GoldCoreX: A Room-Temperature, Photon-Driven Quantum Architecture

GoldCoreX proposes a scalable quantum computing system based on isolated gold atoms embedded in diamond crystal lattices. These atoms are implanted using ion beam technology and act as stable qubits at room temperature. Integrated photonic modulators direct tuned photons to drive state changes, enabling ultra-fast, high-fidelity quantum logic operations. Powered by standard voltages, GoldCoreX eliminates the need for lasers or cryogenics and offers a viable path toward trillion-scale qubit architectures for real-world applications.

This white paper outlines the theory, fabrication process, control architecture, and scientific feasibility of the GoldCoreX system, with procedures for immediate lab-level testing and validation.

Eric Ruecker - 2025

GoldCoreX: A Novel Room-Temperature Quantum Computing Architecture

Abstract

GoldCoreX proposes a photonic-controlled, room-temperature quantum computing platform utilizing gold atoms embedded in diamond crystal structures. This system integrates non-laser photon transistors and waveguide-driven optical control to manipulate isolated gold atom qubits with high precision. The architecture is designed to be scalable, cryogenics-free, and suitable for advanced quantum computing, sensing, and field interaction research.

Theoretical Foundation

Gold atoms exhibit quantum transitions within the visible light range (2-5 eV), which can be exploited for state manipulation using photons. By isolating individual gold atoms inside wide-bandgap insulators such as diamond, quantum coherence can be preserved at room temperature. Photon-based control replaces traditional RF or microwave methods, enabling femtosecond-scale qubit operations and a potential for trillions of qubits per chip.

GoldCoreX Qubit Design

Each qubit consists of a single Au-197 atom embedded between layers of diamond. The diamond structure minimizes phonon-induced decoherence and serves as an optical access window. Photons directed via integrated waveguides modulate quantum states using Rabi oscillation principles. Readout is achieved via Raman shift or photon re-emission detection.

Photon Modulator Integration

GoldCoreX integrates silicon photonic modulators to drive optical signals into the qubit layer. These modulators operate at room temperature using standard voltages (1-5V) and are fabricated with CMOS-compatible processes. They modify the timing, amplitude, or phase of photons sent to each gold atom. This configuration enables compact, laser-free quantum logic gates controlled by electrical input.

Photon Driver Architecture

Photon delivery is powered by electroluminescent emitters such as QLEDs or integrated nano-LEDs. These sources emit 520 nm photons, aligned to the gold atom's absorption profile. Each photon pulse is electrically modulated, enabling fast, targeted state transitions without the need for bulky laser systems. All emitters operate at low voltage and minimal current, making GoldCoreX fully portable and scalable.

Power System

GoldCoreX is powered by standard voltage sources, including portable batteries, lab power supplies, or solar-linked DC regulators. All control components, including the photonic modulators and emitters, operate at low voltage (typically 1-3V), with minimal thermal load. This power efficiency enables mobile use, edge computing integration, and off-grid quantum experimentation without cryogenics.

Chip Construction & Stack Design

The GoldCoreX chip integrates a grid of gold-diamond qubits onto a silicon photonic base layer. Photonic interposers and waveguides route photon signals to and from each site. Vertical stacking allows for exponential scale-up, with each layer featuring control, logic, and readout zones. Standard CMOS-compatible materials ensure integrability with existing semiconductor infrastructure.

Testable Procedures

1. Simulate atomic transitions of gold in diamond using DFT.

2. Fabricate small-scale diamond wafers with gold ion implantation.

3. Integrate with a waveguide-driven photon source.

4. Perform optical state readout and coherence time measurements.

5. Confirm qubit manipulation using Rabi oscillation validation.

6. Scale to multiple qubits and test entanglement pathways.

Peer Readiness Statement

GoldCoreX is grounded in known atomic physics, photonic control, and solid-state engineering. All components proposed-including gold-based qubit transitions, diamond insulation, room-temperature operation, and non-laser photonic drivers-are based on demonstrated or feasibly integrable technologies. There are no known theoretical barriers preventing its feasibility. Experimental validation is the next step.

Qubit Control Feasibility and Scaling Considerations

GoldCoreX incorporates scalable, precise control mechanisms for gold atom qubits using photonic waveguides and modulators. Each qubit can be selectively targeted through integrated optical routing, which uses sub-wavelength photonic confinement and phase tuning. Photon energy is tuned to match the transition frequency of gold atoms, enabling state flips via Rabi oscillation. Pulse timing and waveform shaping ensure minimal overdrive. Readout is achieved via optical techniques such as Raman spectroscopy or photon re-emission capture, with alignment to qubit waveguide channels. Crosstalk and scattering are minimized through isolation structures and synchronized timing. Control electronics are integrated using CMOS-compatible photonic interfaces, allowing GoldCoreX to orchestrate trillions of qubit interactions with high efficiency and fidelity.