

## Asymptotic freedom, quark confinement, proton spin crisis, neutron structure, dark matters, and relative force strengths

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### Abstract;

The relative force strengths of the Coulomb forces, gravitational forces, dark matter forces, weak forces and strong forces are compared for the dark matters, leptons, quarks, and normal matters (p and n baryons) in terms of the 3-D quantized space model. The quark confinement and asymptotic freedom are explained by the CC merging to the  $A(CC=-5)_3$  state. The proton with the (EC,LC,CC) charge configuration of  $p(1,0,-5)$  is  $p(1,0) + A(CC=-5)_3$ . The  $A(CC=-5)_3$  state has the 99.6% of the proton mass. The three quarks in  $p(1,0,-5)$  are asymptotically free in the EC and LC spaces of  $p(1,0)$  and are strongly confined in the CC space of  $A(CC=-5)_3$ . This means that the lepton beams in the deep inelastic scattering interact with three quarks in  $p(1,0)$  by the EC interaction and weak interaction. Then, the observed spin is the partial spin of  $p(1,0)$  which is 32.6 % of the total spin (1/2) of the proton. The  $A(CC=-5)_3$  state has the 67.4 % of the proton spin. This explains the proton spin crisis. The EC charge distribution of the proton is the same to the EC charge distribution of  $p(1,0)$  which indicates that three quarks in  $p(1,0)$  are mostly near the proton surface. From the EC charge distribution of neutron, the 2 lepton system (called as the koron) of the  $\pi^- (e\bar{\nu}_e)$  koron is, for the first time, reported in the present work.

**Key words:** Quark confinement, Asymptotic freedom, Relative force strength, Dark matters, Proton crisis, Deep inelastic scattering, Neutron structure, Two lepton system.

### 1. Introduction

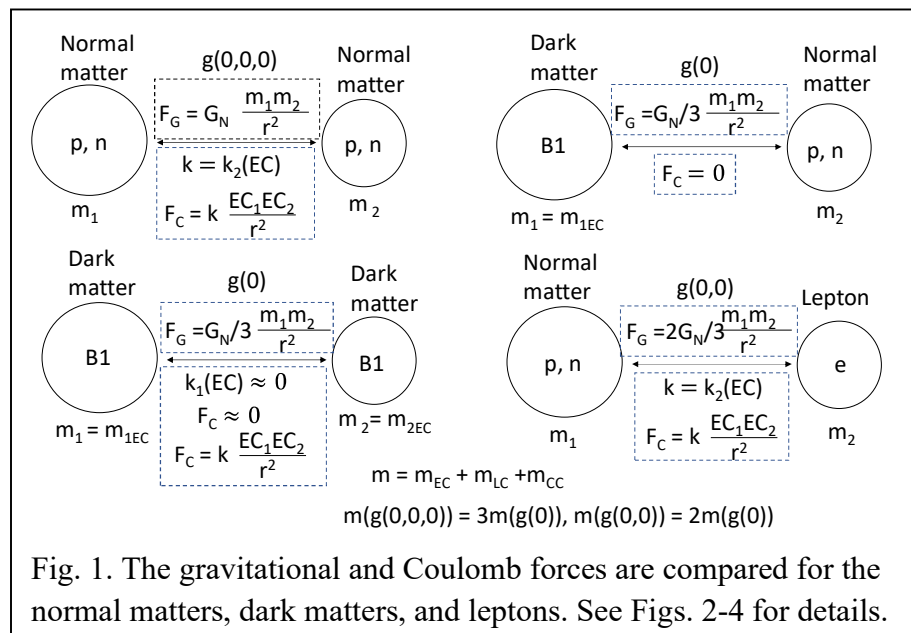


Fig. 1. The gravitational and Coulomb forces are compared for the normal matters, dark matters, and leptons. See Figs. 2-4 for details.

In modern particle physics, the three-quark system shows the asymptotic freedom and quark confinement within the baryon. The asymptotic freedom and quark confinement have been

explained by introducing the gluon field at the short distance. This strong force through the gluons has the characteristics different from other forces like the Coulomb forces and gravitational forces. The strong force is nearly free at the very short distance and is getting constant or even stronger with increasing of the distance between the quarks. This is called as the asymptotic freedom. Experimentally it has been observed that quarks are acting like being nearly free inside the baryon [1]. In the energy point of view, the interactions between quarks is weaker at the high energy and stronger at the low energy. This asymptotic freedom was discovered by Gross, Wilczek and Politzer [2,3]. The quark confinement is closely related to the asymptotic freedom through the gluons. The quark confinement takes place when the total color charge is neutral. The origins of the quark confinement are not clearly understood in terms of QCD.

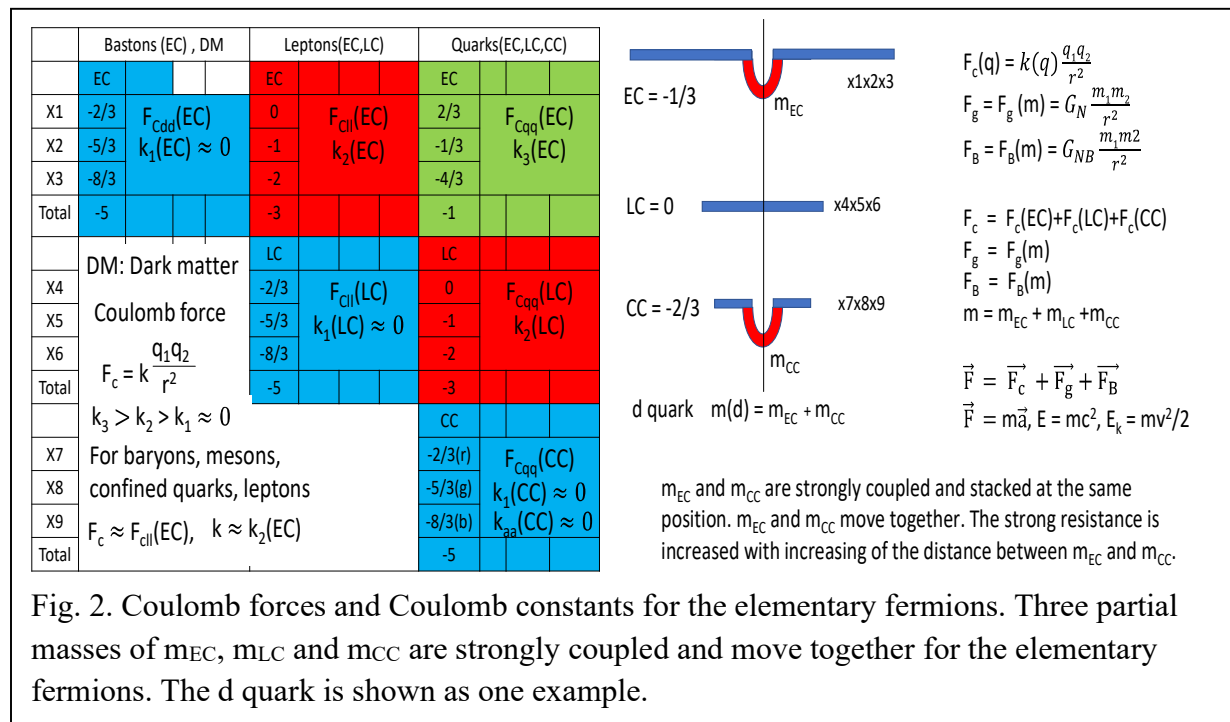
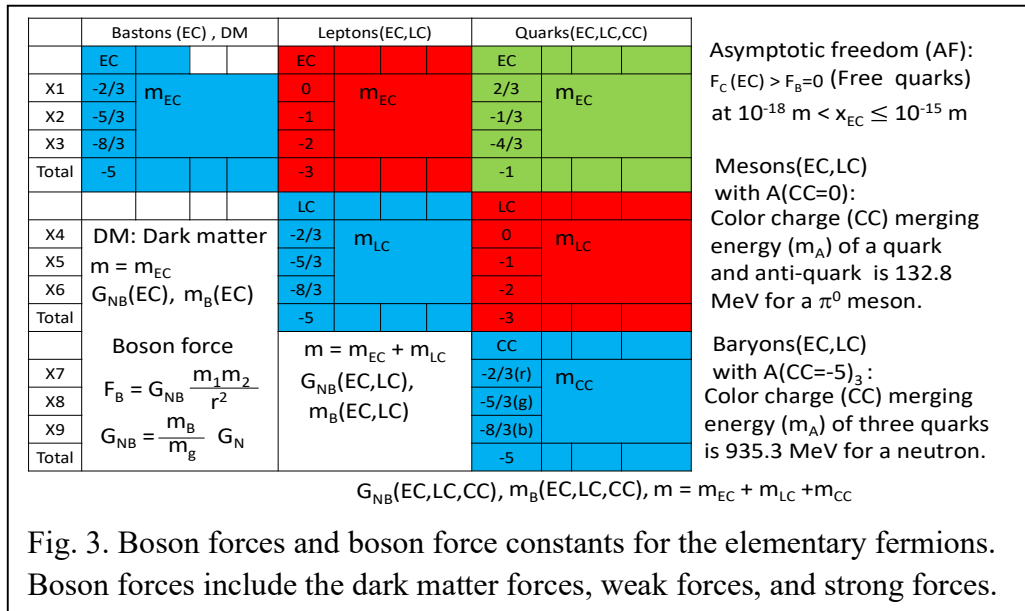


