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Research Article

The Dual (Energy) Equivalence Principle, Use Cubic Square and Fiber Curvature to Develop a Next-Generation Quantum Glass Fiber Chip

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Abstract
Constructing quantum chips involves a complex, multi-stage manufacturing process that combines concepts from quantum mechanics, materials science, semiconductor technology, and nanotechnology. Our pioneering research can form the core processing units of quantum computers, using qubits that leverage superposition and entanglement to perform computations beyond classical capabilities. Developing these chips demands precise management of qubit coherence, error correction, and integration with classical control circuits to ensure reliable and scalable quantum information processing. This research paper presents a new method for creating quantum computing chips aimed at industry adoption and advancement. Our innovative approach involves studying fabrication methods, material characteristics, and strategies to preserve quantum coherence (0, 1), with the goal of enhancing chip performance and scalability.
Keywords: Dual (Energy) Equivalence, Wave-Light Dual Properties, Particle Light, Dual Properties, Wave-Like and Particle-Like Form-State, Wave-Light Behaviors.

Introduction
Quantum chips are challenging to develop in the computer industry because they are linked to traditional thinking, which imposes many restrictions during manufacturing and design that can hinder their creation. To realize quantum chips, we must innovate new approaches to overcome these hurdles. The development of quantum computing hardware, especially chips, faces major difficulties mainly due to the entrenched paradigms rooted in classical computing methods. These conventional frameworks restrict fabrication processes, material choices, and design structures, blocking the development of scalable, reliable quantum microchips.

Advancing the field requires pioneering novel engineering techniques and technological solutions, such as redefining fabrication protocols, exploring new qubit materials, and designing architectures compatible with quantum mechanics. Such strategic improvements are crucial for transforming quantum chip concepts into practical, deployable technologies. Cross-disciplinary collaboration is essential to overcome these challenges, accelerating the transition of quantum chips from experimental prototypes to commercially viable components for quantum information systems. This paper proposes a new method for developing quantum computing chips, aiming to support and accelerate technological progress in the micro-conductor, quantum chips, and computer industry.

Discussion and Insight
Physics fundamentally underpin the principles governing electronic behavior at the nanoscale. As electrons in materials are confined to dimensions on the order of 1-10 nanometers, quantum mechanical effects become increasingly significant, prominently manifesting wave-particle duality. In bulk solids, electrons predominantly exhibit particle-like behavior; however, at nanometric scales comparable to or smaller than the de Broglie wavelength, their wave-like properties are markedly enhanced. The de Broglie wavelength, derived from experimental observations, indicates the critical length scale where quantum confinement effects lead to discrete energy states rather than continuous bands [1, 2]. This confinement results in modifications to the electronic density of states, necessitating quantum statistical descriptions of electron and photon behavior.

To explain, an electron can be envisioned as a quantum object exhibiting vibrational modes akin to mechanical waves. Consider a string fixed at both ends: when flicked gently, the resulting wave patterns are more perceptible for shorter lengths due to increased boundary effects and wave confinement. Similarly, in semiconductor nanostructures such as quantum dots, the physical dimensions directly influence the electronic band structure. Specifically, reducing the size of a quantum dot induces quantum confinement, enlarging the effective energy band gap-the energy differential between the valence band maximum and the conduction band minimum. Conversely, larger quantum dots exhibit a reduced band gap, approaching the quasi-bulk material behavior. While the energy band gap, a fundamental electronic property, quantifies the minimum energy required for an electron to transition from the valence band, where electrons are bound to atoms, to the conduction band, where electrons are free to contribute to electrical and photon conduction. This energy threshold is critically dependent on quantum confinement effects, which alter the electronic density of states and the effective mass of charge carriers. As the size diminishes, quantum confinement leads to an increase in the band gap, thereby affecting optical absorption, emission spectra, and charge transport properties. This size-dependent tuning of electronic and optical properties is central to the design of semiconductor nanostructures for applications in optoelectronics, photovoltaics, and quantum computing.

Suggestion

The magnitude of the energy barrier inversely correlates with its width, implying that narrower potential barriers require less energy for electrons to tunnel through. Consider a mechanical analogy: when a wave propagates along a string, the fundamental frequency of vibration is inversely proportional to the length of the string segment. Specifically, a plucked string of greater length produces a lower frequency, whereas a shorter segment yields a higher frequency. This inverse relationship between vibrational frequency and string length has a direct analogy in quantum mechanics, where the electron's wave-like properties mean that its energy eigenvalues are associated with the wave's frequency. Higher frequencies correspond to higher electron energies, analogous to higher photon energies in electromagnetic radiation. Quantum confinement effects are exemplified in quantum dots-nanoscale semiconductor particles whose electronic and optical properties depend critically on their physical dimensions. When electrons within quantum dots transition from the valence band to the conduction band upon absorbing energy, they emit photons as they relax to lower energy states.

