The Non-Uniform Pion Tetrahedron Condensate Aether and the Electron Cloud

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Abstract: We propose that the QCD vacuum pion tetrahedron condensate density may vary in space and drop to extremely low values in the Kennan, Barger and Cowie (KBC) void in analogy to earth's atmospheric density drop with elevation from earth. We propose a formula for the gravitation acceleration based on the non-uniform pion tetrahedron condensate. The MOND acceleration limit may be due to the extremely low pion tetrahedron condensate density at the galaxies' edges. Gravity may be due to the underlying microscopic attraction between quarks and antiquarks which are part of the vacuum pion tetrahedron condensate. Due to rapid quark exchange reactions between electrons, assumed to be comprised of four quarks and antiquarks, and the pion tetrahedrons, the electrons are delocalized electron clouds. The electrons are comprised of tetraquarks $d\tilde{u}\tilde{d}d$, where the $d\tilde{u}$ quarks determine the electron charge and the $\tilde{d}d$ quarks determine the electron tetraquark spin state. A $\tilde{u}u$ quarks determine the second spin state for the electron tetraquark $d\tilde{u}\tilde{u}u$. The major difference between classical and quantum mechanics may be due to the antimatter discovered by Dirac that may be part of the Aether. The central roles of antimatter and the non-uniform QCD vacuum that contains antimatter were not anticipated by general relativity and quantum mechanics. Their roles are not fully understood still and the discovery of the KBC giant voids and the possibility of a non-uniform pion tetrahedron condensate Aether need further study.

Keywords: QCD vacuum condensate, KBC Void, Antimatter, MOND Theory, Aether, Superfluid and Pion tetrahedron condensate.

1. Non-Uniform Universe – the KBC Giant Voids

Kennan, Barger and Cowie (KBC)[1] found that galaxy counts and measurements of the luminosity density in the near infrared indicate the possibility that the local universe may be under-dense on scales of several hundred megaparsecs. The presence of a largescale under-density in the local universe could introduce significant biases into the interpretation of cosmological observables and into the inferred effects of dark energy on the expansion rate.

According to Banik[2,3], we live in a giant void in space, an area with below average density that could inflate local measurements through outflows of matter from the void. Outflows would arise when denser regions surrounding a void pull it apart – they'd exert a bigger gravitational pull than the lower density matter inside the void. We are near the center of a huge void about a billion light years in radius and with density about 20% below the average for the universe. The Cosmic Microwave Background (CMB) suggests that matter should be uniformly spread out. However, directly counting the number of galaxies in different regions suggests that we are in a local void contradicting the CMB uniform and isotropic universe. Such a huge deep void was not expected in the standard model and is controversial. If the universe is not uniform and isotropic, what about its underlying QCD vacuum quark condensate, can it also be non-uniform?

2. Non-Uniform QCD Vacuum Quark Condensate

Brodsky et al[4,5] presented a new perspective on the nature of quark and gluon condensates in quantum chromodynamics where the QCD condensates are restricted to the interiors of hadrons. According to Brodsky these condensates arise due to the interactions of confined quarks and gluons leaving the external QCD vacuum empty, devoid of vacuum condensates that fill space-time. Lee[6] argues in favor of the non-vanishing QCD vacuum quark condensate and refutes the notion of Brodsky in-hadron only quark and gluon condensates. Halle et al presented equations that reveal effects of modified gravity and dark matter with a non-uniform dark energy fluid[7].

Buballa and Carignano studied an inhomogeneous chiral condensate, which is constant in vacuum and may become spatially modulated at moderately high densities where in the traditional picture of the QCD phase diagram a first-order chiral phase transition occurs[8].

We propose that the QCD vacuum pion tetrahedron condensate[9] exist and that its density in space is non-uniform and should drop in the KBC giant voids in analogy to earth's atmospheric density drop[10]. We propose to calculate the gravitation acceleration from the non-uniform pion tetrahedron condensate density variation. In the extreme MOND limit at the galaxies' edges with r > λ, the gravitational acceleration is stronger and given by $\frac{GM}{\lambda r}$ [11] and not $\frac{GM}{r^2}$.

