DOI: https://doi.org/10.24297/jap.v23i.9796

Electric Charge, CD-quarks, and the Formation of Electrons, Protons, and Neutrons in the Early Universe

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Abstract

Understanding the few minutes of our universe is important in our quest to discover the origins of electric charge. The electric charge began in the early universe during the first few minutes. The first moments after the Big Bang are called the quark-gluon plasma phase. During this phase, there are two distinct periods. The first occurs immediately after the universe's start. The temperatures are so high during the first few minutes that quarks and gluons form strings. The top quark and antibottom quark are strings during this time in the early universe. As they collide, they start to spin, oscillate, and rotate, eventually merging into a single quark. This heavy quark, called the CD-quark, was responsible for developing electric charges in the early universe. Changes in the mass of the CD-quark are the true origin of electric charges. Electric charge is not dependent on mass, but rather on the mass change that occurred during the early universe. The CD-quark spins faster than the speed of light and vibrates in different modes, leading to the creation of electrons, protons, and neutrons. If it rotates clockwise, it generates a negative charge and shifts its vibration mode to produce an electron. An electron is not a fundamental particle. If it spins counterclockwise, it creates a positive charge and shifts into a proton. Some CD-quarks do not spin, resulting in a third vibration mode that creates a neutron. The CD-quark is a heavy quark; however, it is unique because the quark and antiquark are composed of different quarks. This property is crucial for the creation of electric charges and the formation of fundamental particles in the early universe. The CD-quark is the only source of electrons, protons, and neutrons during the first few minutes after the universe begins. After that, CD-quarks cease to exist. Charged particles have finite lifetimes; they are not stable like other particles.

Keywords Electric Charge, CD-quarks, and Particle Creation

Recent developments are underway in cosmology and particle physics. New theories have emerged in recent years, sparking increased interest in understanding the universe's first few minutes. Many physicists are now questioning the standard model of particle physics, recognizing its limitations and inconsistencies. The Standard Model has failed to explain several key issues, including fundamental parameters, the CP problem, neutrino oscillations, and the nature of dark energy and dark matter. Many models beyond the Standard Model incorporate supersymmetry and new particles to address issues that the current Standard Model appears to contain. Modern cosmology posits that the universe is a vast, expanding entity composed of dark energy, which accounts for approximately two-thirds of its total mass density. Observations from the James Webb Telescope suggest that our universe is expanding at an accelerated rate, a phenomenon that is increasingly understood through advancements in research tools, such as advanced telescopes. This instrument has provided unprecedented insights into previously enigmatic aspects of the cosmos, fueling new inquiries into the fundamental principles of its formation. The new James Webb Telescope has given us new views of our universe. These new images enable us to see things that were previously a mystery. This is an unexpected development in our attempt to understand the beginnings of our universe. This paper focuses on the generation of electric charge in the early universe, emphasizing the critical role of the CD-quark. This heavy quark existed in the first two minutes of our universe's beginning. The CD-quark is important due to its role in the formation of electric charge and the creation of electrons, protons, and neutrons in the early universe. This paper will discuss strings, electric charge, and calculate the mass of the CD-quark. Finally, to calculate the mass of the CD-quark heterotic string theory will be used. As the C-Neutralinos start to collide in the early universe, temperatures rise. When temperatures become as hot as $10^{\wedge 1000000}$ degrees Celsius, our universe gets its start. We have come to understand this as the Big Bang that happened at the beginning of our universe. The electric charge started in the early universe during the first few minutes. The first moments after the Big Bang are referred to as the quark-gluon plasma phase. In this phase, there are two different periods. The first period occurs immediately after the universe's beginning. The temperatures are so hot during the first few minutes that the quarks and gluons are strings. The top quark and the antibottom quark are strings during this time in the early universe. As they collide, they begin to spin, oscillate, and rotate, eventually merging into a single quark. This heavy quark, called the CD-quark, was responsible for developing electric charges in the early universe. This change in the mass of the CD-quark is the true origin of electric charges. Electric charge is not dependent on the mass amount, but on the mass change in the early universe. Charged particles have finite lifetimes [1][2][3][4][5].