Fig. 2. Coulomb forces and Coulomb constants for the elementary fermions. Three partial masses of  $m_{EC}$ ,  $m_{LC}$  and  $m_{CC}$  are strongly coupled and move together for the elementary fermions. The d quark is shown as one example.

In the present work, the properties of quark confinement and asymptotic freedom are explained without introducing the gluons of the quantum chromodynamics (QCD). Instead of the gluons, the strong force bosons [4] are introduced. The present analysis in Figs. 1-5 is based on the 3-D quantized space model. The fermions are drawn as the half circles [4] in the Euclidean space as shown in Fig. 5. The bosons are drawn as the full circles [4] in the Euclidean space as shown in Fig. 5. The brief review [4,5] is given in section 2 before the asymptotic freedom and quark confinement inside baryons like proton and neutron are explained in sections 3 and 4. The quark confinement and asymptotic freedom are closely related to the strong boson force including the color charge (CC) force within the force range of  $x < 10^{-18}$  m.

The normal matters are made of the protons and neutrons in Fig. 1. And the dark matters are the B1 bastons [4]. The gravitational force in our universe is applied to the normal matters and dark matters. The Coulomb forces, boson forces and gravitational forces are explained for the elementary fermions in Figs. 2-4. Therefore, the newton gravitational constant of  $G_N$  is taken for the quarks and hadrons in Figs. 1 and 4. Here, “a” means  $A(CC=-5)_3$  in the baryons like proton and neutron in Figs. 6-8. For example, the proton is separated into the EC charge part of  $p(1,0)$

and the CC charge part of  $A(CC=-5)_3$  in Figs. 6-8. The proton with the (EC,LC,CC) charge configuration of  $p(1,0,-5)$  is  $p(1,0) + A(CC=-5)_3$ . And the leptons have the (EC, LC) charge configurations. And the Coulomb force is applied to the EC charges of the normal matters and leptons. And the Coulomb constant of  $k$  is taken as  $k = k_2(EC) = k_{ll}(EC)$  in Figs. 1 and 2. And  $k_1 = k_{qq}(CC) = k_{ll}(LC) = k_{dd}(EC) \approx 0$ . Normal matters are made of the lepton-like particles of the protons ( $p(1,0)$ ) and neutrons ( $n(0,0)$ ). The Coulomb constant of  $k_1(EC) = k_{dd}(EC)$  between the dark matters is nearly zero. This condition makes the Coulomb forces between the dark matters to be nearly zero. The Coulomb force between the dark matters and the normal matters are zero. The Coulomb force between the dark matters and leptons is zero. The gravitational force constant ( $G_N/3$ ) between the dark matters and normal matters is weaker by 1/3 than the gravitational force constant ( $G_N$ ) between the normal matters in Figs. 1 and 4. The dark matters are grouped, and the normal matters are grouped. The weak gravitational force constant between the dark matters and normal matters makes the normal matters and dark matters to move separately as observed in several galaxy structures. The normal matters can move and rotate following the path different from the moving path of the dark matters. The normal matters and dark matters cannot be completely separated because of the weak gravitational force between the dark matters and normal matters.



These conditions for the gravitational forces and Coulomb forces can explain the observed properties of the normal matters and dark matters in our universe. The more details for the gravitational forces, Coulomb force, dark matter (boson) force, weak (boson) force and strong (boson) force [4,5] are shown in Figs. 2 - 4.

Based on the information obtained from Figs. 2 - 4, the quark confinement and asymptotic freedom are discussed in section 3 and section 4, respectively. In addition to the asymptotic freedom and quark confinement, the two lepton system (koron) and proton spin crisis are explained in section 5 and section 6, respectively. Two lepton system is discovered by comparing the EC charge distributions of the proton and neutron [6,7] in section 5. And the proton spin crisis [8] is explained from the  $p(1,0)$  part of the proton. A proton consists of two parts of  $p(1,0)$  and  $A(CC=-5)_3$ . Because these two parts are separated, the total spin (1/2) of the  $p(1,0,-5)$  proton is separated to the spin (0.163) of  $p(1,0)$  and the spin (0.337) of  $A(CC=-5)_3$ . The spin of  $p(1,0)$  was observed from the

lepton deep inelastic scattering to the proton. The lepton interacts with the three quarks in p(1,0) by the EC Coulomb force and weak force. The observed spin is the spin of p(1,0) but not the total spin of the proton of p(1,0,-5). The observed spin value of 0.165 (30) [8] is consistent with the calculated spin value of 0.163. Therefore, the proton spin crisis is explained in the present work. The more details are discussed in section 6. The partial spins and partial masses of the EC charge masses, LC charge masses and CC charge masses for the quarks and leptons are calculated in section 6 and section 7. And the EC charge distributions of the proton and neutron are discussed in section 5. The EC charge distribution of the neutron could be caused by the neutron oscillation between the udd state and the uud+ e $\bar{\nu}_e$  state. This neutron oscillation is, for the first time, reported in the present work. And the 2 lepton system (called as the koron) of the  $\pi_l^-$  (e $\bar{\nu}_e$ ) koron is, for

	Bastons (EC) , DM			Leptons(EC,LC)			Quarks(EC,LC,CC)		
	EC			EC			EC		
X1	-2/3	$m = m_{EC}$ $G_N/3, m_g/3$		0	$m_{EC}$		2/3	$m_{EC}$	
X2	-5/3			-1			-1/3		
X3	-8/3			-2			-4/3		
Total	-5			-3			-1		
				LC			LC		
X4	DM: Dark matter			-2/3	$m_{LC}$		0	$m_{LC}$	
X5	Gravitation force			-5/3			-1		
X6				-8/3			-2		
Total	$F_G = G_N \frac{m_1 m_2}{r^2}$			-5			-3		
	$G_{NB} = \frac{m_B}{m_g} G_N$			$m = m_{EC} + m_{LC}$ $2G_N/3, 2m_g/3$			CC		
X7							-2/3(r)	$m_{CC}$	
X8							-5/3(g)		
X9							-8/3(b)		
Total							-5		