3. Non-Uniform Pion Tetrahedron Condensate

In 1983 Milgrom proposed the Modified Newtonian Dynamics theory, MOND[12-15], explaining the observed rotational curves of galaxies without adding dark matter, which Kroupa et al suggest does not exist[16]. MOND is a phenomenological theory and does not provide a microscopic mechanism explaining the crossover to the extremely low accelerations limit far from the galaxy center. Milgrom proposed a new acceleration constant $a_0 = 1.2 * 10^{-10}$ cm/sec^2 that fits well the observed galaxy rotation curves. The MOND gravitational force and acceleration in the MOND limit where a << a_0 is -

$$F = m\ \frac{a^2}{a_0} \tag{1}$$

In a previous paper[9] we assumed that the QCD vacuum pion tetrahedron condensate drops like the atmospheric density due to gravity as shown in the figure 1 on the left hand side. We proposed that similar to ideal gas kinetic theory, the pressure difference on a virtual box top and bottom surfaces that contains an infitisimal volume of the pion tetrahedron condensate is due to the difference in the number of collisions at the top and the bottom surfaces due to the non-uniform pion tetrahedron condensate density induced by a massive stars, where M is the star mass, r is the distance to the star, and ρ is the pion tetrahedron condensate density. A and dr are the surface area and height of the virtual integration box -

$$p_{up}A - p_{bottom}A = -\frac{\rho A dh GM}{r^2} \tag{3}$$

Assuming an ideal gas state equation ($PV = nk_BT$) for the pion tetrahedron condensate ρ with particle mass m_π–

$$\rho = \frac{m_\pi n}{V} = \frac{m_\pi p}{k_B T} \tag{4}$$

The differential equation for the non-uniform condensate pressure is -

$$\frac{dp}{p} = -\frac{G\, m_\pi M}{k_B T\, r^2} dr \tag{5}$$

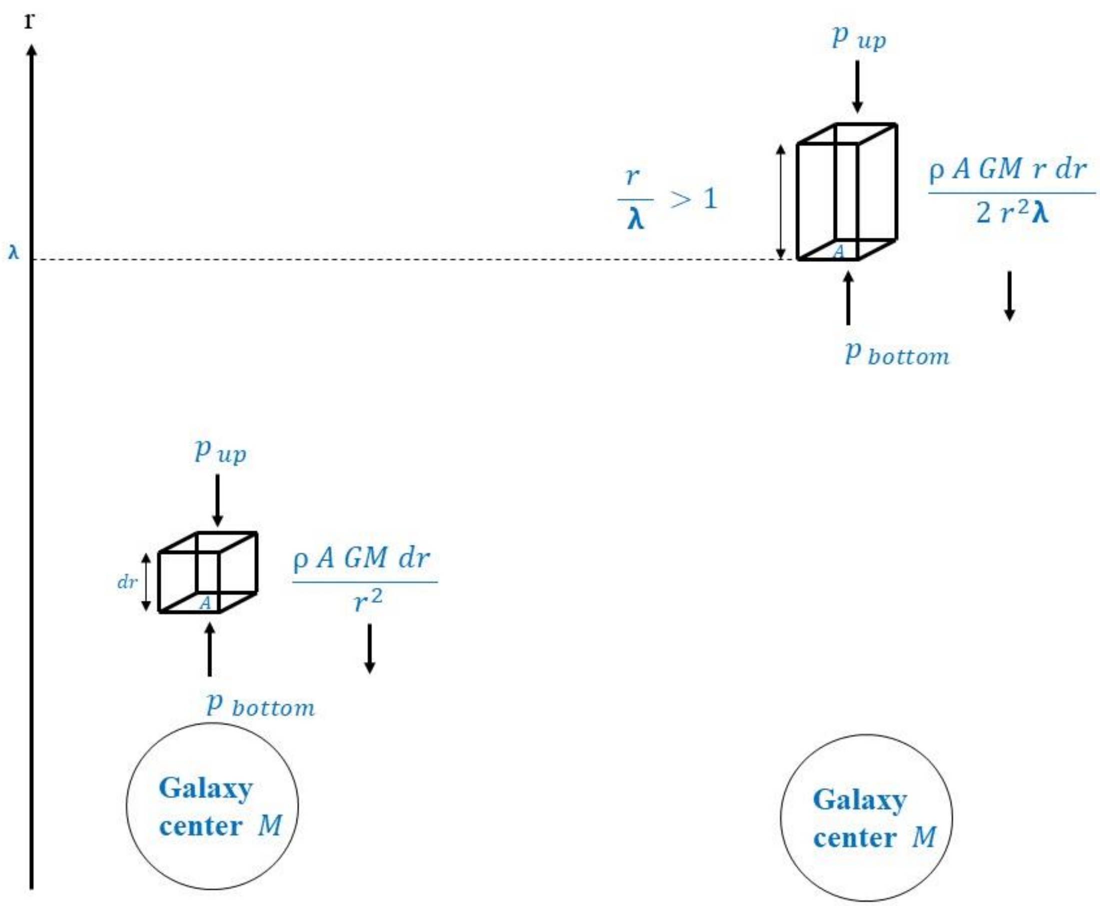

Figure 1 illustrates on the left-hand-side the pressure difference on a virtual box of area A and height dr that contains the pion tetrahedron condensate close to the galaxy center and on the right-hand-side, the box height element dr is stretched by the term r/**λ** > 1 at the MOND limit.