In the early universe, the temperatures during the quark-gluon plasma era were around a googolplex degrees Celsius. Over time, these temperatures decreased. This state lasted for a few minutes. During this period, space and time began to expand. Like in a soup, quarks and gluons could move freely during the quark-gluon plasma phase. Quarks and gluons existed as individual particles. In this sea of quarks and antiquarks, gluons tried to hold them together. Quarks and antiquarks frequently appeared and disappeared, which made the early universe appear chaotic. At these temperatures, the classical treatment of general relativity no longer applies. At this stage, the universe was creating strings and electric charges. During this period, the top quark and the anti-bottom quark played key roles in the development of electric charge. Under these conditions, the top and anti-down quarks rotated and spun, creating electric charge. In the quark-gluon plasma, electric charge was neither positive nor negative. The universe was electrically neutral during its early formation. The color charge effectively remained neutral within the plasma. At very high temperatures, quarks and gluons became vibrating strings. Remember that open strings have endpoints, while closed strings do not. An open string can be a C-Neutralino or a gravitino. An open string moves through spacetime with its endpoints attached to a specific object called a D-brane. After the top and antibottom quarks generate an electric charge, open strings can carry this charge. These strings behave as charged particles at their endpoints, similar to how a point particle carries electric charge. An open string thus represents a gauge theory. As they move through spacetime, these open strings oscillate. In the early universe, these strings initially had no degrees of freedom. These degrees of freedom correspond to the two polarizations of the photon. If open strings have endpoints on a D-brane, they can attach in various ways. The gauge theory on a D-brane is localized on it. D-branes can exist in many dimensions, but we focus on four-dimensional gauge theories. We are interested in both QCD and QED. By analyzing string oscillations, one can see how a C-Neutralino is represented. Oscillations on a string have two modes: one to the left and one to the right. For open strings, these modes can mix at the endpoints, but for closed strings, the modes are independent. A C-Neutralino has four degrees of freedom, meaning it can oscillate in four directions simultaneously [7][8][9]. A gravitino has two degrees of freedom, oscillating in two directions at once. During Planck's era, the four fundamental forces unified into one. This occurred only at the universe's beginning and immediately after the Big Bang. SUSY particles are believed to form pairs due to gravitational interactions. In the early universe during Planck's time, these pairs were not suppressed, indicating they had relatively long lifetimes, though not as long as previously thought.

$$\tau \sim \frac{M_{pl}^2}{M_{\frac{4}{5}}} \tag{2}$$

where $m_{4/5}$ is the mass of the gravitino. Even though the gravitino has a long lifetime, it does not mean its decaying products would destroy light elements. During Planck's time, only quarks and gluons exist as a string. So then, we can let the string worldsheet ∈ be an infinite strip that has coordinates (ϑ, γ). In this situation $\vartheta \in$ Complex and $\gamma \in [0,1]$. If this is the case we can write,

$$S_{Strip} = \frac{1}{4\pi\alpha'} \int d\vartheta d\gamma \left(\partial\vartheta x^{\mu} \partial\vartheta x_{\mu} + \partial\gamma x^{\mu} \partial\gamma x_{\mu} \right)$$

$$+ \frac{\vartheta_2}{2} \int d\vartheta F_{\mu\varepsilon} x^{\varepsilon} \partial\vartheta x^{\mu} \text{ if } \gamma = 1$$

$$- \frac{\vartheta_1}{2} \int d\vartheta F_{\mu\varepsilon} x^{\varepsilon} \partial\vartheta x^{\mu} \text{ if } \gamma = 0, \tag{3}$$

In this equation, we can let script theta be the coordinate for time. Also, we have γ in this equation as the coordinate for space. We can then use the mixed Neumann-Dirichlet boundary conditions, which are,

$$\left(\partial\gamma x^{\mu} - 2\pi\alpha' \vartheta_1 F^{\mu}_{\varepsilon} \partial\vartheta x^{\varepsilon} \right) \text{ if } \gamma = 0 \text{ the equation equals } 0, \tag{4}$$

$$\partial\gamma x^{\mu} - 2\pi\alpha' \vartheta_2 F^{\mu}_{\varepsilon} \partial\vartheta x^{\mu}) \text{ if } \gamma = 1, \text{ the equation equals } 0. \tag{5}$$

