Journal of Modern Physics, 2025, 16(1), 140-151
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Complex Field Theory: A Unifying Framework for Dark Matter and Dark Energy with the Material Universe

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How to cite this paper: Abdeldayem, H. (2025) Complex Field Theory: A Unifying Framework for Dark Matter and Dark Energy with the Material Universe. *Journal of Modern Physics*, **16**, 140-151.
https://doi.org/10.4236/jmp.2025.161006

Received: November 2, 2024
Accepted: January 21, 2025
Published: January 24, 2025

Abstract

Complex Field Theory (CFT) proposes that dark matter (DM) and dark energy (DE) are pervasive, complex fields of charged complex masses of equally positive and negative complex charges, respectively. It proposes that each material object, including living creatures, is concomitant with a fraction of the charged complex masses of DM and DE in proportion to its mass. This perception provides new insights into the physics of nature and its constituents from subatomic to cosmic scales. This complex nature of DM and DE explains our inability to see DM or harvest DE for the last several decades. The positive complex DM is responsible for preserving the integrity of galaxies and all material systems. The negative complex charged DE induces a positive repelling force with the positively charged DM and contributes to the universe's expansion. Both fields are Lorentz invariants in all directions and entangle the whole universe. The paper uses CFT to investigate zero-point energy, particle-wave duality, relativistic mass increase, and entanglement phenomenon and unifies Coulomb's and Newton's laws. The paper also verifies the existence of tachyons and explains the spooky action of quantum mechanics at a distance. The paper encourages further research into how CFT might resolve several physical mysteries in physics.

Keywords

Dark Energy, Dark Matter, Complex Field Theory, Entanglement, Zero-Point Energy, Particle-Wave Duality, Gravity, Unification of Coulomb's and Newton's Laws, Tachyons, Spooky Action Effect

1. Introduction

DM was first named in 1933 [1], and DE was hypothesized via the observations of supernovas in 1604 and 1987 [2] [3]. DE and DM are estimated to form more than 95% of the universe's structure and are responsible for the formation of galaxies, the expansion of the universe, and the lensing effects [1]-[4]. According to CFT [4] [5], the inability to see DM or harvest DE throughout these past decades is due to their complex nature.

CFT [4] [5] has been formulated in terms of complex charged masses, which cannot be seen, sensed, or experimented with, while their forces and energies are real and play the roles of holding and preserving the integrities of the galaxies and expanding the universe [4] [5]. The theory provides novel ways of examining and explaining several physical phenomena. CFT introduces the concept that the positively charged complex mass of DM is concomitant with every positively charged and neutral material object in proportion to its mass, and the negatively complex charged mass of DE is associated with every negatively charged particle such that the universe is neutrally charged. At the same time, similar complex charges attract each other while opposite complex charges repel.

In the last century, physicists have built the standard model encompassing the three nongravitational forces and are currently working on a theoretical framework to construct a unified field theory for the four forces of nature. CFT introduces a peculiar force between the complex charges that behaves differently for different scales, which might unify all four forces into one force. It also introduces a complex field to every material object, which might pave the way for quantum gravity.

The complex field lines of each object entangle all particles and act as a nerve system of natural frequencies that characterize each element in the periodic table. The excited electron in an atom does not remain indefinitely at its excited level. The virtual nerve system forces it to return to its initial state and ejects a photon. The real forces induced by the complex charges and the entanglements among all particles will allow the scientific community to reflect on several physical mysteries, such as the nonradiative atomic electrons, the Casimir effect, nuclear force, Lamb shift, anomalous magnetic moment, and other unresolved physical phenomena.

Section 2 discusses the implications of the CFT. Section 3 demonstrates the existence of tachyons. Section 4 brings to life the old concept of Ether Medium and explains the reasoning for the inability to detect it. Section 5 provides a new insight into the zero-point energy and examines the cause for our inability to harvest DE. Section 6 discusses the particle-wave duality concept. Section 7 discusses the spooky actions of quantum mechanics at a distance via the entanglement phenomenon, using the path integral method in quantum field theory. Section 8 unifies Newton's law and Coulomb's law by deriving one from the other.

