Layered Photon Confinement and the $\sqrt{2}$ Progression in T. Lockyer's Proton Model: A 3D Orthogonal Coupling Mechanism in the Primordial Plasma

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Abstract

The model of T. Lockyer describes the proton and neutron as positron-based structures with 18 concentric energy layers, each increasing in mass–energy by a factor of $\sqrt{2}$, reproducing their mass ratios to the electron with high precision [1]. We propose a physical mechanism where this $\sqrt{2}$ progression arises from the vectorial coupling of two orthogonal frequency-doubling cascades in the nonlinear primordial plasma. Two scenarios are explored: (1) direct decomposition of two high-energy photons with an energy ratio of $\sqrt{2}$ into layered frequencies, and (2) assembly of these frequencies from the plasma's broadband photon bath, stabilized by nonlinear refractive trapping and whispering-gallery resonances. Frequency-mixing processes (second-harmonic generation, sum-frequency generation, four-wave mixing) and plasma wave phase-matching enable the cascade formation. This speculative model suggests that protons and neutrons form directly from photon interactions; quarks do not exist naturally; they are transient excitations appearing during high-energy collisions in particle accelerators. The strong force is the result of the neutron sharing its electron with a proton. It thus offers an alternative to the Standard Model and a solution to the antimatter asymmetry problem.

Keywords: Proton structure; neutron structure; T. Lockyer model; $\sqrt{2}$ ratio; photon self-confinement; orthogonal mode coupling; primordial plasma; whispering-gallery modes; frequency cascades; strong force; electromagnetic interactions; matter-antimatter asymmetry.

1 Introduction

The structures of proton and neutron are conventionally described by Quantum Chromodynamics (QCD) as bound states of quarks and gluons. Alternative models, rooted in electromagnetic and geometric principles, propose different frameworks, such as those exploring electromagnetic structures for nucleons [12]. T. Lockyer's model [1] envisions the proton and neutron as positron-based structures containing 18 concentric energy layers, each with energy increasing by a factor of $\sqrt{2}$, yielding their mass ratios to the electron with high precision (seven and six significant figures for proton and neutron, respectively) [2]. This $\sqrt{2}$ progression, combined with the specific choice of 18 layers, suggests a structured energy assembly in the early Universe, possible during the primordial plasma epoch—a hot, dense state filled with photons, electrons, positrons, and ions conducive to nonlinear electromagnetic interactions [6].

This paper explores the physical origins of the $\sqrt{2}$ progression, proposing that it arises from the orthogonal coupling of two frequency-doubling cascades within the primordial plasma. We consider two pathways: (1) direct decomposition of two high-energy photons with an energy ratio of $\sqrt{2}$ into a series of lower frequencies, forming the proton and neutron directly, and (2) gradual assembly of these frequencies from the plasma's broadband photon bath, requiring temporary stabilization of the layered structure. We describe mechanisms such as nonlinear refractive trapping, whispering-gallery modes (WGMs), and frequency-mixing processes (second-harmonic generation, sum-frequency generation, four-wave mixing) that could enable this assembly, offering an alternative to the quark-based Standard Model, with the strong force mediated by electron sharing, and a resolution to the antimatter asymmetry problem.

2 Recap of Lockyer's Layered Model

Lockyer's model [1] represents the proton as a positron with rest energy $E_0 = m_e c^2$, enclosing 18 concentric energy layers. Each layer's energy increases as:

$$E_n = E_0(\sqrt{2})^n, \quad n = 0, \ldots, 18.$$

The proton radius is adjusted using the proton's magnetic moment and the fine-structure constant. Inner layers (n large) dominate the mass–energy, while outer layers are dilute and less significant in scattering. The choice of 18 layers aligns with thermodynamic constraints from the primordial plasma's energy scales, consistent with baryogenesis epochs [3]. This model's remarkable numerical accuracy motivates the search for a physical mechanism to explain the $\sqrt{2}$ progression and layer formation.

3 Photon Interaction Scenario

We propose that the proton layered structure originates from two high-energy photons colliding perpendicularly in the primordial plasma, with one photon's energy $\sqrt{2}$ times that of the other. This perpendicularity excites orthogonal electromagnetic modes, critical for the vectorial coupling that produces the $\sqrt{2}$ progression. Each photon decomposes into a series of frequencies, forming energy layers that sum to produce a proton, an electron, and residual energy, consistent with Lockyer's neutron model (a proton with doubled outer layers).