We can start to write these conditions in a complex space coordinate,

$$x^{\pm} = \frac{1}{\sqrt{2}} \left(x^0 \pm i x^i \right) \tag{6}$$

After that, we can write the boundary conditions,

$$\left(\partial\gamma x^{t} + 2\pi i \alpha' \vartheta_1 F \partial\vartheta x^{t} \right) \text{ if } \gamma = 0 \text{ the equation equals } 0, \tag{7}$$

$$\left(\partial\gamma x^{-} + 2\pi i \alpha' \vartheta_2 F \partial\vartheta x^{-} \right) \text{ If } \gamma = 1, \text{ the equation equals } 0. \tag{8}$$

Both equations (6) and (7) can be a free open string. This open string, along with Neumann boundary conditions, is transverse to the 0-1 plane. We are just interested in electric charge, and after the quarks create an electric charge, some open strings can become charged. Of course, we realize the existence of both charged and neutral strings in the early universe. This paper will not consider the neutral strings because they are not crucial in developing electric charges in the early universe. The open strings have no integer modes. Even the zero mode in this situation can have a charge. In this case, no functions can satisfy the boundary conditions in equations (6) and (7). If $\vartheta_1 - \vartheta_2 \neq 0,\ then$

$$x^{\pm}(\vartheta, \gamma) = y^{\pm} \mp i a_0^{\pm} \frac{e^{\pm i\alpha\vartheta}}{\alpha} \times cos\left(\pi\alpha\gamma - \arctan\ arctan\, 2\pi\alpha' \vartheta_1 F\right)$$
$$+ i \sum_{n=1}^{\infty} \left[\frac{a_n^t}{n\mp\alpha} e^{-i\vartheta n \mp \alpha)\vartheta} \times cos(n\pm\alpha)\pi\gamma \pm \arctan\ arctan\, 2\pi\alpha' \vartheta_1 F \right]$$
$$- \left[\frac{\left(a_n^{\pm}\right)}{n\pm\alpha} e^{i(n\pm\alpha)\vartheta} \times cos(n\pm\alpha)\pi\vartheta \mp \arctan\ arctan\, 2\pi\alpha' \vartheta_1 F \right]. \quad (9)$$

In this equation, α is equal to

$$\alpha = \frac{1}{\pi}\left(\arctan\ arctan\, 2\pi\alpha' \vartheta_1 F - \arctan\ arctan\, 2\pi\alpha' \vartheta_2 F\right). \quad (10)$$

If we then consider the situation when $\alpha > 0,\ then\ \theta_1 >, \vartheta_2$, we can then discover the quantum commutators,

$$\left[a_n^{\pm},\ a_m^{\mp}\right] = (n + \alpha)\varphi_{nm}, \quad (11)$$

$$\left[y^t,\ y^-\right] = \frac{1}{2\alpha' F} - \frac{1}{\vartheta_1 - \vartheta_2}. \quad (12)$$

Finally, we can write the worldsheet Hamiltonian as,

$$L_0'' = \sum_{n=1}^{\infty}\left(a_n^{+}) - a_n^{-} + \sum_{n=1}^{\infty}\left(a_n^{-}\right)a_n^t + \frac{1}{2}\alpha(1 - \alpha)\right). \quad (13)$$

In equation (12) if $\vartheta_1 \neq \vartheta_2$, then the zero mode operators $y^{\pm}$ commutes with the Hamiltonian L_0''. Even in the situation where $\vartheta_1 = \vartheta_2$, we can say that $\left[y^+, y^-\right] = \frac{1}{2\alpha' F}$, so that L_0'' does have some interplay on the $y^{\pm}$ operators. Returning to our previous work, we can write F= iE and $\alpha = i\vartheta$. These two ideas are related to Wick rotations of the worldsheet and the target spacetime coordinate. The vacuum energy can then be computed using the conformal field theory σ-model, where

$$L_0 = L_0^{\rightarrow} + L_0'' + L_0^{Ghosts}, \quad (14)$$

where this is the total Hamiltonian that includes all the contributions from all the plane of the electric charge. This Hamiltonian is parallel to the 0-1 plane, and finally includes ghost planes. The Amplitude is given by