2. Theory and Discussion

Quantum field theory (QFT) developed Klein-Gordon's, Dirac's, and Proca's equations using harmonic exponentials for subatomic particles of spins 0, 1/2, and

1, respectively. Complex harmonic exponentials have been used for decades, even before the advent of quantum mechanics, to solve real-world problems and ease mathematical derivations without understanding their origins. Schrödinger quantized energy and momentum as complex operators. He was confused [6] about the complexity of the transition amplitude, which led him to introduce the absolute $\langle f | e^{-iHt/\hbar} | i \rangle$ value concept ($|\psi|^2 = \psi_f^* \psi_i$) to eliminate the complexity of the result.

The most meaningful information in quantum mechanics (QM) exists in the complex parts of the functions rather than the real ones, which is quite opposite to our intuition in the classical world. The crucial information about a system is obscured by applying Schrodinger's operators on the exponential form $e^{i(kx-\omega t)}$; while expressing the exponential as [$\cos(kx-\omega t) + i\sin(kx-\omega t)$], it becomes evident that valuable information, such as energy and momentum, are stored in the complex terms of the field. This means that QM, which successfully provides the physical properties of subatomic particles, is not a real physical theory but a complex one and always deals with the complex fields of these micro-objects. Failing to incorporate gravity or macro-objects in QM is attributed to looking at them as real physical objects rather than dealing with their complex fields introduced by the CFT [4]. These complex fields of DM and DE are associated with all material objects and might also be the source of the vitalities and characteristics of living creatures.

Quantum Field Theory (QFT) is the best tool for handling CFT. The particles in QFT are virtual and are represented by unbounded propagating space harmonics (sin and cosine), which are omnipresent in the infinite universe rather than the bounded space Hermit polynomial in Nonrelativistic Quantum Mechanics (NRQM). Also, the fields are operators rather than limited states within a volume because they are caused by complex charges of unbounded fields that interact among themselves.

The complex charge on a relativistic mass can be expressed as:

$$|iq(v)| = \delta m = \delta\left[m_o + \Delta m(v)\right] \tag{1}$$

where $\delta = \sqrt{G/k}$, as defined in reference [4]. G is the gravitational constant, and k is Coulomb's constant. "$\Delta m(v)$" is the relativistic mass increase, where:

$$m = \frac{m_o}{\sqrt{1-(v/c)^2}} = \gamma m_o \tag{2}$$

$$\frac{\Delta m}{m_o} = \gamma - 1 \tag{3}$$

$$|iq(v)| = \delta\gamma m_o \tag{4}$$

The conversion of the complex dark matter to real mass has been discussed in reference [5]. The rate of mass-increase (Δm) versus the relativistic speed (v/c) is expressed below in Equation (5) from the fitting curve in **Figure 1**:

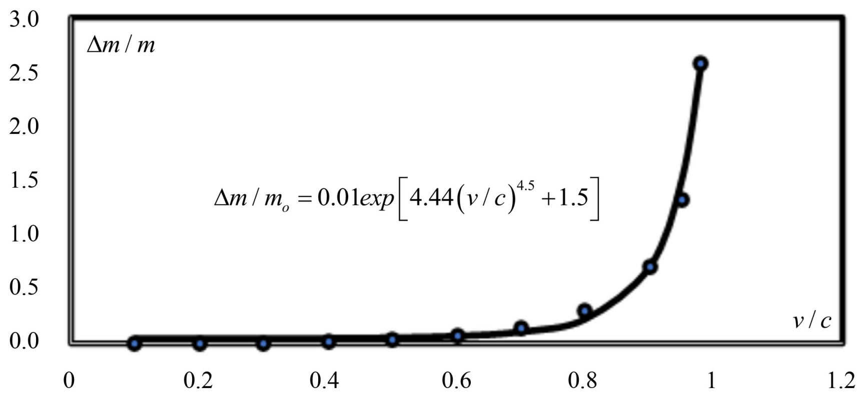

Figure 1. $\Delta m/m_0$ vs. v/c. $\Delta m/m_o$ picks up at a speed of $0.6c$ and increases exponentially afterward.

$$\Delta m/m_o = 0.01\exp\left[4.44(v/c)^{4.5} + 1.5\right] \tag{5}$$

HERA II results between years 2004-2006 with electron energy of 27.6 GeV, proton energy of 920 GeV, and a center of mass energy of 318 GeV, gave speeds to the electrons and the protons very close to the speed of light (~0.99999999c). This relativistic speed translates to an increase of more than 7000 times that of the rest masses and, consequently, the same increase with the complex charges each particle carries, noting that ($-iq_e$) of electrons and (iq_p) for protons induce a robust repulsive force preventing them from sticking together.

