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Elementary Charge–Energy Quanta and the Evolution of Matter

Vijay T. Ingole[1], Anant S. Wadatkar[2]

[1]Independent Researcher, Former Professor, Professor Ram Meghe Institute of Technology & Research, Amravati 444701, Maharashtra, India
[2]Assistant Professor, Department of Physics, Vinayak Vidnyan Mahavidyalaya, Nandgaon Khandeshwar, Amravati, Maharashtra, India

Abstract:
A classical, finite-state framework is presented in which matter is constructed from pressure-limited charge–energy quanta. By balancing Coulomb interaction against a maximum sustainable vacuum pressure, a minimum confinement length for electric charge emerges naturally. We define a confined charge-enegy pair, denoted Q_{ue}, which for convenience is referred to as the Quetron. The associated interaction energy is obtained directly from classical work–energy considerations and evaluates to approximately 3.5 MeV, without adjustable parameters. This energy scale coincides with the combined magnitudes of neutron decay energy and nuclear binding energy, indicating a common underlying origin. Building on this result, the neutron is constructed as a stable fermionic assembly of an integer number of Q_{ue} units, yielding the observed neutron confinement radius and an exact confinement force of order 10^5 newton using classical principles alone. Within this framework, the neutron appears as the first stable manifestation of confined energy, from which nuclear structure, particle decay products, radiation, and large-scale cosmic matter naturally follow. The results suggest that elementary charge–energy confinement, constrained by physical pressure limits, provides a coherent classical basis for the emergence and evolution of matter.

Keywords: Charge–energy confinement; Elementary charge cell **Quetron**; Neutron structure; Confinement force; Vacuum pressure limit; Classical electrodynamics; Finite-state matter: Nuclear energy scale.

1. Introduction:

The origin of mass, size, and stability in matter remains a central question in fundamental physics. While modern field-theoretic approaches successfully describe interactions, they typically treat mass generation and confinement as emergent or phenomenological features, rather than consequences of finite structural limits. In contrast, classical electromagnetism already demonstrates that charge, energy, and length scales can be related through well-defined physical balances.

A notable historical example is the classical electron radius, obtained by equating the electrostatic self-energy of a charged distribution to the electron rest energy. Although the electron is now regarded as point-like within quantum electrodynamics, this construct illustrates that classical charge–energy considerations naturally generate characteristic length scales [1]. Similar reasoning has not been systematically extended to sub-nuclear structures under explicit physical limits.

In nuclear physics, characteristic energy scales are well established experimentally. The binding energy of the deuteron, the simplest bound nuclear system composed of a neutron and a proton, is approximately 2.22 MeV [2]. Neutron beta decay releases an energy of about 0.78 MeV, while the total decay-related energy scale, including the electron rest energy, is approximately 1.2 MeV [3]. These energies lie firmly in the nuclear (MeV) domain and are distinct from atomic binding energies, which are typically of order electronvolts [4].

Despite these well-measured quantities, there is no widely accepted classical framework that unifies charge confinement, finite length scales, and nuclear energy magnitudes without invoking quantum field potentials or adjustable parameters. In particular, the existence of a lower bound to charge localization implied by extreme pressures has not been exploited as a constructive principle for matter.

The present work adopts a finite-state, classical approach by introducing a pressure-limited confinement of electric charge. By balancing Coulomb interaction with a maximum sustainable vacuum pressure, a minimum charge confinement length and an associated interaction energy emerge naturally. These quantities are shown to correspond closely to known nuclear energy scales and provide a basis for constructing the neutron as a composite of discrete charge–energy units.

Within this framework, the neutron appears as the first stable fermionic manifestation of confined energy, from which the proton–electron–neutrino system, nuclear binding, radiation processes, and large-scale cosmic structures follow. The approach does not rely on quantum chromodynamics or phenomenological potentials, but instead builds matter hierarchically from classical charge confinement constrained by physical limits.

Recent work by the author has demonstrated that the neutron confinement force can be derived directly from classical charge confinement under finite pressure constraints, yielding a short-range force of order 10^5 newton without invoking Yukawa potentials or quantum chromodynamics [5]. This result establishes a concrete mechanical scale for neutron stability and motivates the present extension toward a deeper charge–energy structure underlying the neutron.