$$-iV_d\zeta(\vartheta_1, \vartheta_2) = \frac{1}{2}\, tr\left(\vartheta_1, \vartheta_2\right) \ln ln\left(L_0 - 1\right), \quad (15)$$

in this equation V_d is the spacetime volume. Also, the $tr(\vartheta_1, \vartheta_2)$is the trace over all string states in the charged area. The total amplitude is the sum of all endpoint charges. We can evaluate the trace using proper time representation,

$$\ln A = -\int_0^{\infty} \frac{dt}{t} e^{-\pi t A}, \quad (16)$$

and for any set of oscillators a_n, we can write the formula as,

$$tre^{-\pi t} \sum_{n\geq 1} a_n^t a_n = \prod_{n=1}^{\infty} e^{-\pi t a_n^t a_n}. \quad (17)$$

Equation (16) can be written in this form as well,

$$\prod_{n=1}^{\infty}\sum_{m=0}^{\infty} e^{-\pi tmn} = \prod_{n=1}^{\infty}(1 - e^{-\pi tn)-1}, \tag{18}$$

where we have included all of the multiparticle states. For the fields along the 0-1 plane, one can start with equation (17) and integrate over the zero mode $y^{\pm}$ from equation (11). By collecting all of these ideas we have,

$$\eta\left(\vartheta_{1,}\vartheta_{2}\right) = \frac{1}{2}\int_{0}^{\infty}\frac{dt}{t}(44\pi^{2}\alpha^{'}t)\,\gamma(\frac{it}{2})^{-24}c_{a}(t,\varepsilon), \tag{19}$$

where,

$$c_{a}(t,\varepsilon) = \alpha^{'}(\vartheta_{1,}\vartheta_{2})\varepsilon t e^{-\pi t\vartheta^{2/2}}\frac{\xi^{'}(\gamma)}{\xi(\frac{\vartheta t}{2,})}. \tag{20}$$

Equation (19) is just a correction factor in this situation. An essential outcome of equation (19) is that the vacuum energy is imaginary. The theta-function has in it a trigonometric function, and that leads $c_{a(t,\varepsilon)}$ to have simple poles on the positive t-axis. The amplitude then, has an imaginary part that is the sum of the residues at each pole times the factor of π. If we use the Feynman propagator, then integrating in the complex plane passes to the right of the of all poles. At the Quantum level, this instability leads to the creation of charged strings. The total rate of pair production is given by,

$$\zeta_{string} = -2\,IMF, \tag{21}$$

$$\zeta_{string} = \frac{1}{(2\pi)^{d}}\sum_{\vartheta_{1,\vartheta_2}}\sum_{s}\frac{\alpha^{'}(\vartheta_{1}-\vartheta_{2)}}{\varepsilon}\sum_{h=1}^{\infty}(-1)^{h+1}\left(\frac{\vartheta}{j}^{d/2}\right)e^{\frac{-2\pi j}{\vartheta}(m_{s}+\left(\vartheta^{2}\right)+\frac{\vartheta^{2}}{2})}. \tag{22}$$

The generating function can be written as,

$$\frac{e^{\left(1-\frac{\vartheta^{2}}{2}\right)l}}{\sin\frac{\vartheta l}{2}}\prod_{n=1}^{\infty}\frac{(1-e^{-nl})^{-(d-4)}}{(1-e^{-(n+i\vartheta)l})(1-e^{-ni\vartheta)l}}. \tag{23}$$

The equation (21) represents the classical Schwinger probability Amplitude. This probability amplitude represents charged strings and also charged C-Neutralinos in a uniform electric field E. For this situation, we have,

$$\omega_{0} = \frac{2S+1}{2\pi^{2}}\sum_{j=1}^{\infty}(-1)^{(2S+1)(k+1)}\frac{QE^{2}}{k^{2}}e^{-2\pi kM^{2}/QE}. \tag{24}$$