We can rewrite equation 5 as

$$\frac{1}{p}\frac{dp}{dr} = -\frac{G\, m_\pi M}{k_B T\, r^2} \tag{6}$$

The gravitational acceleration applied on a mass m inside the virtual box of figure 1 above due to the non-uniform pion tetrahedron condensate density is-

$$g_N = -\frac{k_B T}{m_\pi}\,\frac{1}{p}\,\frac{dp}{dr} = \frac{GM}{r^2} \tag{7}$$

We propose below that particles are attracted to their antimatter particles and since the antimatter density at the bottom of the virtual box is higher than at its top (as part of the pion tetrahedron density), particles will have more frequent exchange reactions with pion tetrahedron condensate at the bottom and will move downwards.

However, far from the galaxy center with the MOND acceleration limit, a << a_0, the pion tetrahedron condensate is extremely diluted and we propose to scale up the virtual box height with the term $\frac{r}{\lambda}$ > 1 to allow more collisions to occur in the diluted virtual box. In the MOND limit, the antimatter density difference between the upper and lower virtual integration box surfaces is extremely low. Particles that will move downwards will increase the chiral entropy of the pion tetrahedron condensate since they will have more collisions that will increase the frequency of flipping the chirality of the pion tetrahedron condensate. The differential equation for the non-uniform condensate pressure (equation 5 above) with the scaling term $\frac{r}{\lambda}$ is -

$$\frac{1}{p}\frac{dp}{dr} = -\frac{G m_\pi M}{k_B T\, r^2}\left(\frac{r}{\lambda}\right) \tag{8}$$

The gravitational acceleration (equation 7 above) in the MOND limit is-

$$g_{MOND} = -\frac{k_B T}{m_\pi}\frac{1}{p}\frac{dp}{dr} = \frac{GM}{\lambda r} \tag{9}$$

Hence, the acceleration far from the galaxy center, at r >> λ where $g \ll a_0$, is $\frac{GM}{\lambda r}$ and not the Newtonian acceleration $\frac{GM}{r^2}$ with $\lambda = \sqrt{\frac{MG}{a_0}}$ -

$$g_{MOND} = \frac{GM}{\lambda r} = \frac{\sqrt{GMa_0}}{r} \tag{10}$$

The MOND gravitational acceleration at the galaxy edge is extremely small but will be larger than the Newtonian gravitation acceleration if r >> λ. For the milky-way mass, $\lambda = 51.5$ parsecs and the galaxy radius is about 16 parsecs so the MOND limit is not reached.

4. The Pion Tetrahedron Condensate and Matter Dynamics

In previous papers we proposed that hadron quarks perform quark exchange reactions with the pion tetrahedrons[9-10,17-20]. The pion tetrahedrons collide with each other like in the ideal gas model as shown in figure 2 below. The gluons exchanges may flip the quark flavor from d to u and vice versa.