$g(0) \longleftrightarrow g(0,0) \longleftrightarrow g(0,0,0) \quad G_N, m_g, m = m_{EC} + m_{LC} + m_{CC}$

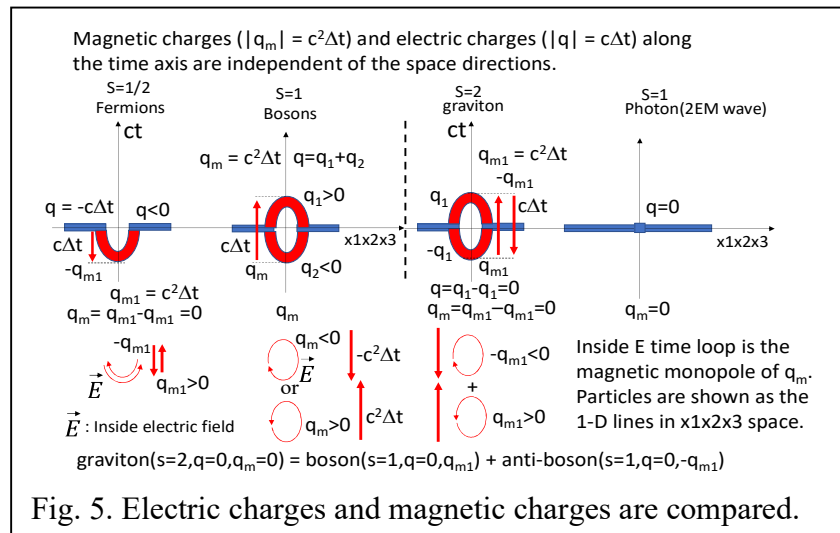
Fig. 4. Gravitational forces and gravitational constants for the elementary fermions. The fermions and bosons are drawn on the Euclidean space (see Ref. 4 for more details.).

the first time, reported in the present work. The EC charge distribution of the neutron was explained by introducing the n = (u-e-u)d state for the neutron by Guglinski [7]. The previous explanation using the n = (u-e-u)d state [7] could be compared with the present explanation using the neutron oscillation.

## 2. Brief review of the force concepts in 3-D quantized space model

In Fig. 5, the fermions, bosons, graviton, and photon are compared. The massive particles are described as the warped shape of the flat photon space. The energy of the massive particle has the rest mass energy (4-D space volume) of  $E = c\Delta t\Delta x_1\Delta x_2\Delta x_3$ . And the electric charge (q) and magnetic charge (q<sub>m</sub>) are defined as  $|q| = c\Delta t$  and  $|q_m| = c^2\Delta t$  from  $|q_m| = c|q|$  in Fig. 4. All the energy, electric charge and magnetic charge are the vectors along the time axis of ct. Therefore, the rest masses, electric charges and magnetic charges of the elementary particles are the physical constants when seen from the 3-D space. This indicates that these physical constants have the space direction independence. The elementary fermions have the opened 4-D shape of the half circle and the elementary bosons have the closed 4-D shape of the full circle. The more details on the origins of these physical constants can be seen in my publications [4,5, others].

To understand the quark confinement better, the origins of the electromagnetic waves and gravitational wave need to be uncovered [4]. As shown in Ref. 4, the electric wave and magnetic wave are originated from the space fluctuations along the two space axes. The gravitational wave is originated from the time fluctuation along the time axis. The Coulomb force and gravitational force have the force equations with the  $1/r^2$  term. Force carrying bosons make the boson force waves along the time axis. This indicates that the boson force equations of dark matter force, weak force and strong force should have the  $1/r^2$  term like the Coulomb force equation and gravitational force equation have the  $1/r^2$  term. Each 3-D quantized space has its own characteristics like the charges and forces. In our universe, three kinds of the 3-D quantized spaces exist in terms of the 3-D quantized space model (TQSM). One (space A) has the total 3-D charge of -5 which are separated into the three 1-D charges of  $-2/3$ ,  $-5/3$  and  $-8/3$  along three space axes for the elementary fermions. Another one (space B) has the total 3-D charge of -3 which are separated into the three 1-D charges of 0, -1 and -2 along three space axes for the elementary fermions. Another one (space C) has the total 3-D charge of -1 which are separated into the three 1-D charges of  $2/3$ ,  $-1/3$  and  $-4/3$  along three space axes for the elementary fermions. Our universe consists of these three spaces (space A, space B and space C). For example, the space A ( $x1x2x3$  space) corresponds to the dark matters (bastons). The space B ( $x1x2x3$  space) and space A ( $x4x5x6$  space) correspond to the leptons. The space C ( $x1x2x3$  space), space B ( $x4x5x6$  space) and space A ( $x7x8x9$  space) correspond to the quark space. And the more details are shown in Ref. 5.



The masses of the elementary fermions are  $m = m_{EC}$  for the dark matters,  $m = m_{EC} + m_{LC}$  for the leptons and  $m = m_{EC} + m_{LC} + m_{CC}$  for the quarks, mesons, and baryons. As shown for the d quark in Fig. 2, the partial masses of  $m_{EC}$ ,  $m_{LC}$  and  $m_{CC}$  are located at the same position. The strong resistance takes place when increasing the distance between the partial masses of  $m_{EC}$ ,  $m_{LC}$ , and  $m_{CC}$  because of the gravitational force. These partial masses move together when the forces are applied in Figs. 2 - 5.

The Coulomb forces are  $F_c = F_c(EC)$  for the dark matters,  $F_c = F_c(EC) + F_c(LC)$  for the leptons, mesons and baryons and  $F_c = F_c(EC) + F_c(LC) + F_c(CC)$  for the quarks because the Coulomb forces depend on the charges in Fig. 2. Because of the hadronization (leptonization), the baryons and mesons act like the leptons for the electromagnetic interactions. This quark confinement is explained in the later section. The boson forces are  $F_B = F_B(m)$  for the dark matters,  $F_B = F_B(m)$  for

the leptons and  $F_B = F_B(m)$  for the quarks, mesons and baryons in Fig. 3. The gravitational forces are  $F_G = F_G(m)$  for the dark matters,  $F_G = F_G(m)$  for the leptons and  $F_G = F_G(m)$  for the quarks, mesons and baryons. Here,  $m = m_{EC} + m_{LC} + m_{cc}$ . The dark matters are electrically charged. The dark matters are grouped from the gravitational attraction between dark matters. It is concluded that there are very weak repulsive Coulomb forces between dark matters because the dark matters are grouped unlike the leptons and quarks. From this observation, in Fig. 2  $k_1(EC) = k_{dd}(EC) \approx 0$ . The EC space (space A) of the dark matters, LC space (space A) of the leptons and CC space (space A) of the quarks have the same physical properties for the electromagnetic interactions. It means that  $k_1 = k_{qq}(CC) = k_{ll}(LC) = k_{dd}(EC) \approx 0$ . Also, the Coulomb forces between charged leptons and charged baryons, are relatively strong compared to the gravitational forces. This means that  $k_2(EC) = k_{ll}(EC)$  is what has been observed and reported as  $k$  in the Coulomb force in Figs. 1 and 2. Therefore,  $k = k_{ll}(EC) > k_{dd}(EC) \approx 0$ .