S, Q, and M are the charged strings' spin, charge, and mass, and C-Neutralinos. If one looks at the Quantum Field Theory calculation the imaginary part comes from $\det(D_{a}^{2})^{-1/2}$. This result goes along with Q $=2\alpha^{'}(\vartheta_{1}-\vartheta_{2})$ in the weak-field limit [10][11]. If ε→∞, the pair production can diverge at the critical electric field. This can also happen at the quantum level. Open strings can look like a long, thin rod in this situation. It is proportional to EQ, as the Quark-gluon plasma phase ends; at this time, open strings can create an electric dipole. In the early universe, an electric dipole was a fundamental particle. It has a slight separation of positive and negative charges. The electric dipole would not be symmetrical. The electric dipole is responsible for propagating positive and negative charges across the early universe as it cools, approximately five minutes after the Big Bang. It is associated with the electromagnetic force. As temperatures fall at the beginning of the universe, the electric dipole moment helps assign a negative charge to the electron and a positive charge to the proton. During this period, the electron's electric dipole moment violates both parity and time-reversal symmetry. This means that the electron's negative charge is not uniformly distributed around the electron in the early universe. The value of the electron's electric dipole moment is $\left|d_{e}\right| = 10^{-25}e\cdot cm$[12][133][144][15].

Quarks are the fundamental particles of matter, created in the early universe as it cooled. Remember that, in the hot early universe, everything existed as strings. Quarks mark the beginning of the particle stage in the early universe. However, these quarks could still reassemble into strings. The CD-quark is responsible for producing electric charge. It combines a quark and an antiquark to form a meson. The CD-quark appears as a string. Although we refer to electrons, protons, and neutrons as particles, they were string-like during the first five seconds of the early universe. The quarks of the CD-quark have different colors. The CD-quark is less stable than baryons, existing for only about a minute after the universe's creation. Quarks and mesons play a crucial role in mediating the interaction between the strong force and baryons. They are essential for understanding quark behavior at extremely high temperatures. The CD-quark is a hadron with a spin of 4, making it a boson. It is responsible for creating positive and negative charges. It plays a key role in developing electric charges in the early universe. The CD-quark is unstable, with a lifetime of 10-30 seconds, and is considered the origin of electrons, neutrons, and protons. The CD-quark spins faster than the speed of light and vibrates at different modes, which leads to the creation of electrons, protons, and neutrons. If it rotates clockwise, it generates a negative charge and shifts its vibration mode to produce an electron. An electron is not a fundamental particle. If it spins counterclockwise, it creates a positive charge and shifts into a proton. Some CD-quarks do not spin, resulting in a third vibration mode that creates a neutron. The CD-quark is a heavy quark; however, it is unique because the quark and antiquark are composed of different quarks. This property is crucial for the creation of electric charges and the formation of fundamental particles in the early universe. The CD-quark is the only source of electrons, protons, and neutrons during the first few minutes after the universe begins. After that, CD-quarks cease to exist. After this period, the electric dipole helps to propagate positive and negative charges across the early universe. [16][17][18][19].

