hadamard Gate (CH)

Bloch sphere



Properties of Quantum Gates

- Reversibility
- Unitary Operations
- Linear Algebra

Feature	Single-Qubit Gates	Two-Qubit Gates
Definition	Operate on individual qubits	Operate on pairs of qubits
Primary Function	Change the state of a single qubit	Create entanglement and conditional operations
Matrix Representation	2x2 unitary matrices	4x4 unitary matrices
Complexity	Easier to implement and understand	More complex due to interactions between qubits
Reversibility	All operations are reversible	All operations are reversible
Role in Quantum Circuits	Prepare initial states, apply transformations	Create entanglement, essential for quantum algorithms
Use Case	Initializing and manipulating individual qubits	Implementing entanglement, executing quantum algorithms
Visualization	**Bloch sphere** for single-qubit states	More complex state space representation
Impact on Computation	Basis for building more complex operations	Enable quantum speedup and entangled states

Quantum algorithms

1. Shor's Algorithm
2. Grover's Algorithm
3. Quantum Fourier Transform (QFT)
4. Deutsch-Jozsa Algorithm
5. Simon's Algorithm
6. Quantum Phase Estimation (QPE)
7. Amplitude Amplification
8. HHL Algorithm
9. Variational Quantum Eigensolver (VQE)
10. Quantum Approximate Optimization Algorithm (QAOA)