The Coulomb forces between leptons, mesons and baryons use  $k = k_{ll}(EC)$  in Figs. 1 - 4. In Fig. 5, the charges and magnetic charges are newly defined and compared. The EC space (space B) of the leptons and LC space (space B) of the quarks have the same physical properties in the electromagnetic interactions. It means that  $k_2 = k_{qq}(LC) = k_{ll}(EC) > k_1 = k_{dd}(EC) \approx 0$ . And in the

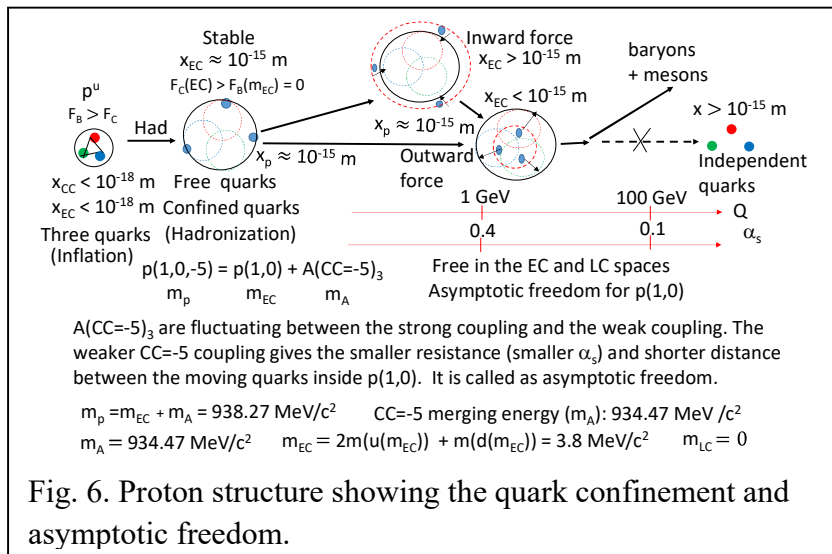


Fig. 6. Proton structure showing the quark confinement and asymptotic freedom.

present work, it is assumed that  $k_3 = k_{qq}(EC) > k_2 = k_{qq}(LC)$ . The details of Coulomb force can be shown in Fig. 2. The quark confinement is caused by the strong force of the color charges (CC) because the  $Z(0,0,0)$  boson mass is much heavier than the  $Z(0,0)$  boson. In the present work, the strong force is called as the strong boson force in Fig. 3. The strong boson ( $Z(0,0,0)$ ) force the quarks is very strong enough to form the 3-D CC merging state of  $A(CC=-5)_3$ . Within the baryon space with the short range of the boson force, a baryon of  $(EC,LC,-5)$  related to the  $Z(0,0,0)$  boson can be separated into two states of  $(EC,LC)$  related to the  $Z(0,0)$  boson and  $(0,0,-5)_3 = A(CC=-5)_3$  related to the  $Z(0,0,0)$  boson. For the long range gravitational force, the baryon state of  $(EC,LC,-5)$  without the separation of the  $Z(0,0)$  boson and  $A(CC=-5)_3$  can be used for the gravitational force. The EC space (space A) of the dark matters, LC space (space A) of the leptons and CC space (space A) of the quarks have the same physical properties in the charge point of view. The EC space (space B) of the leptons and LC space (space B) of the quarks have the same physical properties in the charge point of view. The boson force and gravitational force have the same list of the force strengths between elementary fermions as shown in Figs. 3 and 4. The force range

should be very long (about  $x < 10^{23}$  m) for the gravitational forces and about very short ( $x < 10^{-18}$  m) for the boson forces. All physical processes in our universe are based on the relative force strengths in Figs. 1 - 4.

### 3. Quark confinement

The quark confinement is explained in Figs. 6 and 7. The u and d quarks have the (EC,LC,CC) charge configurations of (2/3,0,CC) and (-1/3,0,CC) [5]. The CC value is -2/3, -5/3 or -8/3. The proton is made by three quarks of udd with the total CC charge of  $-5 = -2/3 - 5/3 - 8/3$  [5]. The proton has the charge configuration of (1,0,-5). Three quarks inside the proton build the complete 3-D CC state of  $A(CC=-5)_3$  by the CC merging. The boson force between quarks is very strong and make the CC states of three quarks to be merged to  $A(CC=-5)_3$  when the average distance between three quarks is within the force range of  $x_r < 10^{-18}$  m. It is thought the quarks are densely populated with the average distance of  $x < 10^{-18}$  m between quarks during the inflation of our universe. It is assumed that the CC charge are perfectly balanced during the inflation to  $N(CC=-2/3):N(CC=-5/3):N(CC=-8/3) = 1:1:1$ . Three quarks build the complete 3-D CC state of  $A(CC=-5)_3$  by the CC merging and form the baryons like the proton and neutron in Fig. 6. Therefore, a proton of p(1,0,-5) is separated into p(1,0) and  $A(CC=-5)_3$  which are called as the hadronization. Electromagnetically, a proton of p(1,0) acts like the lepton because the 3-D  $A(CC=-5)_3$  state is separated from the p(1,0) state. Therefore, p(1,0) is the lepton-like particle. Therefore, p(1,0) interact with leptons electromagnetically by the EC Coulomb force. This is called as the leptonization in the present work, too. Inside the baryon, the quarks inside p(1,0) with the size of  $10^{-18} \text{ m} < x_{EC} \leq 10^{-15} \text{ m}$  in Fig. 6 are free of the attractive strong force. Therefore, the three quarks are the free quarks inside p(1,0). Three quarks are asymptotically free without the strong EC and LC boson forces in the EC and LC spaces of p(1,0) and are strongly confined with the strong boson forces in the CC space of  $A(CC=-5)_3$ . The quark confinement in the proton is caused by the strong CC merging to the  $A(CC=-5)_3$  state in the proton. To make the strong coupling of the  $A(CC=-5)_3$  state, the strong boson force needs to be strong. The proton size is decided by the size of the  $A(CC=-5)_3$  state. The quark confinement and asymptotic freedom are explained by the CC merging to the  $A(CC=-5)_3$  state. The proton with the (EC,LC,CC) charge configuration of p(1,0,-5) is  $p(1,0) + A(CC=-5)_3$ . The three quarks in p(1,0) are located at  $10^{-18} \text{ m} < x_{EC} \leq 10^{-15} \text{ m}$  in the EC and LC charge space which is out of the force range ( $x < 10^{-18}$  m) of the strong boson force.

The boson force will be very strong to form the complete  $CC=-5$  state of  $A(CC=-5)_3$ . This means that the strong force constant of  $G_{NB}$  is very strong as shown in Fig. 3. Because a proton of p(1,0) acts like the lepton, three quarks of u, u and d inside p(1,0) have  $F_B(m_{EC})$  with the weak boson force constant of  $G_{NB}(m_{EC})$  and  $F_c(EC)$  with the lepton Coulomb force constant of  $k_2(EC) = k_{II}(EC)$ . This means that the confined quarks act like the leptons and these confined quarks decay via the weak force bosons as shown in the beta decays. In other words, the confined quarks (EC,LC), baryons (EC,LC) and mesons (EC,LC) have to be treated like the leptons (EC,LC) that use the lepton force constants like the lepton Coulomb constants, weak force boson constants and lepton gravitational constants. Here the mesons are separated into meson (EC,LC) and  $A(CC=0)$ . Here the  $A(CC=0)$  state acts like the photon on the CC charge space. The quark and anti-quark are confined in the CC charge space of  $A(CC=0)$  and are asymptotically free in the EC and LC charge space of meson (EC,LC).