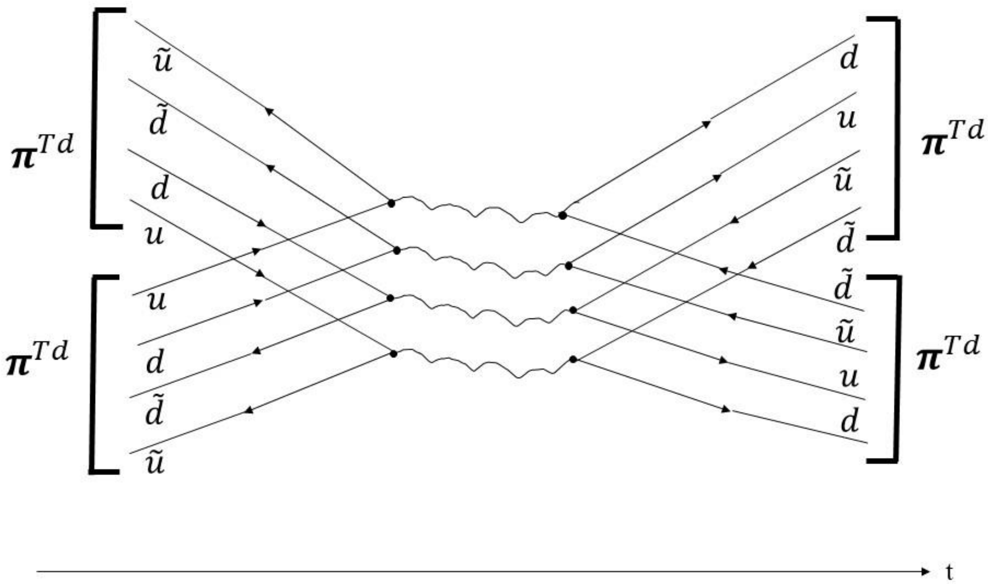

Figure 2 illustrates scattering of two pion tetrahedrons in the pion tetrahedron condensate.

Baryonic particles, a neutron or a proton for example, may interact with the pion tetrahedron condensate via tunneling. For example, a hot d and u quarks of an accelerated neutron (dud) or accelerated proton (uud) can be exchanged with a cold d and u quarks of a pion tetrahedron via gluons as shown in equations 11a and 11b and the Feynman diagram below. The two antiquarks of the pion tetrahedrons $\tilde{d}$ and $\widetilde{u}$ are the active reagents that trigger the exchange reactions as shown in the Feynman diagrams below -

$$dud + u\tilde{d}d\widetilde{u} \rightarrow ddu + u\tilde{d}d\widetilde{u} \qquad (11a)$$

$$uud + u\tilde{d}d\widetilde{u} \rightarrow udu + u\tilde{d}d\widetilde{u} \qquad (11b)$$

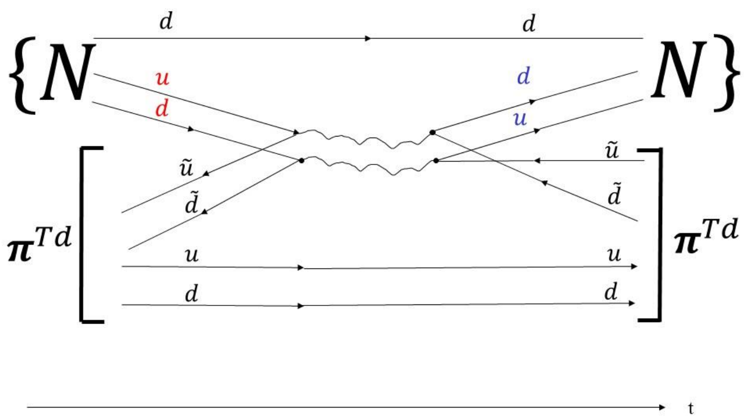

Figure 3 illustrates quarks exchange reaction of a neutron and a pion tetrahedron where the antiquarks $\tilde{d}$ *and* $\widetilde{u}$ are the reagents that drive the exchange reactions via gluons.

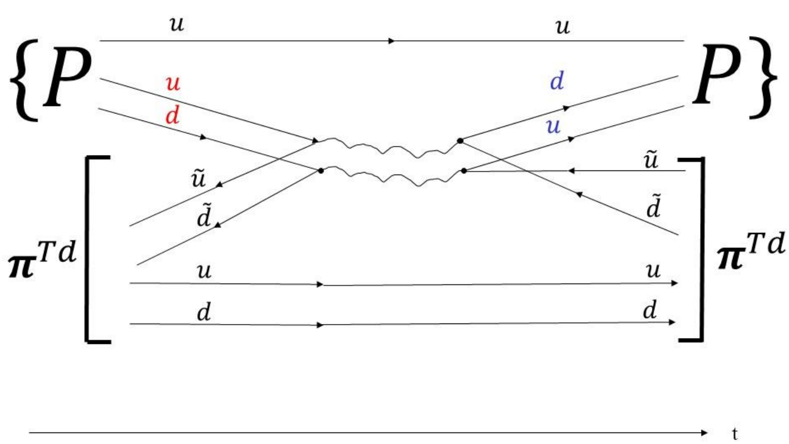

Figure 4 illustrates quarks exchange reaction of a proton and a pion tetrahedron where the antiquarks $\tilde{d}$ *and* $\widetilde{u}$ are the reagents that drive the exchange reactions via gluons.