The energy series for the photons can be expressed as:

$$2^{n+1} = 2^n + 2^{n-1} + \cdots + 2^1 + 2^0 + 2^0,$$

$$\sqrt{2} \cdot 2^{m+1} = \sqrt{2} \cdot (2^m + 2^{m-1} + \cdots + 2^1 + 2^0 + 2^0).$$

For $n = 10$ and $m = 9$, the summed series yields a proton, an electron, and residual energy equivalent to $\sqrt{2} \cdot m_e$ (see Appendix A for details). This decomposition suggests that the proton's layered structure can form directly from the photon collision, provided the plasma's nonlinear properties stabilize the resulting modes.

4 From Photon Collision to Layered Structure

The perpendicular collision of two high-energy photons creates a localized region of intense electromagnetic energy in the primordial plasma. This region, characterized by high photon density, induces a nonlinear refractive index ($n_{\text{eff}} \propto \rho_E$), forming optical potential wells that trap radiation in spherical configurations, such as WGMs. The perpendicular photon incidence ensures orthogonal mode excitation, enabling two frequency cascades to develop via nonlinear processes like second-harmonic generation (SHG, $\omega + \omega \to 2\omega$), sum-frequency generation (SFG, $\omega_a + \omega_b \to \omega_c$), and four-wave mixing (FWM). These cascades, coupled vectorially due to orthogonality, produce the $\sqrt{2}$ energy progression observed in Lockyer's model. Alternatively, the required frequencies could be drawn from the plasma's broadband photon bath, requiring temporary stabilization of the layered structure during assembly.

5 Orthogonal Coupling Mechanism

The orthogonal coupling of the two photon-induced mode families modifies the energy sum to produce the $\sqrt{2}$ progression. When two perpendicular layers with equal energy (e.g., 1+1) couple vectorially, their combined energy scales as $\sqrt{2}$ (analogous to $\sqrt{1^2 + 1^2} = \sqrt{2}$), rather than 2. This coupling occurs within the nonlinear plasma, where frequency-mixing and plasma wave phase-matching enable efficient energy transfer. For example, the series for one photon:

$$\frac{2^{10}}{\sqrt{2}} = \frac{2^9 + 2^8 + \cdots + 2^0 + 2^0}{\sqrt{2}},$$

combined with the second photon's series, yields:

$$1 \text{ proton} + 1 \text{ electron} + \text{energy equivalent to } \frac{1}{\sqrt{2}} \cdot m_e.$$

Accounting for particle–antiparticle pair creation, the final outcome is:

$$1p + 1\bar{p} + 1e^- + 1e^+ + \text{energy equivalent to } \sqrt{2} \cdot m_e,$$

matching the energy required to convert a proton and electron into a neutron in Lockyer's model (see Appendix A).

6 Mechanisms in the Primordial Plasma

The primordial plasma's nonlinear and resonant properties enable the formation and stabilization of the layered structure:

A high photon density increases the effective refractive index, $n_{\text{eff}} = n_0 + \beta\rho_E(\mathbf{r})$, creating optical potential wells that trap radiation in spherical shells. WGMs concentrate energy near shell boundaries, with radial gradients in n_{eff} defining discrete layers [11]. Nonlinear processes—second-harmonic generation (SHG), sum-frequency generation (SFG), four-wave mixing (FWM), and parametric decay (e.g., Raman or Brillouin-like interactions)—generate frequency cascades [8]. Plasma waves act as a momentum reservoir, relaxing phase-matching constraints and enabling efficient energy transfer [10]. The spherical geometry and index inhomogeneities select discrete mode sets, with the 18-layer structure likely arising from thermodynamic constraints (available pump energy) and geometric mode selection.

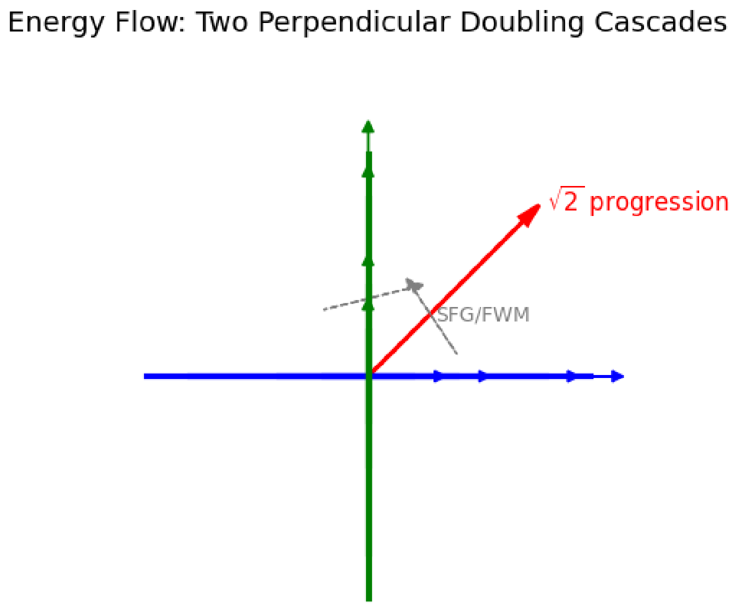

Figure 1: Energy flow during proton formation: two perpendicular photon trains feed a nonlinear, resonant plasma region, forming a layered structure with a $\sqrt{2}$ energy progression. Nonlinear processes (SHG, SFG, FWM) generate the orthogonal frequency cascades.