In Figs. 6 and 7, three quarks are changed to the baryons by the quark confinement. The proton case is shown as one example. Three quarks are close enough to interact through the strong force bosons. These three quarks should be within  $x = 10^{-18}$  m which is the force range of the strong

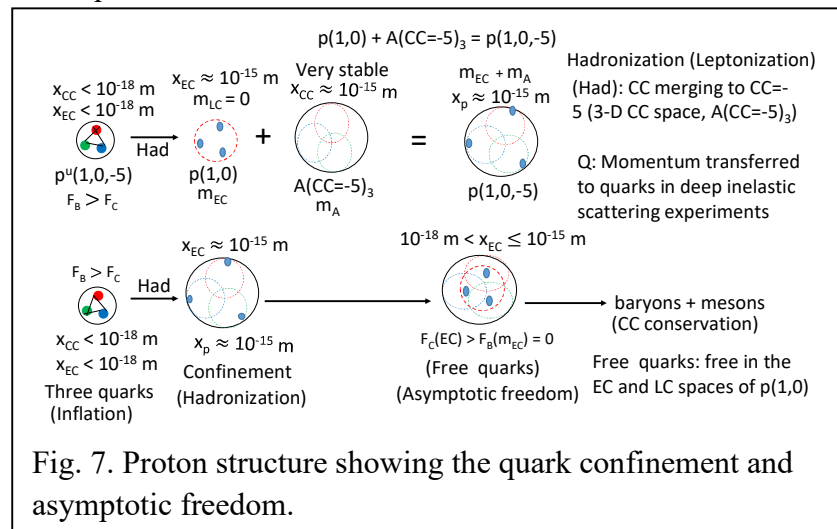


Fig. 7. Proton structure showing the quark confinement and asymptotic freedom.

boson force. And when these three quarks have the CC charges of  $-2/3$ ,  $-5/3$  and  $-8/3$ , three quarks form the baryon like a proton of  $p(1,0)$  and  $A(CC=-5)_3$ . A proton is shown as one example. The  $A(CC=-5)_3$  state is the strongly bound state and the  $p(1,0)$  state has the three free quarks of  $2u(2/3,0)$  and  $d(-1/3,0)$ . This is called as quark confinement. The strongly confined quarks are mostly located near the surface of the proton as seen in the EC charge distributions of the proton and neutron [6,7] in Fig. 8. The fast rotation of three free quarks in  $p(1,0)$  makes three quarks to stay near the surface of the proton as shown at the EC charge distribution of the proton. Therefore, in Fig. 6, the quarks moving out of the proton size of  $x_{EC}$ , the quarks feel the inward pressure (force) and the quarks moving into the proton size of  $x_{EC}$  feel the outward pressure (force) [9,10]. This outward pressure could be very strong inside the proton because the quark confinement caused by the  $A(CC=-5)_3$  coupling is very strong and stable. This phenomenon was observed from the pressure distribution inside the proton by Burkert et al. [10].

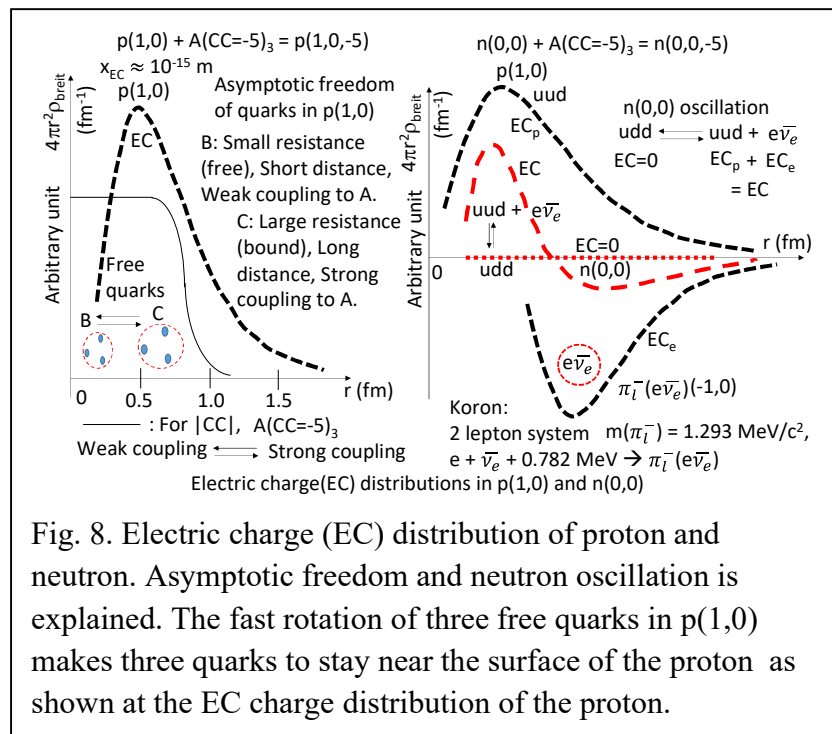
#### 4. Asymptotic freedom

The asymptotic freedom of the quarks has been observed inside the protons by using the deep inelastic scattering. This is very important because the attractive strong boson forces between quarks are decreasing or disappear at the short distance between the quarks. This means that the strong boson force does not follow the usual force formula with the  $1/r^2$  term. To explain the asymptotic freedom, the quantum chromodynamics with the gluon fields has been introduced [1-3].

In the present work, the asymptotic freedom and quark confinement are explained in terms of the 3-D quantized space model in Figs. 6 - 8. The gluons are not used, and the strong force bosons and color charges (CC) are newly introduced in the 3-D quantized space model (TQSM) [4,5]. The quark confinement is explained by the CC merging to  $A(CC=-5)_3$  state in the section 3. The proton consists of two parts of  $p(1,0)$  and  $A(CC=-5)_3$ . The  $2u$  and  $d$  quarks exist near the surface of the



proton and are relatively stable with the strong resistance by the connection to the very strongly coupled  $A(CC=-5)_3$  state. Three quarks are free without the strong EC and LC boson forces in the EC and LC spaces of  $p(1,0)$  and are strongly confined with the strong CC boson forces in the CC space of  $A(CC=-5)_3$ . The three quarks of  $p(1,0)$  have the relatively long distance between the quarks. The three quarks in  $p(1,0)$  fluctuates on the EC space. The  $A(CC=-5)_3$  state fluctuates between the strong CC coupling state and the weak CC coupling state on the CC space. Following the fluctuations of the  $A(CC=-5)_3$  state, the resistance of three quarks changes between the strong resistance and weak resistance when the quarks are moving. The center of mass of three quarks is at the center of the proton because the center of mass of the  $A(CC=-5)_3$  state is at the center of the proton. When three quarks have the weaker resistance, three quarks move to the distance closer to the center of the proton and the distance between the quarks get shorter. The three quarks near the center of the proton can move more freely with the much less resistance and have been investigated by the lepton (e/muon) deep inelastic scattering. The lepton (e/muon) deep inelastic scattering detected the asymptotically free quarks near the center of the proton. Therefore, the present



explanation in Figs. 6-8 agree with the observation of the lepton (e/muon) deep inelastic scattering experiments.

##### 5. Two lepton system (Koron) and neutron structure

In Fig. 8, the neutron with the (EC,LC,CC) charge configuration of (0,0,-5) has the EC charge distribution with the negative charge part and positive charge part. But the proton with the (EC,LC,CC) charge configuration of (1,0,-5) has only the positive EC charge distribution. It is expected that the EC charge distribution of the neutron should be zero like that of the proton has the positive EC charge part. Therefore, the observed data could indicate that the neutron fluctuates between the EC=0 state and observed EC state. In Fig. 8, the observed EC state can be originated from the combined EC charge state of proton and  $e\nu_e$ . The new state of two lepton system is called

as the Koron in the present work. And the new koron is  $\pi_l^-(e\bar{\nu}_e)$  in Fig. 8. The negative EC charge part in the neutron comes from the negative EC charge of the  $\pi_l^-(e\bar{\nu}_e)$  koron. The positive EC charge part in the neutron is originated from the positive EC charge of the proton. In conclusion, the neutron is oscillating between udd and uud+  $e\bar{\nu}_e$ . This neutron oscillation is, for the first time, reported in the present work. In the koron, the LC charges of should be merged to LC = 0. In other words, e and anti-electron neutrino have the charge configurations of (-1,-2/3) and (0,2/3), respectively. Therefore, the  $\pi_l^-(e\bar{\nu}_e)$  koron has the charge configuration of (-1,0) with the LC charge merging to LC=0. The LC merging energy is 0.782 MeV in Fig. 8. When the additional energy is added to the neutron, the combination of uud+  $e\bar{\nu}_e$  is broken and decays to an electron and anti-electron neutrino. In other words, the neutron oscillation is broken. This is called as the beta decay. Also, the inside structure of the uud part of the neutron could be investigated. Because the Coulomb force between the uud part and  $e\bar{\nu}_e$  part of the neutron is applied, the d quark could be pushed inward, and two u quarks could be pulled outward because the  $e\bar{\nu}_e$  part is relatively in the outside of the neutron. This can make the negative charge due to the pushed d quark to be located closer to the center of the neutron than the two u quarks. Miller and Arrington [11] reported the experimental result of the negative central charge density in the neutron in the year of 2008. This experimental discovery is consistent with the present understanding of the neutron structure.