3. Faster than Light (Tachyons)

The concept of tachyons, or faster-than-light particles, was introduced decades back [7]-[10]. Feinberg [7] indicated that future experiments might prove the existence of particles acting as tachyons. The CFT demonstrates below in Equation (6) that only the fields of complex masses of DM and DE can travel as tachyons without violating the special theory of relativity.

The relativistic real mass energy for a complex dark matter (DM) is:

$$\bar{E} = \frac{(i\mu)c^2}{\sqrt{1-(v/c)^2}} = \gamma(i\mu)c^2 \tag{6}$$

For "$\bar{E}$" to be real, "γ" must be imaginary. This can take place only for $v > c$. This means that the complex-charged masses of DM and DE are field tachyons.

4. Ether Medium

CFT [4] proposes that the complex fields of DM and DE are all-pervasive, ubiquitous fields throughout the universe. They constitute the Ether medium, thought of in the 19th century, and scientists could not detect it because of its complex nature. Note that even the photon [4] carries a complex field proportionate to its momentum. The interesting point inferred from the above discussion is that when a photon is ejected from a far star, its complex field, which stores the photon's physical characteristics and travels faster than the photon itself, travels throughout the Ether complex space and paves the way for the photon to a predetermined endpoint.

5. Zero-Point Energy

Zero-point energy or the vacuum expectation value (VEV) is the lowest energy a system of particles might have at absolute zero temperature. The oscillating energy of the omnipresent complex fields of DE and DM causes all objects in the universe to oscillate according to their energy states and even at absolute zero. Experimental measurements for the zero-point energy fluctuations were demonstrated while measuring the Casimir effect [11]-[14] and Lamb shift [15] [16]. QFT concludes that Zero-point energy is a stormy and boiling sea of quantum fluctuations [17]:

$$\begin{aligned}\langle 0|H^{o}|0\rangle &= \langle 0|\sum_k \hbar\omega_k\left[a^{\dagger}(k)a(k)+1/2+b^{\dagger}(k)b(k)+1/2\right]|0\rangle \\ &= \langle 0|\sum_k \hbar\omega_k\left[1/2+1/2\right]|0\rangle \\ &= \sum_k \hbar\omega_k\end{aligned} \tag{7}$$

This is initially thought to be a creepy [18] result, and more disturbing is the inability to sense or harvest it despite its abundance. This is meanly due to the complex nature of its fields with their expectation value for any of the field states is zero:

$$\begin{aligned}\bar{\phi} &= \langle \phi_{k'}|\phi|\phi_{k'}\rangle = \langle \phi_{k'}|\sum_k \frac{1}{\sqrt{2V\omega_k}}a(k)\mathrm{e}^{-ikx}+\frac{1}{\sqrt{2V\omega_k}}b^{\dagger}(k)\mathrm{e}^{ikx}|\phi_{k'}\rangle \\ &= \langle \phi_{k'}|0\rangle+\langle \phi_{k'}|\tilde{\phi}_{ki}\phi_k\rangle \\ &= 0\end{aligned} \tag{8}$$

Same with the expectation values for the charge and current operators:

$$\langle \phi|\rho|\phi\rangle = \langle \phi|i\left(\frac{\partial\phi}{\partial t}\phi^{\dagger}-\frac{\partial\phi^{\dagger}}{\partial t}\phi\right)|\phi\rangle = 0 \tag{9}$$

$$\langle \phi|j|\phi\rangle = \langle \phi|i\left[(\nabla\phi)\phi^{\dagger}-(\nabla\phi^{\dagger})\phi\right]|\phi\rangle = 0 \tag{10}$$

Equations (9) and (10) show the impracticability of sensing or experimenting with complex fields. As proposed earlier [4], Equation (8) represents the DE and DM, which form 95% of the cosmos' energy. Note also that experiments can only measure energy differences between states.