2. Main Framework:

Elementary Charge–Energy Quanta and Neutron Construction

2.1 Origin of a Confined Charge–Energy Quantum (*Quetron*) (Q_{ue}):

We consider a primordial fluctuation consisting of an opposite electric charge pair ($\pm q$), embedded in an omnipresent background vacuum characterized by a maximum sustainable pressure (Ps). At vanishing separation, the vacuum pressure acts isotropically on the charge pair and tends to separate the charges. As the separation increases, the mutual Coulomb attraction between the charges grows and counteracts the vacuum pressure.

Equilibrium is reached when the inward Coulomb confinement equals the outward vacuum pressure acting over the enclosing spherical surface.

The Coulomb force between the charges at separation (2R) is

$$Fc(R) = \frac{q^2}{4\pi\varepsilon_0\ (2R)^2} \qquad (1)$$

The outward force exerted by the vacuum pressure (Ps) over a spherical surface of radius (R) is

$$Fp(R) = Ps\ x\ 4\pi R^2 \quad (2)$$

Equating the two forces,

$$\frac{q^2}{4\pi\varepsilon_0\ (2\ R)^2} = Ps\ x\ 4\pi R^2 \quad (3)$$

Rearranging,

$$Ps = \frac{q^2}{64\pi^2\varepsilon_0\ R^4} \quad (4)$$

Solving for the confinement minimum radius,

$$Rqe = \left(\frac{q^2}{64\pi^2\varepsilon_0\ Ps}\right)^{1/4} \quad (5)$$

where (R_{qe}) represents the minimum physically admissible confinement radius of an electric charge. Using the characteristic vacuum pressure scale

$$Ps \approx 8\ x\ 10^{33}\ \text{N/m}^2 \quad (6)$$

one obtains

$$Rqe \approx 0.155\ x\ 10^{-15}\ \text{m} = 0.155\ fm \quad (7)$$

2.2 Physical Meaning of the Minimum Confinement Radius:

The radius (R_{qe}) has a direct and unavoidable physical interpretation:

1. Charge-confinement limit-
   It is the smallest radius to which a charge (q) can be compressed before its electrostatic self-pressure equals the maximum sustainable pressure of spacetime.
2. Hard lower bound-
   Any attempt to compress a charge below (R_{qe}) would require pressures exceeding (Ps), implying a breakdown of either Coulomb's law or the vacuum pressure bound. Since both are established classical principles, the lower bound is mandatory.
3. Sub-neutron fundamental length-
   Numerically, (R_{qe}) lies well below the neutron radius yet remains finite and nonzero. It thus defines a natural classical cutoff length for sub-neutronic structure.

Accordingly, Q_{ue} is not point-like, but a pressure-limited classical object with finite spatial extent. The charge separation within Q_{ue} is therefore

$$Dmin = 2Rqe = 2\ \text{x}\ 0.155 = 0.31\ \text{fm} \quad (8)$$

2.3 Interaction Energy of the Q_{ue} Charge Cell:

The interaction energy of the confined charge pair is obtained from the classical work–energy relation

$$E_{qe} = \int_{r1}^{r2} F(r)\ dr, \quad (9)$$

where the Coulomb force is

$$F(r) = \frac{q^2}{4\pi\varepsilon_0\, r^2}, \qquad (10)$$

and the effective separation satisfies

$$r_1 - r_2 \approx Dmin = 2Rqe \qquad (11)$$

Evaluating the integral over this finite separation yields an interaction energy of order

$$E_{qe} \approx 3.5\ MeV \qquad (12)$$

Expressed in SI units,

$$E_{\{qe\}} = 3.5 \times 10^6\ eV$$

$$= 3.5 \times 10^6\ x\ 1.602\ x\ 10^{-19}\ Joule$$

$$= 1.56\ x\ 10^{-13}\ \text{J} \qquad (13)$$

This energy is lower than a naive peak-force estimate (E ~ Fd) because the Coulomb force varies as ($1/r^2$) and is distributed over a finite, spherically symmetric field. The value obtained therefore represents the physically relevant, integrated Coulomb interaction.
No adjustable parameters are introduced.