## 6. Proton spin crisis and quark masses

The elementary particles have the intrinsic spin. The elementary particles have the spin of  $1/2$  and the elementary bosons have the spin of 1. The spin value is the very fundamental physical constant that does not change. Then one experiment raised the question of this fundamental spin value of

u quark			mass: MeV/c <sup>2</sup>			d quark			mass: MeV/c <sup>2</sup>			Proton	Spin	s(m <sub>EC</sub> )
EC	2/3	2/3	2/3	EC	-1/3	-1/3	-1/3	u(2/3,0,-2/3)	↑	+1/4				
CC	-2/3	-5/3	-8/3	CC	-2/3	-5/3	-8/3	u(2/3,0,-5/3)	↓	-2/14				
m <sub>EC</sub>	1.1	1.1	1.1	m <sub>EC</sub>	1.6	1.6	1.6	d(-1/3,0,-8/3)	↑	+1/18				
m <sub>CC</sub>	1.1	2.8	4.4	m <sub>CC</sub>	3.1	8.0	12.8	s(p(1,0))		0.163				
m(u)	2.2	3.9	5.5	m(d)	4.7	9.6	14.4	s(p(1,0,-5))		1/2				
s(m <sub>EC</sub> )	1/4	2/14	1/10	s(m <sub>EC</sub> )	1/6	1/12	1/18	a <sub>0</sub>		0.326				
s(m <sub>CC</sub> )	1/4	5/14	4/10	s(m <sub>CC</sub> )	2/6	5/12	8/18	m(A(CC=-5) <sub>3</sub> ) = 1.1 + 2.8 + 12.8 + m(E <sub>mer</sub> ) = 934.77						
s(u)	1/2	1/2	1/2	s(d)	1/2	1/2	1/2	m(E <sub>mer</sub> ) = 917.77 MeV/c <sup>2</sup>						
LC=0			LC=0											
Calculation(QCD): m(u) = 2.2 MeV/c <sup>2</sup> , m(d) = 4.7 MeV/c <sup>2</sup> ,														
Observation: s(p(1,0)) = s(p(1,0,-5))*0.33 = 0.165														
m <sub>p</sub> = m(p(1,0)) + m(A(CC=-5) <sub>3</sub> ) = 938.27 MeV/c <sup>2</sup>												m(A(CC=-5) <sub>3</sub> ) = m <sub>A</sub> = m <sub>cc</sub> + m(E <sub>mer</sub> )		
m(p(1,0)) = 2m(u(m <sub>EC</sub> )) + m(d(m <sub>EC</sub> )) = 3.8 MeV/c <sup>2</sup> ,												E <sub>mer</sub> : Merging energy		
s(p(1,0)) = a <sub>0</sub> s(p(1,0,-5)) = a <sub>0</sub> /2, a <sub>0</sub> = 0.33 ± 0.06 (HERMES), 0.26 - 0.36 (COMPASS)														

Fig. 9. Proton spin is calculated. The proton spin crisis is explained.

the proton. The European muon collaboration (EMC) performed the deep inelastic scattering by muon to search for the spin effect from the inside quarks. The observe spin from the quarks was nearly zero. And then the following experiments like HERMES and COMPASS [8] reports the quark effect of only 33(6) % and 26 – 36 % to the spin (1/2) of the proton. The missing spin of the proton is about 67 % which requires other explanations like the gluon effect or quark orbital angular momentum effect in terms of the quantum chromodynamics (QCD). But still the origin of the proton spin requires more studies experimentally and theoretically.

The proton spin of the proton is connected to the quark confinement that means the CC charge merging to  $A(CC=-5)_3$  state. In Figs. 6-8, the proton of  $p(1,0,-5)$  has two parts of  $p(1,0)$  and  $A(CC=-5)_3$ . The CC charge space correspond to the  $CC=-5$  state of  $A(CC=-5)_3$  and EC charge space corresponds to the  $p(1,0)$  state with only the EC charge. A proton has the lepton charge of  $LC=0$ . In the inelastic scattering by the lepton like muon and electron, the lepton has the Coulomb and weak interactions with the proton on the EC charge space. This indicates that the lepton

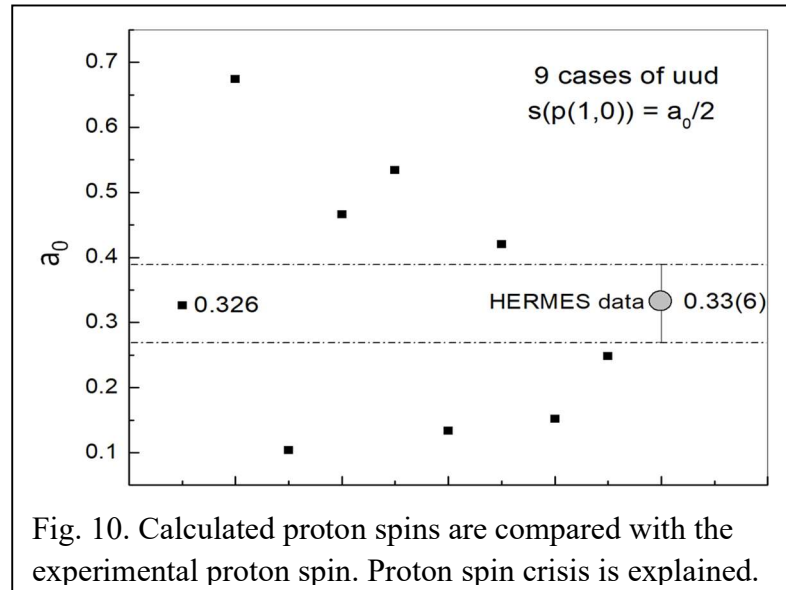


Fig. 10. Calculated proton spins are compared with the experimental proton spin. Proton spin crisis is explained.

interacts with the quarks in  $p(1,0)$  on the EC charge space. The observed spin should be the spin of the three quarks in  $p(1,0)$  but not in  $p(1,0,-5)$ . The CC charge part of  $A(CC=-5)_3$  should be excluded because the CC charge part of  $A(CC=-5)_3$  does not interact with the leptons like muon and electron with the EC and LC charges. The  $p(1,0)$  and  $A(CC=-5)_3$  states have the different masses and different spins. The spins of  $p(1,0)$  and  $A(CC=-5)_3$  depend on the spin contribution of three quarks.