The CD-quark mass can be calculated using E_8 x E_8 heterotic string compactifications of Calabi-Yau threefold with vector bundles. This provides a framework for developing four-dimensional supersymmetric string vacua. Such vacua can lead to extensions that go beyond the standard model of particle physics. The vector bundles are crucial for breaking the initial E8 gauge symmetry into smaller ones. They also help generate chiral matter content. Heterotic string theory is a ten-dimensional theory. When it is compactified on a six-dimensional Calabi-Yau manifold, it enables the development of a four-dimensional theory. Calabi-Yau manifolds are the preferred choice in N=1 supersymmetric compactifications. In Heterotic string theory, there is the freedom to choose a vector bundle. These bundles are placed on Calabi-Yau manifolds. Then, Yukawa couplings can be solved, and the CD-quark mass can be approximated. The physical Yukawa couplings can be specific to two-moduli-dependent quantities that appear in the low-energy four-dimensional N = 1 supersymmetric Lagrangian. The holomorphic Yukawa couplings and the matter field Kahler metric lead us to the chiral superfields. The holomorphic Yukawa couplings are parameters in heterotic string theory that tell about the interactions between quarks and scalar fields. They are important for determining the mass of the CD-quark. Understanding the Yukawa couplings is crucial for connecting string theory to the observed particle physics during the early universe. Calabi-Yau threefolds are geometrical structures that play a crucial role in string theory compactifications. Yukawa couplings are crucial for understanding the interactions between fundamental particles. The Ricci-flat metric is a defining part of the Calabi-Yau manifolds. Holomorphic Yukawa couplings are topological in nature. They can be calculated using differential geometrical techniques. They can be calculated without knowing the Ricci-flat metric on the Calabi-Yau threefold. However, the Physical Yukawa couplings depend on a combination of Holomorphic Yukawa couplings and the matter field Kahler metric. The field Kahler metric is important in the normalization of the chiral superfields. They depend on the Ricci-flat metric of the Calabi-Yau manifold. To solve the matter field Kahler metric, we need to find and understand the Ricci-flat metric and the holomorphic vector bundle. One also, will also need to look at various harmonic bundle-valued forms on the Calabi-Yau threefold. Differential forms are crucial for satisfying the Laplace equation. They are part of the Cohomology of manifolds through the understanding of the Hodge Decomposition Theorem. A bundle-valued form on a manifold M is a differential form. It has values in a vector bundle E over M. If this is the case, each point of the manifold takes its value in the fiber of the vector bundle. To start, one can use the E_8 x E_8 heterotic string. It will be on a smooth $A = Z_2 \times Z_2$ quotient of a Calabi-Yau hypersurface x of multi-degree a product of four $P^1 spaces$. The quotient $\frac{x}{A}$, has four Kahler parameters. It will also have 20 complex structure parameters. These standard Kahler forms on the four P^1 factors, can be restricted to x. This will provide us a basis, (G_i), where i = 1,2,3,4…, for the second cohomology of x. After this, one can use the first Chern class of a line bundle $H \rightarrow x$, which can then be written as $c_{1(H)} = F^i G_{i\cdot}$ In this case, if $F^i \in Z$, then this line bundle is written as $H = \varphi_x(F)$[29][30]. The vector bundle can be written $v \rightarrow x$, which has a sum of five-line bundles. So then,

$$v = \otimes_{a=1}^{5} H_a \tag{25}$$

with the Chern classes equal to,

$$c_{1(H_a)} = F^i G_{i\cdot} \tag{26}$$

One can then write the five-line bundles that are specified by the column vectors of the matrix as,

$$H_1\, H_2\, H_3\, H_4\, H_5$$

$$\left(F^{i}_{a}\right) = \begin{bmatrix} -1 & -1 & 0 & 1 & 1 \\ 0 & -3 & 1 & 1 & 1 \\ 0 & 2 & -1 & -1 & 0 \\ 1 & 2 & 0 & -1 & -2 \end{bmatrix} \quad (27)$$

The extra U (1) symmetries are Green-Schwarz together with associated gauge bosons. These bosons are super-heavy. If they are at low energy, the bosons appear as global symmetries. The SU (5)-gauge symmetry is broken by certain discrete Wilson lines with the structure group $A = Z_2 \times Z_2$. If this is the situation, then the supersymmetries along the locus are where all Kahler moduli take on the same value, so then

$$t : t_1 = t_2 = t_3 = t_4. \quad (28)$$

The particle content is MSSN. However, one can include a number of singlet fields that are uncharged under the standard model gauge group. These fields are given with U (1) charges. The U(1) symmetries will enforce the vanishing of the CD-quark at the perturbative level. The left-handed CD-quark can be written as $(S^i) = (S^1_2, S^2_2, S_5)$, the right-handed CD-quark can be written like this $(U^i) = (U^1_2, U^2_2, U_5)$. The holomorphic CD-quark Yukawa couplings can be written in the form,

$$W_u = Y^{u}_{ij} H^u Q^i U^j, \quad (29)$$

Where i,j = 1,2,3, which is the label for the three quark families. One can then specify the structure of the CD-quark matrix by

$$Y^u = [0\ 0\ \delta_1\ 0\ 0\ \delta_2\ \delta_3\ \delta_4\ 0\ ] \quad (30)$$

The entries δ_1, δ_2, δ_3, δ_4 are quasi-topological and can be solved with differential geometric techniques. The full perturbative superpotential can be written,

$$W = W_u + \varsigma_{\mu i} R^{\mu}_{2,4} v^{i}_{4,5} H^{u}_{2,5} \quad (31)$$

where the index is μ = 1, 2, 3 is the three singlets in the spectrum. These are thought to be right-handed neutrinos. The physical CD-quark Yukawa couplings can be written as,

$$F = F^{Q}_{ij} Q_i \bar{Q}^j + F^{u}_{ij} U^{i\bar{U}j} + f\, H^{u\bar{H}u}. \quad (32)$$