6. Particle-Wave Duality

The famous double-slit Young's experiment (1801) demonstrated the wavy nature of light [19]. Einstein's photoelectric experiment [20] (1905) showed that light behaves as particles. Louis de Broglie [21] (1924) proposed that electrons revolve around the nuclei as standing waves and that electrons and all matter could behave as waves. Young's experiment [22]-[24] was repeated using beams of electrons, atoms, and molecules, which confirmed de Broglie's claim and produced similar interference patterns as light. These results raised the concept of particle-wave duality.

The wavy nature of particles remained an uneasy concept to grasp because the interference pattern means an interference among particles without consideration for their interactions, especially if they are charged, as in the case of electrons. The CFT provides a different interpretation of the concept of particle-wave duality. The complex field associated with each particle has its natural frequency according to the energy state of the particle. The complex field on each object has infinite branches of complex virtual oscillating field lines generated instantaneously from every ejected particle in all directions. These complex field lines can be represented by multivalued complex function "F" [25] as:

$$F = z^{\alpha} = \mathrm{e}^{\alpha \log z} \tag{11}$$

where "α" is irrational and $z = r\mathrm{e}^{i\theta}\left(-\pi < \theta < \pi\right)$

These complex field lines carry the complete information about the ejected particle. When these infinite oscillating complex field lines diffract through a double-slit experiment, they interfere and form an interference pattern on the second screen of the experiment. In this case, the interference occurs among the same coherent field lines of every particle and not among the particles themselves, as some might think.

7. Entanglement between Two Electrons

Entanglement or nonlocality phenomenon is at the heart of quantum physics. It is the effect of one particle upon another, even separated by a vast distance from each other. For a long time, the instantaneous response among entangled particles brings a fuzzy understanding and unsettled debates. Einstein, Podolsky, and Rosen (EPR) [26] (1935) argued that the electron and the positron are fermions, and they are of opposite spins at any moment. This implies nonlocal instantaneous interaction faster than the speed of light between the two systems. This violates the theory of relativity. To refute their argument, Bohr [27] argued without proof that "what happened to one object could indeed influence the behavior of another instantaneously by uncontrollable physical effects, though no physical force connecting them." The CFT confirmed Bohr's claim regarding the instantaneous response of the tachyon's presence, which is an uncontrollable complex field, but disagreed with his claim that no force is present because the complex charges induce a real force among each other.

Bell's theorem [28] illustrated the nonlocality in 1964. It was also demonstrated experimentally [29]-[32] and discussed by several [33]-[40].

The CFT settles the debates about entanglement using the path integral approach of QFT. Much of the derivations here are part of Zee's book [41]. To avoid repeating lengthy derivations, we start with the first Equation on page 24.

$$W\left(J\right) = -1/2\iint \mathrm{d}^4x\mathrm{d}^4y\, J\left(x\right)D\left(x-y\right)J\left(y\right) \tag{12}$$

$J(x)$ and $J(y)$ are localized Dirac's delta functions $[-iq\delta(x)]$ and $[-iq\delta(y)]$ for two electrons of the complex charges "$-iq$" each.

$$W(J) = -1/2 \int \frac{\mathrm{d}^4 k}{(2\pi)^4} J(k)^* \frac{1}{k^2 - \mu^2 + i\varepsilon} J(k) \tag{13}$$

where $J(k)$ is the Fourier transform for $J(x)$ and μ is reduced mass = $m_e/2$ for the two electrons at regions 1 and 2, $J = J_1(x) + J_2(y)$. Then, $W(J)$ contains four terms. Ignoring the self-interacting terms and considering only the two terms of $J_1^* J_2$ and $J_2^* J_1$, then:

$$W(J) = -\int \frac{\mathrm{d}^4 k}{(2\pi)^4} J_2(k)^* \frac{1}{k^2 - \mu^2 + i\varepsilon} J_1(k) \tag{14}$$

where:

$$\begin{aligned} J_1(k) &= \frac{-iq}{\sqrt{(2\pi)^4}} \int \mathrm{d}^0 x \mathrm{e}^{ik^o x^o} \int \mathrm{d}^3 x \mathrm{e}^{i\boldsymbol{k}\cdot\boldsymbol{x}} \\ J_2(k)^* &= \frac{iq}{\sqrt{(2\pi)^4}} \int \mathrm{d}^0 y \mathrm{e}^{-ik^o y^o} \int \mathrm{d}^3 y \mathrm{e}^{-i\boldsymbol{k}\cdot\boldsymbol{y}} \end{aligned} \tag{15}$$

$$W(J) = \frac{-q^2}{(2\pi)^4} \left(\int \mathrm{d}x^o \right) \int \mathrm{d}^3 k \frac{\mathrm{e}^{i\boldsymbol{k}\cdot(\boldsymbol{x}-\boldsymbol{y})}}{k^2 - \mu^2 + i\varepsilon} \tag{16}$$

The first integral is time and $k^2 = k_o^2 - \boldsymbol{k}^2$. Setting $k_o = \omega = 0$ for the average or non-varying part of the signal.

$$\begin{aligned} W(J) &= \frac{q^2}{(2\pi)^4} \left(\int \mathrm{d}x^o \right) \int \mathrm{d}^3 k \frac{\mathrm{e}^{i\boldsymbol{k}\cdot(\boldsymbol{x}-\boldsymbol{y})}}{\boldsymbol{k}^2 + \mu^2 + i\varepsilon} \\ Z &= \langle 0 | \mathrm{e}^{-iHT} | 0 \rangle = C\mathrm{e}^{iW(J)} = \mathrm{e}^{-iET} \end{aligned} \tag{17}$$

Then,

$$E = \frac{-q^2}{(2\pi)^3} \int \mathrm{d}^3 k \frac{\mathrm{e}^{i\boldsymbol{k}\cdot(\boldsymbol{x}-\boldsymbol{y})}}{\boldsymbol{k}^2 + \mu^2} = \frac{-\delta^2 m_e^2}{(2\pi)^3} \int \mathrm{d}^3 k \frac{\mathrm{e}^{i\boldsymbol{k}\cdot(\boldsymbol{x}-\boldsymbol{y})}}{\boldsymbol{k}^2 + \mu^2} \tag{18}$$

This is the real instantaneous energy of the complex nerve field line, which entangles the two electrons, maintaining the opposite orientations of their spins. Once an external force flips the spin of one electron, this energy instantaneously flips the spin of the second electron. This illustrates the profound uncontrollable physical interconnection, which Einstein called a spooky action at a distance between particles at a vast distance from each other and challenged our conventional understanding of space and time for a long time.

8. Newton's Gravity Law and Coulomb's Law

Newton could not explain the cause for the attractive force between two neutral inanimate masses. The CFT attributes the attraction to the complex charges "iq_1" and "iq_2" of the DMs on the two masses.

Physicists divided the universe into classical and quantum domains or macro and micro scales, respectively, and classified the forces of nature into four forces. CFT classifies the universe into nonrelativistic and relativistic systems (NR/R) and unifies the four forces into a single real force. The two domains of NR/R will be discussed here, while the unification of the four forces will be discussed in a future publication.

1) Nonrelativistic (NR)

In the NR domain, the absolute value of the complex charge on an object from Equation (1) is:

$$|iq| = \delta m_o \tag{19}$$

where "m_o" is the rest mass of the object.

The Klein-Gordon equation is the relativistic form of the Schrodinger equation that treats the complex field. Gravity problems are always treated as nonrelativistic problems, but we can still obtain the nonrelativistic Schrodinger equation from the Klein-Gordon equation:

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} - \frac{\partial^2\phi}{\partial x^2} + \frac{m^2c^2}{\hbar^2}\phi = 0 \tag{20}$$

Using the substitution:

$$\phi(x,t) = \psi(x,t)\mathrm{e}^{imc^2 t/\hbar} \tag{21}$$

where ψ is a slowly varying function in time compared to the exponential $\mathrm{e}^{imc^2/\hbar}$. The substitution produces the free-Hamiltonian Schrodinger equation:

$$i\hbar\frac{\partial\psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} \tag{22}$$

The gravitational potential energy between any two nonrelativistic neutral masses, such as the Earth "m_1" and the Sun "m_2", separated by a distance "r" is:

$$V = G\frac{m_1 m_2}{r} \tag{23}$$

Each mass is concomitant with a complex charge,

$$|iq_1| = \delta m_{1o} \quad \text{and} \quad |iq_2| = \delta m_{2o} \tag{24}$$

Substituting (24) into (23), then:

$$V = k\frac{|iq_1||iq_2|}{r} \tag{25}$$

Equations (25) and (23) answer the long-lived question about the similarity between Coulomb's and Newton's laws.