The photon emission energy, which determines the emitted light's wavelength, is directly related to the size-dependent bandgap of the quantum dots. Smaller quantum dots exhibit larger band gaps, resulting in the emission of photons with higher energy, such as blue light. Conversely, larger quantum dots have smaller band gaps, emitting lower-energy photons like red light. By precisely controlling the size distribution of quantum dots, it is possible to tailor their emission spectra across the visible range. Quantum dots serve as wavelength converters: a blue backlight supplies excitation energy, which is partially absorbed by the quantum dots. The size-dependent emission enables the generation of highly saturated red and green colors, crucial for high-fidelity color rendering. The high energy associated with blue photons facilitates efficient excitation of the quantum dots, as they require only partial absorption of this high-energy light to produce the desired emission. Beyond optoelectronic display applications, quantum dots enhance photovoltaic device performance by broadening the spectral absorption range, thereby improving solar energy conversion efficiency under diverse illumination conditions. The tunable optical properties and high quantum yields make them promising candidates for next-generation photonic optoelectronic devices and nano-quantum chips (glass fiber).

Innovative Idea

In certain quantum dot (QD) semiconductor materials, multipolar excitations can occur, involving the formation of multiple multipole moments arising from the Coulombic interactions between electrons and holes with opposite charges. A similar model can be derived from the hydrogen atom, which serves as a fundamental quantum mechanical system. The primary objective in photovoltaic (PV) applications is to fabricate extensive arrays of QD-based devices to enhance overall photoelectric conversion efficiency. During incident illumination, photons with energy exceeding the material's electronic band gap induce the excitation of electrons from the valence band to the conduction band, resulting in electron-hole pair generation. When the photon energy (E_photon) surpasses the band gap energy (E_gap), the photoexcited electron acquires additional kinetic energy (E_kin), given by E_kin = E_photon - E_gap, enabling it to possess super-bandgap energy transformation to the computation photon state immediately after excitation.

This process indicates that photon absorption exerts sufficient electromagnetic force to liberate electrons from their localized states, allowing the surplus dynamism (get-up-and-go) to be transferred spatially within the device. In traditional bulk photovoltaic (BPV) materials, due to the larger dimensions and subsequent reduced quantum confinement, high-energy carriers frequently undergo rapid thermalization through phonon emission upon scattering with lattice vibrations, dissipating their excess kinetic energy as heat. This cost mechanism fundamentally limits photovoltaic efficiency. When, at the quantum dot scale, quantum confinement effects significantly alter carrier dynamics, enabling alternative pathways for energy transfer. Notably, when an electron retains excess kinetic energy post-excitation, it can undergo impact ionization-a process where a high-energy electron transfers part of its energy to a valence electron, ejecting it and generating an additional electron-hole pair. This phenomenon, termed multiple exciton generation (MEG) with carrier multiplication, introduces a promising mechanism for surpassing the Shockley-Queisser efficiency limit. In essence, quantum dots facilitate the creation of multiple charge carriers from a single high-energy photon, thereby amplifying photocurrent and overall device efficiency. Incorporating quantum dot nanostructures into photovoltaic architectures thus offers a pathway toward next-generation high-efficiency light-electron pair, match-up conversion "glass fiber" quantum chip devices.

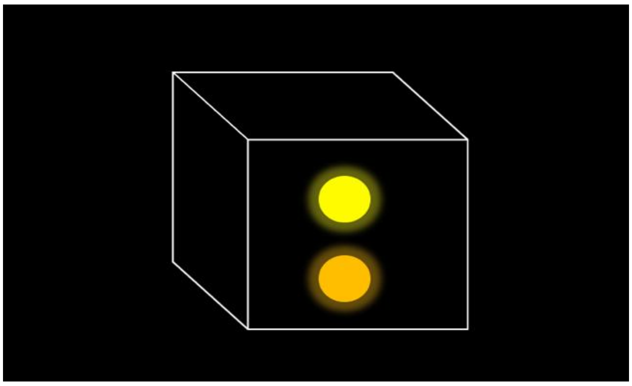

Figure 1. Dual super-position (light-electron pair, match-up conversion) (Author's view).