7 Self-Assembly During the Plasma Epoch

The proton's layered structure may form via:

1. **Pump:** Broadband high-energy photons in the plasma provide the energy source.
2. **Seeding:** Electrons and positrons, present or created simultaneously, act as the core shell.
3. **Geometric Filtering:** Spherical geometry selects stable WGMs and spheroidal modes.
4. **Nonlinear Cascades:** SHG, SFG, and FWM transfer energy into discrete modes, with orthogonal coupling producing the $\sqrt{2}$ progression.
5. **Stabilization:** Nonlinear trapping and plasma wave interactions balance pumping and losses, yielding 18 stable layers.

Alternatively, frequencies drawn from the plasma bath require temporary stabilization, possibly via resonant feedback, to assemble the layered structure progressively.

8 Mass Distribution and Collision Phenomenology

The $\sqrt{2}$ progression concentrates mass–energy in inner layers (n large). Outer layers, being dilute, are easily perturbed in collisions, while high-energy impacts excite internal modes, manifesting as transient quasi-particles. In this model, quarks observed in accelerators are interpreted as excitations of deep layers, not permanent constituents, offering an alternative to the QCD picture.

9 Thermal and Cosmological Implications

Energy storage in protons and neutrons reduces the plasma's thermal energy, lowering its temperature and slowing annihilation rates, favoring matter-dominated hydrogen formation [5, 6]. Positrons remain bound within nucleons as the core shell, matched by free or bound electrons, suggesting no antimatter asymmetry: the "missing" antimatter resides in nucleons.

10 Discussion

This model proposes that protons and neutrons form directly from orthogonal photon interactions with an energy ratio of $\sqrt{2}$, either via direct photon decomposition or plasma-driven assembly. The $\sqrt{2}$ progression emerges from vectorial coupling of orthogonal frequency cascades, stabilized by nonlinear plasma dynamics. Quarks, in this view, are transient excitations of deep layers, revealed only in high-energy collisions, challenging the Standard Model's permanent quark constituents. Future simulations of nonlinear photon interactions in plasmas could test the feasibility of the $\sqrt{2}$ cascade, while precision proton structure measurements might reveal layered resonances.

Implications for the Strong Force and Neutron Formation

The Lockyer model's ability to reproduce the neutron-to-electron mass ratio with high precision (six significant figures) relies on doubling the energy of the two outermost layers [1]. This doubling suggests that the energy required to form a proton, an electron, and residual energy ($\sqrt{2} \cdot m_e$) matches that needed to create a neutron, a coincidence that strengthens the model's physical basis. This aligns with the Standard Model's weak interaction, where a proton captures an electron to form a neutron, as observed in neutron stars where immense gravitational pressure forces electrons into protons [5]. However, the doubling of the outer layers raises questions about the stability of a positron and electron coexisting within the proton without annihilation.

To address this, we propose that the electron is not incorporated into the proton but remains in a low "orbital" state, analogous to a covalent bond in molecular systems. In this view, the electron shared between protons or between a proton and a neutron acts as the strong force, replacing the quark-gluon interactions of the Standard Model. A related study [4] calculates the electron's orbital distance using the residual energy ($\sqrt{2} \cdot m_e$) and finds it consistent with the proton-neutron binding energy in deuterium, supporting this hypothesis. This model thus offers a simpler electromagnetic framework for nuclear binding, interpreting quarks as transient excitations observed in high-energy collisions rather than permanent constituents.

At the same time, the electron in a hydrogen atom does not collapse onto the proton to form a neutron: the neutron's mass is 0.782 MeV greater than that of a proton plus an electron, requiring an energy significantly higher than the 13.6 eV binding energy of the hydrogen atom [5]. Conversely, free neutrons undergo spontaneous beta decay into a proton, an electron, and a neutrino, while confinement in nuclei stabilizes them. In unstable nuclei, when sufficient energy is available, neutrons can decay by beta decay, contributing to radioactive processes.

Our model is based on electromagnetic interactions and energy shell structures and challenges the complexity of the Standard Model, developed to fit experimental collision data, which would not correspond to the natural state of protons and neutrons.