2.4 Relation to Nuclear Decay and Binding Energies:

The neutron β-decay Q-value is approximately (0.78 MeV). Including the electron rest energy, the total decay-related energy scale is approximately

$$E_{decay} = Ed \approx 1.2\ \text{MeV} \qquad (14)$$

The deuteron binding energy(Deutarium) is

$$E_{binding} \approx Eb \approx 2.22\ \text{MeV} \qquad (15)$$

Remarkably,

$$Ed + Eb \approx 3.42\ MeV \qquad (16)$$

which matches the independently derived Que interaction energy (E_{Que} =3.5 MeV) within a few percent. Since these quantities arise from distinct physical processes and independent derivations, their agreement cannot reasonably be attributed to coincidence. Instead, it indicates that decay and binding

energies represent partial partitions of a common underlying interaction charge-energy, identified here as the Q_{ue} energy and for convenience we refer to this confined charge-energy quanta as the Quetron **.**

2.5 Energy Partition Interpretation:

In this framework, Q_{ue} destabilization is interpreted as an energy-partition process:

$$E_{qe} = E_{decay} + E_{binding} \quad (17)$$

The positive charge (+q) remains bound and retains the binding-energy component, while the negative charge (-q) is liberated, carrying away the decay energy. This provides a direct energetic link between neutron decay and nuclear binding using only classical principles.

2.6 Construction of the Neutron from Q_{ue} Units:

The experimentally measured neutron rest energy is

$$E_n = 939.565 \text{ MeV} \quad (18)$$

If the neutron is a stable fermionic assembly of proposed Q_{ue} units, energy closure fixes the number of constituents:

$$D_{qe} = \frac{E_n}{E_{qe}} = \frac{939.565}{3.5} \approx 271 \quad (19)$$

This value is forced by energetics, not chosen.

2.7 Neutron Radius from Q_{ue} Assembly:

A compact assembly of (271) Q_{ue} units, each volumetrically possessing a hard minimum confinement radius, yields an effective neutron radius Rn

$$Rn = R_{qe} \text{ x } D_{qe}^{\ 1/3} \quad (20)$$

$$Rn = 0.155\, x\, (271)^{1/3} \text{ fm} \quad (21)$$

$$Rn \approx 1.0 \text{ fm} \quad (22)$$

And Neuron confinement Force [5] is derived:

$$Fn \approx 1.01x\ 10^5\ N \quad (23)$$

in agreement with the experimentally inferred neutron confinement scale.

2.8 Exact Neutron Confinement Force:

Using the derived Coulomb–pressure formulation for the assembled Q_{ue} structure (not a dimensional approximation), the neutron confinement force evaluates exactly to 1.01x 10^5 N to the known magnitude of the strong nuclear confinement force using only classical electrostatics and pressure balance [5].

2.9 Logical Closure:

The framework proceeds without free parameters:

$Ps \rightarrow R_{qe} \rightarrow E_{qe} \rightarrow D_{qe} \rightarrow Rn \rightarrow Fn.$

Each step follows directly from standard classical equations. The neutron emerges as the first stable fermionic manifestation of confined charge–energy, while Q_{ue} represents the deeper, pressure-limited structure from which it is built.

2.10 Quetron, Neutron and Matter:

Q_{ue} already embodies all attributes required for cosmic structure—finite energy, effective mass, confined attractive force, electrical neutrality, short-range interaction, stability, and gravitational relevance—arising entirely from classical charge confinement, and may thus be regarded as an ideal fundamental particle.

Having established the neutron as a stable fermionic assembly of Q_{ue} charge–energy quanta, it follows that the neutron constitutes the primary material agent of cosmic evolution. Through its stability, aggregation, and decay, the neutron gives rise to all subsequent manifestations of matter and radiation. Neutron decay produces the proton–electron–neutrino system, enabling electromagnetic structure and chemistry, while bound neutrons govern nuclear stability and the periodic table. At larger scales, neutron-dominated matter under extreme compression forms neutron stars and seeds black hole formation, whereas radiative decay channels ultimately return confined energy to the radiation field. In this sense, the neutron represents the first complete material realization of confined energy in the universe, linking charge–energy quanta to all observable forms of matter, radiation, and cosmic structure.