The Hamiltonian of m_{o1} in the field of m_{o2} is:

$$H = -\frac{\hbar^2}{2m_{o1}}\nabla^2 + k\frac{|iq_1||iq_2|}{r} = T + V = E \tag{26}$$

The radial part of the Schrodinger equation in the ground state ($\ell = 0$) for the two charges is:

$$\left(\frac{\partial^2}{\partial r^2}+\frac{2}{r}\frac{\partial}{\partial r}\right)R(r)+\frac{2\mu}{\hbar^2}\left[\left(\frac{(iq_1)(iq_2)}{r}\right)+E\right]R(r)=0 \tag{27}$$

where "μ" is the reduced mass for both masses. The lengthy derivations can be found in many introductory quantum mechanics textbooks with the result:

$$E=-\frac{k^2\mu\left[(iq_1)(iq_2)\right]^2}{2\hbar^2} \tag{28}$$

$$\mu vr=\hbar \tag{29}$$

And $\frac{k(iq_1)(iq_2)}{r^2}=\mu\frac{v^2}{r}$. Equation (28) becomes:

$$\begin{aligned}E&=-\frac{k^2\mu(\delta m_{o1})^2(\delta m_{o2})^2}{2\{r\mu(iq_1)(iq_2)\}}\\&=-\frac{G(m_{o1})(m_{o2})}{2r}\end{aligned} \tag{30}$$

Virial theorem states that the expectation potential energy is minus twice the expectation kinetic energy (*i.e.* $V=-2T$).

$$E=-\frac{G(m_{o1})(m_{o2})}{2r}=\frac{V}{2} \tag{31}$$

This Equation agrees with (23). CFT resolves Newton's confusion about the cause of gravitational force between two inanimate neutral masses.

2) Relativistic (R)

Gravity between two objects can also be treated relativistically using the QFT's path integral approach. Zee's derivations above can still be used by adding a potential energy term "$J\varphi$" to the free Lagrangian:

$$\begin{aligned}Z&=\int D\phi \mathrm{e}^{i\int \mathrm{d}^4x\{\mathcal{L}+J\varphi\}}\\&=\int D\phi \mathrm{e}^{i\int \mathrm{d}^4x\left\{1/2\left[(\partial\varphi)^2-m^2\varphi^2\right]+J\varphi\right\}}\\&=\int D\phi \mathrm{e}^{i\int \mathrm{d}^4x\left\{-1/2\left[\varphi\left(\partial^2+m^2\right)\varphi\right]+J\varphi\right\}}\end{aligned} \tag{32}$$

Using Equation (17), The attractive gravitational energy between the Earth and the Sun can be expressed as:

$$E=\frac{-(iq_1)^*(iq_2)}{(2\pi)^3}\int \mathrm{d}^3k\frac{\mathrm{e}^{i\boldsymbol{k}\cdot(x-y)}}{\boldsymbol{k}^2+\mu^2}=\frac{-\delta^2m_1m_2}{(2\pi)^3}\int \mathrm{d}^3k\frac{\mathrm{e}^{i\boldsymbol{k}\cdot(x-y)}}{\boldsymbol{k}^2+\mu^2} \tag{33}$$

This illustrates that QFT and the CFT are the tools for quantum gravity.

9. Conclusion

CFT presents a unifying framework for DE, DM, and our material universe and how they interact. It offers a novel means of understanding the physics of several fundamental concepts, such as gravity, entanglement, particle-wave duality, and tachyons. The theory explains the spooky action at a distance, which has baffled physicists since the famous EPR thoughtful paper in 1935. It also resolved Newton's perplexing about the cause of attraction between two neutral inanimate objects. The CFT explores the relationship between the complex field and the physical characteristics of systems. CFT opens the door for future extensive studies to explore the many other roles, which the complex fields might play in everyday physics.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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