Our research posits that electromagnetic radiation, specifically visible light (photon), can be conceptualized as a quantized form of energy existing in dual manifestations: wave-like and particle-like states, consistent with wave-particle duality principles. We demonstrate that the energy associated with electromagnetic waves, along with the properties of quantum dot structures, can be engineered into curved geometries analogous to laser resonator cavities. This curvature engineering facilitates advanced functionalities such as high-speed, multi-channel data transmission from binary states 0 and 1. The implications of this framework are profound for the development of quantum information processing devices, notably quantum integrated circuits and optoelectronic systems. By exploiting the dual wave-particle nature of photons and tailoring device architectures-such as optical fibers integrated with quantum dot arrays-this methodology enables efficient generation of quantum superposition states (0, 1) (qubits). Furthermore, these photonic quantum states may contribute to the synthesis of novel superconducting materials, particularly room-temperature superconductors integrated into quantum chip architectures, by enhancing coherence and pairing mechanisms through engineered quantum confinement and electromagnetic interactions.

Innovative Approach

Fabrication Curvature Methodology

This comprehensive process encompasses all phases of manufacturing and assembly, including meticulous material selection, advanced machining techniques, precise forming processes, robust joining strategies, and high-quality finishing procedures. Its critical role is to ensure the fabrication of high-fidelity, reliable components across diverse disciplinary domains such as electronics, mechanical engineering, and materials science. Emphasizing rigorous adherence to industry standards, including IEEE and ISO specifications, the methodology prioritizes stringent quality assurance, safety protocols, and compliance with operational benchmarks, thereby underpinning the development of resilient and scalable technological solutions. The procedure initiates with the strategic selection of qubit architectures, with superconducting qubits-particularly those leveraging Josephson tunneling junctions-being predominantly favored due to their intrinsic nonlinear inductance and coherence properties. Alternative qubit modalities, such as trapped ion systems, semiconductor quantum dots, and spin-based qubits, are evaluated based on their operational distinctiveness, coherence times, and integration capabilities. Superconducting qubits are predominantly utilized in large-scale quantum processors owing to their scalability, compatibility with existing fabrication infrastructure, and facile integration into complex quantum circuit architectures. This rigorous fabrication paradigm ensures optimized device performance, coherence stability, and reproducibility essential for advancing quantum information processing technologies.

Before the fabrication process, comprehensive numerical simulations and sophisticated multi-physics modeling techniques are utilized to perform an in-depth analysis and predictive evaluation of qubit dynamics across a range of operational regimes. These high-fidelity simulations are critical for optimizing key parameters such as coherence times, which quantify the qubit's decoherence resilience; gate fidelities, essential for ensuring adherence to quantum logical operations with minimal error rates; crosstalk suppression strategies, aimed at mitigating parasitic couplings that can degrade qubit performance; and scalability metrics, which evaluate the potential for integrating larger qubit arrays while maintaining system coherence and control. Such rigorous early-stage modeling ensures that the qubit architecture meets the stringent performance criteria mandated for scalable, fault-tolerant quantum computing systems, by iteratively refining design parameters to achieve optimal quantum coherence, operational fidelity, and integration feasibility.

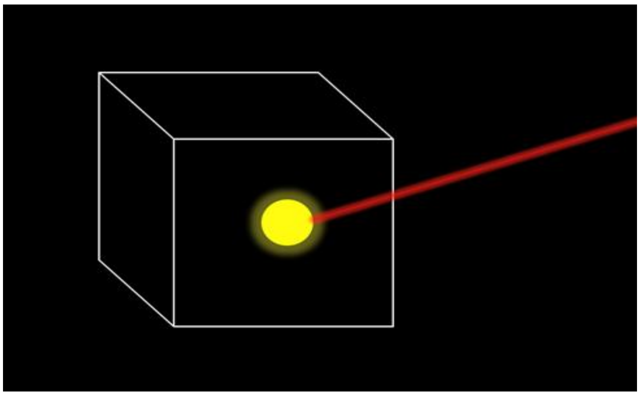

Figure 2. Proposed laser pho-light (photon) particle (Author's view).

Quantum computing chips are fabricated within highly specialized cleanroom environments that comply with rigorous contamination control standards to prevent particulate and chemical contamination, which could compromise device performance. The manufacturing process leverages advanced nanofabrication techniques, prominently electron-beam lithography (EBL), a high-resolution direct-write patterning method capable of achieving nanometer-scale precision on the wafer surface curvature. This process enables the precise definition of complex geometries required for superconducting circuit elements, including Josephson junctions-crucial nonlinear circuit components that beyond exploit the Josephson effect for qubit functionality-and microwave resonators used for qubit state readout and control at the Bruce angle. The construction of multilayered structures, vital for scalable qubit architectures, relies on atomic layer deposition (ALD), a layer-by-layer thin-film deposition technique that ensures conformal, uniform coatings with atomic-scale thickness control. These deposited layers are subsequently patterned and refined via reactive ion etching (RIE), a plasma-based anisotropic etching process that enables the sculpting of nanoscale features with high fidelity, thereby forming the critical nanostructures that underpin high-coherence quantum devices and circuits.