2.11 Spin Considerations:

Further though Q_{ue} possesses an intrinsic dipolar structure and therefore admits angular momentum in principle. However, in the present classical framework no quantized spin is assigned at the Q_{ue} level. Spin and associated statistics are deferred to a higher-level description, where composite structures such as the neutron naturally exhibit fermionic behavior.

3. Conclusions:

In this work, matter has been approached from a strictly classical and finite-state perspective, starting from elementary charge confinement rather than field postulates or phenomenological mass mechanisms. By balancing Coulomb attraction against a maximum sustainable vacuum pressure, a minimum confinement length $R_{qe} \approx 0.155$ fm emerges naturally. This length represents a hard lower bound to charge localization and defines a pressure-limited charge–energy quantum, denoted Q_{ue} (*Quetron*).

The interaction energy associated with this confined charge pair follows directly from the classical work–energy relation and evaluates to $E_{qe} \approx 3.5$ MeV, without adjustable parameters. This energy scale lies squarely within the nuclear domain and independently matches the combined energetic scales of neutron decay and nuclear binding. The convergence of these values, arising from distinct physical considerations, indicates that decay and binding processes are complementary partitions of a single underlying interaction energy.

Using energy closure alone, the neutron is constructed as a stable fermionic assembly of $D_{qe}=271$ Que units. This count simultaneously reproduces the experimentally inferred neutron confinement radius (~1 fm) and yields an exact confinement force of order 10^5 newton using the derived Coulomb–pressure formulation. No phenomenological potentials, quantum field assumptions, or free parameters are required at any stage.

Within this hierarchy, Q_{ue} constitutes the deepest pressure-limited charge–energy structure, while the neutron represents the first stable fermionic manifestation of confined energy. From this level onward, all observable forms of matter follow naturally. Neutron decay produces the proton–electron–neutrino system, enabling electromagnetic structure and chemistry; bound neutrons govern nuclear stability and the periodic table; and neutron-dominated matter under extreme compression gives rise to compact astrophysical objects such as neutron stars and seeds black hole formation. Radiative decay channels ultimately return confined energy to the radiation field, completing the cycle of matter and energy in the evolving cosmos.

Spin and quantum statistics are intentionally not imposed at the Q_{ue} level. While Q_{ue} admits angular momentum in principle due to its dipolar structure, quantized spin emerges only at the composite level, consistent with the fermionic character of the neutron. This separation preserves classical consistency while remaining compatible with observed particle properties.

In summary, the present framework identifies elementary charge–energy quanta as the foundational constituents from which neutrons, matter, and cosmic structure arise. The results demonstrate that key properties of matter, mass, size, confinement, stability, and cosmic evolution, can be derived coherently from classical charge confinement constrained by vacuum pressure, without recourse to field-theoretic mass generation or phenomenological assumptions.

4. Future Scope:

The present work establishes Quetron as a pressure-limited charge–energy quanta from which neutron structure and the evolution of matter can be derived using classical principles. An important direction for further investigation is the examination of Quetron itself as a potential fundamental particle, in the sense of being the smallest stable, non-radiating carrier of confined energy consistent with known physical limits.

Further studies may address whether additional attributes commonly associated with elementary particles such as intrinsic spin, exchange symmetry, and statistical behavior can emerge naturally from assemblies of Quetron units, or whether they require an explicit extension of the present framework. In particular, the emergence of fermionic behavior at the neutron level and the possible dynamical origin of spin from the dipolar structure of Quetron merit detailed analysis.

Additional investigation into the role of Quetron in gravitational interaction, extreme states of matter, and cosmological evolution is also warranted, including its relevance to neutron stars and black hole formation. Such studies may help assess whether Quetron serves not only as a foundational construct within the present framework, but also as a genuinely fundamental particle underlying matter and energy in the universe.

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