Now one condition is assumed to calculate the proton spin. The assumption is that the intrinsic spin values of  $m_{EC}$ ,  $m_{LC}$  and  $m_{CC}$  for each fermion are proportional to the charge values of EC, LC and CC for each fermion. Note that  $p(1,0)$  is the lepton-like particle with the charge configuration of  $(EC=1, LC=0)$ . Based on this assumption, the spins of  $p(1,0)$  and  $A(CC=-5)_3$  are calculated from the spins of the three quarks. First of all, the spins of u and d quarks are calculated in Fig. 9. The intrinsic spin of  $1/2$  in the u and d quarks are separated to the spin ( $s(m_{EC})$ ) of the CC charge mass and spin ( $s(m_{CC})$ ) of the EC charge mass. From the condition that the intrinsic spin values of  $m_{EC}$ ,  $m_{LC}$  and  $m_{CC}$  for each fermion are proportional to the charge values of EC, LC and CC for each fermion, the spin tables of the u and d quarks are completed in Fig. 9. The 9 groups of three uud quarks are obtained under the condition of  $CC=-5$ . Total 9 cases gives total 9 spins of  $p(1,0)$  as shown in Fig. 10. Only one case corresponds to the the experimental value of HERMES that is the quark effect of only 33(6) % and 26 – 36 % to the spin ( $1/2$ ) of the proton. Three quarks are  $u(2/3,0,-2/3)$  with the up-spin of  $1/4$ ,  $u(2/3,0,-5/3)$  with the down-spin of  $-2/14$  and  $d(-1/3,0,-8/3)$  with up-spin of  $1/18$ . These quarks gibe the  $p(1,0)$  spin of 0.163 which corresponds to 32.6% of the total  $p(1,0,-5)$  spin of  $1/2$ . This calculated value of 32.6 % consists with the experimental value of 33(6) %. The  $A(CC=-5)_3$  state has the 67.4 % of the proton spin.

The quark mass cannot be obtained experimentally. Therefore, the quark mass has been calculated in terms of QCD. This calculated quark mass corresponds to the total mass of each quark. This

Leptons (l)			mass: MeV/c <sup>2</sup>			Leptons (l)			mass: MeV/c <sup>2</sup>		
	$\nu_e$	$\nu_\mu$	$\nu_\tau$		$\nu_e$	$\nu_\mu$	$\nu_\tau$		e	$\mu$	$\tau$
EC	0	0	0	EC	-1	-1	-1	$m_{EC}$	0.307	39.62	484.6
LC	-2/3	-5/3	-8/3	LC	-2/3	-5/3	-8/3	$m_{LC}$	0.204	66.04	1292.2
$m_{EC}$	0	0	0	$m(l)$	0.511	105.66	1776.8	$s(m_{EC})$	3/10	3/16	3/22
$m_{LC}$	$m(\nu_e)$	$m(\nu_\mu)$	$m(\nu_\tau)$	$s(m_{LC})$	2/10	5/16	8/22	$s(l)$	1/2	1/2	1/2
$m(l)$	$m(\nu_e)$	$m(\nu_\mu)$	$m(\nu_\tau)$								
$s(m_{EC})$	0	0	0								
$s(m_{LC})$	1/2	1/2	1/2								
$s(l)$	1/2	1/2	1/2								

From the lepton ( $e(-1,-2/3)/\mu(-1,-5/3)$ ) -  $p(1,0)$  deep inelastic scattering, spins ( $s(m_{EC})$ ) of the u and d quarks are determined. Total spins ( $s = 1/2$ ) of the u and d quarks should include the CC charge effect of  $A(CC=-5)_3$ . Note that  $p(1,0)$  is the lepton-like particle. The neutrino masses ( $m_{LC}$ ) are not zero because the lepton charges (LC) are not zero.

Fig. 11. Lepton spins are calculated for the EC and LC charge masses.

mass cannot be seriously considered because it could depend on the applied model. But in the table of Fig. 9, the QCD mass is applied to calculate the EC mass and CC mass of each quark. When the EC mass and CC mass of u and d quarks are calculated, the condition that the mass values of  $m_{EC}$ ,  $m_{LC}$  and  $m_{CC}$  for each fermion are proportional to the charge values of EC, LC and CC for each fermion is used. Then the mass of  $A(CC=-5)_3$  is obtained for the proton. And the  $CC=-5$  merging energy (917.17 MeV) of Emer is calculated for the proton.  $A(CC=-5)_3$  takes 934.47 MeV/c<sup>2</sup> from the proton mass of 938.27 MeV/c<sup>2</sup>. The total  $m_{EC}$  mass of three quarks is only 3.8 MeV/c<sup>2</sup>. Therefore, the  $A(CC=-5)_3$  state has the 99.6 % of the proton mass (938.27 MeV/c<sup>2</sup>). For the neutron of  $n(udd)$ ,  $n(0,0,-5) = n(0,0) + A(CC=-5)_3$ .  $A(CC=-5)_3$  takes 935.3 MeV/c<sup>2</sup> from the neutron mass of 939.6 MeV/c<sup>2</sup>. The total  $m_{EC}$  mass of three quarks is only 4.3 MeV/c<sup>2</sup>. Therefore, the  $A(CC=-5)_3$  state has the 99.5 % of the neutron mass (939.6 MeV/c<sup>2</sup>). The EC and CC masses of the leptons and the spins of the EC charge masses and LC charge masses are calculated in Fig. 11. The masses of the leptons are obtained experimentally. By using the experimental masses of the leptons like e, muon and tau, the EC mass and LC mass are calculated and the spin of the EC mass and spin of the LC mass are calculated in Fig. 11. The neutrino masses ( $m_{LC}$ ) are not zero because the lepton charges (LC) are not zero.

## 7. Quark mass determinations

The quark masses are dependent on the CC charges. The quark masses could be indirectly extracted from the meson masses and baryon masses [12]. As shown in Fig. 9, the u quark has three different masses corresponding to three different CC charges. In other words,  $u(2/3,0,-2/3)$ ,  $u(2/3,0,-5/3)$  and  $u(2/3,0,-8/3)$  have the masses of 2.2 MeV/c<sup>2</sup>, 3.9 MeV/c<sup>2</sup> and 5.5 MeV/c<sup>2</sup> if the QCD mass value (2.2 MeV/c<sup>2</sup>) of the u quark is the right mass of  $u(2/3,0,-2/3)$ . And,  $d(-1/3,0,-2/3)$ ,  $d(-1/3,0,-5/3)$  and  $d(-1/3,0,-8/3)$  have the masses of 4.7 MeV/c<sup>2</sup>, 9.6 MeV/c<sup>2</sup> and 14.4 MeV/c<sup>2</sup> if the QCD mass value (4.7 MeV/c<sup>2</sup>) of the u quark is the right mass of  $d(-1/3,0,-2/3)$ . Therefore, it will be

interesting to look for the mesons and baryons with the different combinations of the CC charges. From the data of mesons and baryons, it will be interesting to find the quark masses with the different CC charges. For the proton,  $p(1,0,-5) = p(1,0) + A(CC=-5)_3$ . The  $m_{EC}$  masses of the u quark and d quark are  $1.1 \text{ MeV}/c^2$  and  $1.6 \text{ MeV}/c^2$ , respectively.