Innovative Idea Approach

Dual Equivalence of Light in Wave-Light Commonality Framework

Pho-light (photon) can be conceptualized as a form of quantum energy manifesting in dual states, specifically as wave phenomena when analyzed through the lens of electromagnetic energy distributions. Our research indicates that the intrinsic energy of photons, coupled with the quantum dot's physical properties, can be exploited in curvature-sensitive applications, enabling the simultaneous transmission of binary signals ('0' and '1') through quantum superposition and entanglement mechanisms. This paradigm holds significant potential for the development of advanced electronic systems, especially in the realms of quantum computing chips and photonic integrated (interaction) circuits, by facilitating high-fidelity quantum bit manipulation and low-loss optical transmission.

Wave-Pho-Light Commonality Existence

Dual equivalence, also referred to as WaveLight Commonality Existence (WLCE), constitutes a comprehensive theoretical construct within the domains of physics and electrical engineering, aimed at elucidating the collective dynamical behaviors and invariant features inherent in electromagnetic wave phenomena. This framework concentrates on the identification and characterization of fundamental commonalities among diverse wave modes, which is pivotal for the optimization and advancement of cutting-edge optical communication systems, integrated photonic circuits, and electromagnetic compatibility

(EMC) methodologies. At its core, dual equivalence investigates underlying symmetry operations, modal correlation matrices, and energy transfer mechanisms-including Poynting vector dynamics-that facilitate nonlinear wave interactions and coupling phenomena. The approach integrates principles from classical wave theory, quantum electrodynamics, and electromagnetic field theory, emphasizing invariance principles and conservation laws. By leveraging this framework, researchers can achieve a deeper understanding of wave propagation, superposition, interference, coherence, and decoherence effects in highly complex and multiscale systems, all while aligning with IEEE standards for technical rigor standard.

Next Generation of the Quantum-Class Fiber Chip in Dual Wave-Pho-Light Properties

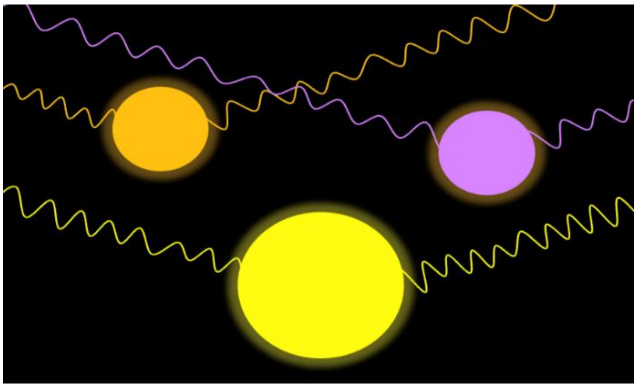

Figure 3. Wave-pho-light form of electromagnetic state pattern (Author's view).

Pho-light is an electromagnetic radiation characterized by its dual wave-particle nature, as described within the framework of quantum electrodynamics (QED). Its wave-like properties are quantitatively described by a continuous spectrum of frequencies and wavelengths, which fundamentally influence its interaction mechanisms with matter at the quantum level. We suggest that the intrinsic electromagnetic energy of pho-light, coupled with the quantum properties of nanostructures-such as quantum dot arrays and other zero-dimensional semiconductor nanostructures can be precisely engineered to facilitate curvature-dependent electronic functionalities. Such functionalities are particularly pertinent in the context of fiber optic systems subjected to dynamic curvature deformation.

These engineered nanostructures could enable the encoding and transmission of multiple binary information states (0s and 1s) through superposition states in curved glass fiber geometries, exploiting quantum coherence phenomena and entanglement mechanisms. This approach aims to leverage quantum superposition and nonlocal correlations to enhance data throughput, reduce power consumption, and improve robustness against decoherence in quantum information processing applications.

The implications of this research are substantial, potentially catalyzing advancements in high-speed, energy-efficient quantum integrated circuits (QICs) and neuromorphic computing architectures. Such developments could significantly contribute to the realization of scalable, fault-tolerant quantum computer architectures integrated within conventional electronic platforms. Ultimately, the proposed methodology may enable the fabrication of next-generation quantum microprocessors and photonic chips capable of executing complex quantum algorithms with heightened fidelity and operational speed, thereby bridging the gap between quantum information science and practical electronic implementations.