This leads to the following structure for the Kahler metrics:

$$F^Q = \xi^{\frac{-1}{3}} F^Q\, F^Q\, 0\, [F^Q\, F^Q\, 0\, 0\, 0\, F^Q\,] \quad (33)$$

$$F^u = \xi^{\frac{-1}{3}} [F^u\, F^u\, 0\, F^u\, F^u\, 0]\, 0\, 0\, F^u \quad (34)$$

The factor $\xi^{\frac{-1}{3}}$ considers the full Kahler moduli dependence due to equation (28). This means that the complex and real numbers in equations (33) and (34) are Kahler moduli independent.

$$Y^{u}_{phys} = (0\ 0\ a_1\ 0\ 0\ a_2\ b_1\ b_2\ 0\ ), \quad (35)$$

$$(a_1\ a_2\ ) = \frac{e^{-\gamma}}{\sqrt{f\, F^Q}}\, P_{Q\,(\delta_1\, \delta_2)}, \quad (36)$$

$$(b_1 b_2) = \frac{e^{-\gamma}}{\sqrt{fF^u}} P_{u\,(\delta_1 \delta_2}). \quad (37)$$

In these equations, P_Q and P_u are 2 x 2 matrices that satisfy,

$$P_Q F^Q P_Q^{+} = I_2, \quad (38)$$

$$P_u F^u P_u^{+} = I_2. \quad (39)$$

Finally, one sees that the CD-quark has a mass which can be written as,

$$(m_{CD}) = \left| \langle H^u \rangle \right| e^{-\gamma} (| P_Q (\delta_1 \delta_2)| / \sqrt{fF^u} \;,\;\; |P_{u\,(\delta_3 \delta_4)}| / \sqrt{fF^Q} \;) \quad (40)$$

The CD-quark only exists in the very early universe. It is present for just a minute or two, and after that, there are no more CD-quarks in the universe. Their purpose is to give the universe its electric charge. In geometric heterotic compactifications, one can write the holomorphic Yukawa couplings and their Kahler metric, so then we can write,

$$\delta_{IJK} = \varphi_{IJK} \frac{c\, 2\sqrt{2}}{|U|} \int_x \sigma_I \wedge \sigma_J \wedge \sigma_K \cap, \quad (41)$$

$$F_{IJ} = \frac{\mu_{IJ}}{2V|U|} \int_x \sigma_I \wedge \star\, (H_{J\bar{\sigma}J}) \quad (42)$$

In these equations σ_I are harmonic forms and represent the matter fields. H_I are HYM bundle metrics that are on υ_I.The line bundles υ_I can be written as,

$$\begin{aligned}
&2Q_2, 2U_2, 2E_2 \leftrightarrow \upsilon_2\\
&2D_{2,5}, 2M_{2,5}, \leftrightarrow \upsilon_4 \otimes \upsilon_5\\
&H^d_{2,5} \leftrightarrow \upsilon_2 \otimes \upsilon_5\\
&3R_{2,4} \leftrightarrow \upsilon_2 \otimes \upsilon_4^*\\
&Q_5, U_5, E_5 \leftrightarrow \upsilon_5\\
&D_{2,4}, M_{2,4} \leftrightarrow \upsilon_2 \otimes \upsilon_4\\
&H^u_{2,5} \leftrightarrow \upsilon_2^* \otimes \upsilon_5^*
\end{aligned} \quad (43)$$

Other singlets.