In the quantum chromodynamics (QCD), the quark masses have been calculated by considering the gluon effects. I am using these masses as the total masses of the quarks in the present work. In

c quark			mass: $\text{MeV}/c^2$	s quark			mass: $\text{MeV}/c^2$
EC	2/3	2/3	2/3	EC	-1/3	-1/3	-1/3
LC	-1	-1	-1	LC	-1	-1	-1
CC	-2/3	-5/3	-8/3	CC	-2/3	-5/3	-8/3
$m_{EC}$	366	366	366	$m_{EC}$	16	16	16
$m_{LC}$	549	549	549	$m_{LC}$	48	48	48
$m_{CC}$	366	915	1464	$m_{CC}$	32	80	128
$m(c)$	1280	1830	2379	$m(s)$	96	144	192
$s(m_{EC})$	2/14	2/20	2/26	$s(m_{EC})$	1/12	1/18	1/24
$s(m_{LC})$	3/14	3/20	3/26	$s(m_{LC})$	3/12	3/18	3/24
$s(m_{CC})$	2/14	5/20	8/26	$s(m_{CC})$	2/12	5/18	8/24
$s(c)$	1/2	1/2	1/2	$s(s)$	1/2	1/2	1/2

Calculation(QCD):  $m(c) = 1280 \text{ MeV}/c^2$ ,  $m(s) = 96 \text{ MeV}/c^2$ ,

Fig. 12. Spins and masses of the c and s quarks are calculated for the EC, LC and CC charge masses.

the present work, because the gluons are not considered, the quark masses need to be recalculated in terms of the 3-D quantized space model. At this moment, how to calculate the partial masses and partial spins of the EC charge masses, LC charge masses and CC charge masses from the total masses of the quarks are shown in Figs. 9 - 13. In the deep inelastic scattering experiments, the total masses of the mesons and baryons have been obtained following their decay modes. Also, the partial spin of the EC + LC charge mass for the mesons and baryons can be measured by the inelastic scattering experiments. For example, the partial spin of the EC charge mass in the proton was measured by the lepton inelastic scattering. This partial spin of the EC mass in the proton is about 33(6) % of the total spin (1/2) of the proton. The calculated partial spin of the EC mass in the proton is 32.6 % of the total spin (1/2) of the proton. From this observation, the partial spins and partial masses of the EC charge mass and CC charge mass of the proton can be calculated as shown in Fig. 9. The partial spins and partial masses of the EC charge masses and LC charge masses of the leptons can be calculated as shown in Fig. 11. For the information, the partial spins and partial masses of the EC charge mass, LC charge masses and CC charge mass of the c, t, s and b quarks can be calculated as shown in Figs. 12 and 13.

## 8. Summary

In summary, the relative force strengths of the Coulomb forces, gravitational forces, dark matter forces, weak forces and strong forces are compared for the dark matters, leptons, quarks, and normal matters (p and n baryons) in terms of the 3-D quantized space model. The Coulomb forces between the dark matters (bastons) are nearly zero and  $k_1(EC) = k_{dd}(EC)$  is nearly zero. The gravitational force constant between the dark matters and normal matters is weaker by 1/3 than the gravitational force constant between the normal matters. The gravitational force constant between the dark matters is weaker by 1/3 the gravitational force constant between the normal matters. These conditions for the gravitational forces and Coulomb forces can explain the observed properties of the normal matters and dark matters in our universe.

The EC charge space of the leptons and CC charge space of the quarks have the same properties of the charge quantities and force strengths. This means that the Coulomb forces and Coulomb constants are nearly zero for the EC charge space of the leptons and CC charge space of the quarks.

t quark			mass: GeV/c <sup>2</sup>			b quark			mass: GeV/c <sup>2</sup>			Bastons (DM)			mass: eV/c <sup>2</sup>		
EC	2/3	2/3	2/3	EC	-1/3	-1/3	-1/3		B1	B2	B3	EC	-2/3	-5/3	-8/3		
LC	-2	-2	-2	LC	-2	-2	-2	$m_{EC}$	26.1	4.27	1.95	$m_{EC}$		$10^{10}$	$10^{15}$		
CC	-2/3	-5/3	-8/3	CC	-2/3	-5/3	-8/3	$s(m_{EC})$	1/2	1/2	1/2						
$m_{EC}$	34.6	34.6	34.6	$m_{EC}$	0.46	0.46	0.46	Calculation(TQSM): $m_{EC}$									
$m_{LC}$	103.9	103.9	103.9	$m_{LC}$	2.79	2.79	2.79										
$m_{CC}$	34.6	86.5	138.4	$m_{CC}$	0.93	2.33	3.72										
$m(t)$	173.1	224.9	276.8	$m(b)$	4.18	5.58	6.98										
$s(m_{EC})$	2/20	2/26	2/32	$s(m_{EC})$	1/18	1/24	1/30										
$s(m_{LC})$	6/20	6/26	6/32	$s(m_{LC})$	6/18	6/24	6/30										
$s(m_{CC})$	2/20	5/26	8/32	$s(m_{CC})$	2/18	5/24	8/30										
$s(t)$	1/2	1/2	1/2	$s(b)$	1/2	1/2	1/2										

Calculation(QCD):  $m(t) = 173.1 \text{ GeV}/c^2$ ,  $m(b) = 4.18 \text{ GeV}/c^2$ ,

Fig. 13. Spins and masses of the t and s quarks are calculated for the EC, LC and CC charge masses. Spins and masses of the bastons (DM, dark matters) are shown [5].

Then, it means that  $k_1 = k_{qq}(CC) = k_{ll}(LC) = k_{dd}(EC) \approx 0$ . The quark confinement in the proton is caused by the strong CC merging to the  $A(CC=-5)_3$  state in the proton. To make the strong coupling of the  $A(CC=-5)_3$  state, the CC part of the strong boson force needs to be strong. The proton size is decided by the size of the  $A(CC=-5)_3$  state.

The quark confinement and asymptotic freedom are explained by the CC merging to the  $A(CC=-5)_3$  state. The proton with the (EC,LC,CC) charge configuration of  $p(1,0,-5)$  is  $p(1,0) + A(CC=-5)_3$ . The three quarks in  $p(1,0,-5)$  are free in the EC and LC space of  $p(1,0)$  and are strongly confined in the CC space of  $A(CC=-5)_3$ . The three quarks in  $p(1,0)$  are located at  $10^{-18} \text{ m} < x_{EC} \leq 10^{-15} \text{ m}$  which is out of the force range ( $x < 10^{-18} \text{ m}$ ) of the strong boson force.  $A(CC=-5)_3$  takes  $934.47 \text{ MeV}/c^2$  from the proton mass of  $938.27 \text{ MeV}/c^2$ . The total  $m_{EC}$  mass of three quarks is only  $3.8 \text{ MeV}/c^2$ . Therefore, the  $A(CC=-5)_3$  state has the 99.6 % of the proton mass ( $938.27$

MeV/c<sup>2</sup>). For the neutron of n(udd),  $n(0,0,-5) = n(0,0) + A(CC=-5)_3$ .  $A(CC=-5)_3$  takes 935.3 MeV/c<sup>2</sup> from the neutron mass of 939.6 MeV/c<sup>2</sup>. The total  $m_{EC}$  mass of three quarks is only 4.3 MeV/c<sup>2</sup>. Therefore, the  $A(CC=-5)_3$  state has the 99.5 % of the neutron mass (939.6 MeV/c<sup>2</sup>).

The lepton beams in the deep inelastic scattering interact with p(1,0) by the EC interaction and weak interaction. Then, the observed spin is the partial spin of p(1,0) which is 32.6 % of the total spin (1/2) of the proton. The  $A(CC=-5)_3$  state has the 67.4 % of the proton spin. This explains the proton spin crisis. The EC charge distribution of the proton is the same to the EC charge distribution of p(1,0) which indicates three quarks in p(1,0) are mostly near the proton surface. From the EC charge distribution, the 2 lepton system (called as the koron) of the  $\pi_l^- (e\bar{\nu}_e)$  koron is, for the first time, reported in the present work.

The partial spins and partial masses of the EC charge mass and CC charge mass of the proton can be calculated as shown in Fig. 9. The partial spins and partial masses of the EC charge masses and LC charge masses of the leptons can be calculated as shown in Fig. 11. For the information, the partial spins and partial masses of the EC charge mass, LC charge masses and CC charge mass of the c, t, s and b quarks can be calculated as shown in Figs. 12 and 13.

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