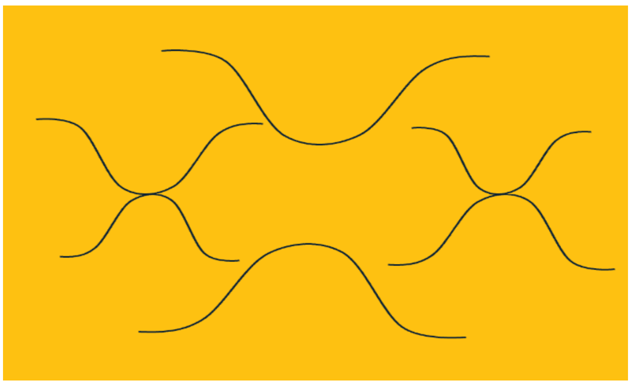

Figure 4. Next generation of the quantum-class fiber chip in dual wave-pho-light properties (Author's view).

In other words, these dual properties are essential for developing advanced quantum photonic chips, especially when working within the collimated regime. When electromagnetic radiation, specifically coherent light, refracts along the curved surface of optical fibers, it preserves its wave-like properties, effectively functioning as a coherent quantum wave. Engineering such wave propagation within a curved fiber structure allows for precise spatial confinement and control of photon states. This environment enables quantum emitters, such as quantum dots, to coexist at well-defined energy levels and spatial positions within the fiber matrix. Such controlled interactions are crucial for scalable quantum information processing and secure quantum communication. Therefore, leveraging these waveguiding properties and quantum dot integration techniques can greatly improve the manufacturing of quantum photonic integrated circuits, meeting the needs for high-fidelity quantum state control and resilient qubit architectures.

Next Generation of the Quantum-Glass Fiber Chip

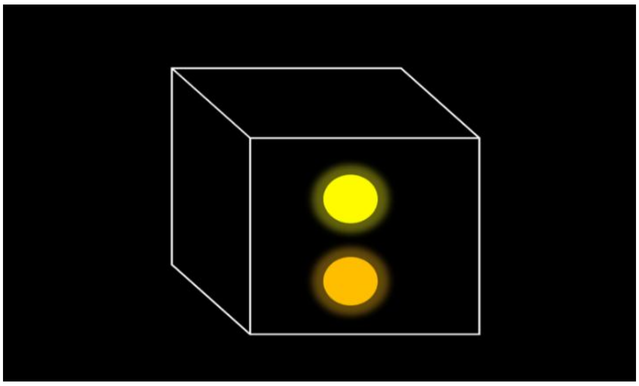

Figure 5. Cubic-chips-domain dual properties-specifically, the wave-like and particle-like behaviors in superposition (cubic 0, 1 domain) (Author's view).

In essence, these dual properties-wave-like and particle-like behaviors-can be strategically exploited in the development of advanced quantum photonic integrated circuits (QPICs) that operate in a collimated and coherent state. When propagating through a curved optical fiber, the curvature induces a spatial modulation of the electromagnetic field, leading to phenomena (interaction) such as wavefront bending and modal dispersion, as characterized by the principles of optical waveguide theory and electromagnetic field perturbation analysis. In this regime, the propagating pho-light exhibits characteristics analogous to a coherent optical mode confined within a specific eigenmode profile. By engineering the wave packet to coincide with the curvature-induced modal eigenstates, it is possible to enhance the preservation of quantum coherence. Embedded quantum dots within the fiber act as localized quantum emitters, maintaining their quantum superposition states at defined interaction regimes, which can be harnessed for applications in quantum information processing, entanglement distribution, and quantum sensing. These processes leverage the interplay between waveguide-induced dispersion, mode confinement, and quantum coherence preservation to optimize device performance in scalable quantum photonic architectures. So, our research paper suggested the wavelike light-electron properties can be utilized to produce the next generation of the quantum glass fiber chip.

Conclusion

This research paper explores an innovative method approach for creating and developing quantum computing chips. Our main aim is to support and speed up the integration of quantum technologies into mainstream hardware, pushing the computer industry forward. By leveraging the dual properties of wave-light, this approach includes an analysis of advanced fabrication techniques, detailed study of material properties, and strategies to maintain quantum coherence. These components are vital for improving the fidelity, scalability, and robustness of quantum processors, making them suitable for real-world use. This research study highlights the need to develop interaction state of coherence, control domain environmental influences, and implement error correction strategies to preserve quantum states, which are essential for reliable and high-performance quantum computing. Hope this research paper can contribute to the computer industry and the mankind.

Declarations

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