The holomorphic form ∩ on X, can be written like,

$$\int_x \cap \wedge \overline{\cap} = 1. \quad (44)$$

If one discusses low-energy U(1) symmetries, the holomorphic Yukawa couplings are nonzero if $\upsilon_I \otimes \upsilon_J \otimes \upsilon_K = \phi_K$. In U(1) symmetries H_I, H_J, and H_K are constant for Yukawa coupling. Factors μ_{IJ} *and* φ_{IJK} are group theoretic factors. For the case of the CD-quark Yukawa coupling can be written by,

$$\mu_{IJ} = \eta_{IJ} / 2, \qquad \varphi_{IJK} = 1/\ 8\sqrt{60} \quad (45)$$

If one then uses Yau's theorem applied to a CY manifold x, one must have a unique Ricci-flat metric, so then,

$$g_{ab} = g^{(ref)}_{ab} + \alpha_{a\bar{\alpha}b\Phi}, \quad (46)$$

In this situation, Φ is a real function on x. This can be solved by using the Monge-Ampere equation. If one computes the holomorphic Yukawa couplings from equation (41), we can write this as,

$$\cap \propto \hat{\cap} = dz_1 \wedge dz_2 \wedge dz_3 / \frac{\partial p}{\partial z_4} . \quad (47)$$

If we go back to equation (44) and Equation (46), we can write the Fubini-study metric and restricted it on x. So then, we have

$$g_{ab}^{(ref)} = \sum_{i=1}^{4} \frac{t^i}{2\pi} \alpha_a \bar{\alpha}_b \ln (\kappa_i) . \quad (48)$$

In this situation $t^{i} \in R^{>0}$, so then the CY volume V is,

$$V = 2 (t_1t_2t_3 + t_1t_2t_4 + t_2t_3t_4). \quad (49)$$

For the HYM bundle metric, let $H = \varphi_x(F)$. This can be a line bundle on x that is associated with one of the matter fields in equation (43). To obtain the correct field normalizations, the HYM metric is required. This can be written as,

$$H^{(ref)} = \prod_{i=1}^{4} \kappa_i^{-n_i}. \quad (50)$$

If one relates $H^{(ref)}$ to the HYM bundle metric H on $\varphi_x(F)$, we have

$$H = \epsilon^{\beta} H^{(ref)}, \quad (51)$$

where β is a real function on x. This equation states that β needs to satisfy the following Poisson equation

$$\Delta\beta = - g^{ab} \alpha_a \bar{\alpha}_b \ln(\bar{H}^{(ref)}). \quad (52)$$

The matter fields in equation (43) should be associated with harmonic bundle forms. Let H be a bundle on x. Each matter field can be represented by a specific cohomology class. If one uses $v^{(ref)}$ to represent this class, they are related by

$$v = v^{(ref)} + \bar{\alpha}_H \varrho . \quad (53)$$

In this equation, ϱ can be determined from the Poisson equation

$$\Delta_H \varrho = -g^{ab} \alpha_a (H\varrho^{(ref)}). \quad (54)$$

Where Δ_H is the Laplacian on H. One can then calculate the harmonic forms. After this, the CD-quark mass can be calculated by using equation (16). By using an approximate method, the final mass of the CD-quark is 181.53 ± 0.4 Gev/c^2 [20][21][22][23][24][25][26].

In conclusion, this paper examines the generation of electric charge in the early universe, emphasizing the crucial role of the CD-quark. This heavy quark existed at the beginning of our universe. The CD-quark is important in the formation of electric charges. However, they are also crucial in the creation of electrons, protons, and neutrons. As C-Neutralinos collide in the primordial environment, temperatures increase markedly, reaching extremely high levels, which marks the onset of the Big Bang. Ultimately, the paper discusses strings and how electric charges are generated in the early universe. Finally, the mass of the CD-quark will be calculated. When the C-Neutralinos start colliding, temperatures rise, and when they reach as high as 10^^{1000000} degrees Celsius, our universe begins. We understand this event as the Big Bang, occurring at the universe's start. Electric charge originated in the early universe within the first few minutes. The initial moments after the Big Bang are known as the quark-gluon plasma phase. This phase comprises two distinct periods. The first occurs immediately after the universe's inception, where temperatures are so extreme that quarks and gluons form strings. During this time, the top quark and antibottom quark are also strings. As they collide, they begin to spin, oscillate, and rotate, eventually merging into a single quark. This heavy quark, called the CD-quark, is responsible for the development of electric charges in the early universe. The change in the mass of the CD-quark is the true origin of electric charges. Electric charge depends not on the amount of mass but on the mass change during the early universe. Charged particles have finite lifetimes[27][28][29][30][31][32][33].

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