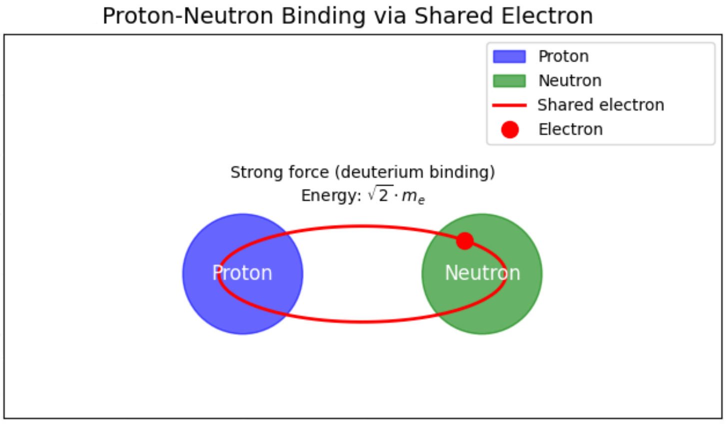

Figure 2: Proposed mechanism for the strong force: a proton and neutron share a low-orbit electron in an orbital-like configuration, analogous to covalent bonding. The electron's energy corresponds to $\sqrt{2} \cdot m_e$, consistent with the proton-neutron binding energy in deuterium.

11 Conclusion

We propose a physical mechanism for Lockyer's $\sqrt{2}$ layered proton model, rooted in orthogonal photon interactions in the primordial plasma. Nonlinear frequency-mixing, whispering-gallery resonances, and plasma wave phase-matching enable the formation of 18 energy layers. The model offers an alternative to QCD, interpreting quarks as transient excitations of deep layers, and resolves the antimatter asymmetry by embedding positrons in nucleons. By proposing that the strong force arises from electron sharing in low-energy orbitals, analogous to covalent bonding, the model provides a simpler electromagnetic framework for nuclear binding, consistent with proton-neutron interactions in deuterium [4]. While speculative, this scenario suggests avenues for numerical modeling of nonlinear photon interactions and precision measurements of proton structure to detect layered resonances.

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A Detailed Derivation of Photon Energy Series

The Proton:
According to Lockyer's theory, the proton-to-electron mass ratio is calculated as:

$$m_p/m_e = (2^0 + 2^0 \cdot \sqrt{2} + 2^0 \cdot \sqrt{2} + 2^1 + 2^1 \cdot \sqrt{2} + 2^2 + 2^2 \cdot \sqrt{2} + \cdots + 2^8 + 2^8 \cdot \sqrt{2} + 2^9) \cdot k,$$

where k is a correction factor derived geometrically from the proton's magnetic moment, using only CODATA physical constants without ad hoc adjustments. The first part of the formula therefore represents the mass of the neutron without the correction derived from the complementary dynamic adjustment which results in the existence of a magnetic moment.

The sum of the following series:

$$2^{10} = 2^9 + 2^8 + \cdots + 2^1 + 2^0 + 2^0,$$
$$\sqrt{2} \cdot 2^9 = \sqrt{2} \cdot (2^8 + 2^7 + \cdots + 2^1 + 2^0 + 2^0), \quad (1)$$

gives:

$$2^0 + 2^0 \cdot \sqrt{2} + 2^0 + 2^0 \cdot \sqrt{2} + 2^1 + 2^1 \cdot \sqrt{2} + 2^2 + 2^2 \cdot \sqrt{2} + \cdots + 2^8 + 2^8 \cdot \sqrt{2} + 2^9.$$
$$= 2^0 + 2^0 \cdot \sqrt{2} + (2^0 + 2^0 \cdot \sqrt{2} + 2^1 + 2^1 \cdot \sqrt{2} + 2^2 + 2^2 \cdot \sqrt{2} + \cdots + 2^8 + 2^8 \cdot \sqrt{2} + 2^9).$$

Setting $2^0 = 1$ as the mass of an electron ou positron:

$$= (1 + \sqrt{2}) \cdot m_{electron} + m_{proton} \quad (2)$$

The Neutron:
In Lockyer's model, the neutron-to-electron mass ratio is also reproduced with high precision: six significant figures. To achieve this, the model doubles the energy of the two outermost layers. Consequently, the sum of energies required to create a proton, an electron, and residual energy matches exactly that needed to form a neutron.

$$(2) = m_{neutron}$$

This result adds to a series of remarkable coincidences, reinforcing the idea that these calculations reflect a physical reality.

Note: Orthogonal coupling ($1 + 1 \to \sqrt{2}$) allows matter creation with less energy. The two series (1) to be added become:

$$[2^{10} + \sqrt{2} \cdot 2^9]/\sqrt{2} = \sqrt{2} \cdot 2^9 + 2^9.$$

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