Feynman diagrams are used to describe high energy scattering events where momentum and energy is transferred in high energy particle colliders. However, we propose here that the quark exchange reactions described above with the pion tetrahedron condensate occur at low energies via tunneling and contribute to the binding energy of the protons and neutrons that are surrounded by a cloud of pion tetrahedrons. In a previous paper we used a double well potential model to describe the binding between a neutron and a proton in a deuterium nucleus[10] and here we propose that the double well potential model may be also used for protons and neutrons surrounded by pion tetrahedron cloud. Accordingly, equation 11a and 11b may be seen as dynamic equilibrium equations for tunneling reactions in a double well symmetric potentials and the barrier heights may be proportional to the condensation energy gap **Δ**.

$$dud + u\tilde{d}d\tilde{u} \rightleftarrows ddu + u\tilde{d}d\tilde{u} \qquad (12a)$$

$$uud + u\tilde{d}d\tilde{u} \rightleftarrows udu + u\tilde{d}d\tilde{u} \qquad (12b)$$

5. The Source of Gravity

We hypothesize that the source of gravity is the microscopic attraction of antimatter to matter, e.g. the underlying attraction of antiquarks and quarks mediated by the vacuum condensate pion tetrahedrons. The protons and neutrons' quarks attract the vacuum pion tetrahedrons antiquarks and create clouds of pion tetrahedrons around them with a density drop similar to the atmospheric density drop. The protons and neutrons perform high frequency quark and antiquark exchange reactions with the pion tetrahedrons described by equation 12a and 12b via tunneling through the gap barrier **Δ**. The protons and neutrons quarks are attracted to the antimatter densities of neighboring particles' clouds as shown in the figure 5 below. The source for gravity is than the attraction between quarks and antiquarks and the pion tetrahedron atmospheric like pressure drop around a massive body.

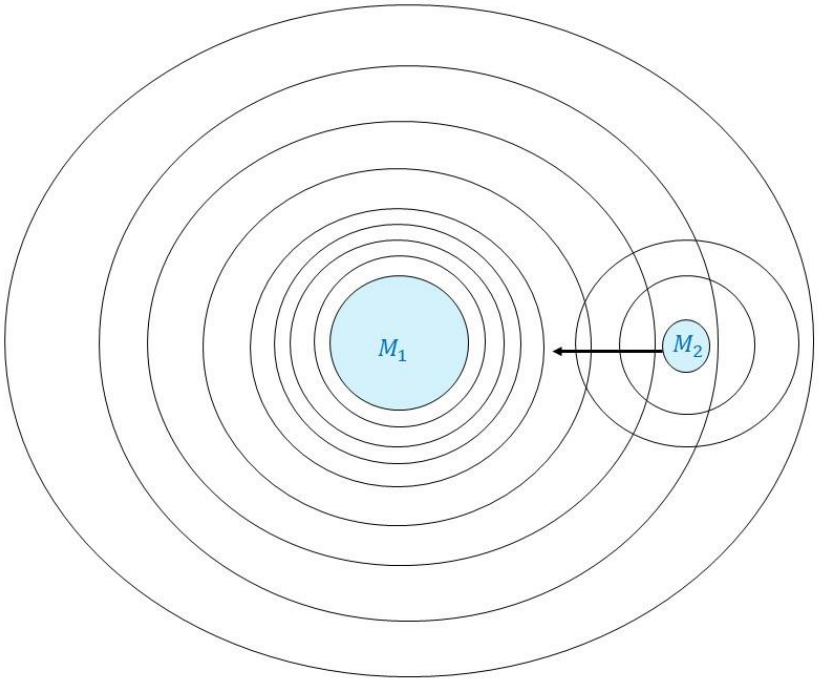

Figure 5 illustrates the pion tetrahedron densities around two masses, M1 >> M2. Since M1 attracts higher density of pion tetrahedrons, M2 will be attracted to it and will fall inwards in the direction of increasing pion tetrahedron density.

We propose to calculate the non-uniform pion tetrahedron condensate pressure based on an ideal gas kinetics where the pion tetrahedrons gravitate and collide with each other in the field of a massive body. Then, based on the pion tetrahedron condensate pressure, a formula for the gravitational acceleration is proposed (see equations 7 and 9). The pion tetrahedron density far from galaxy clusters may be extremely reduced in the KBC giant voids and may reach the MOND acceleration limit.

We assumed an ideal gas equation for the pion tetrahedrons in equation 4, however, the pion tetrahedron condensate is not an ideal gas. We assume that it can perform quark exchange reactions with matter particles and hence is reactive and it probably be better described for example by Sinha et al invisible superfluid fermion and antifermions Aether[21]. We proposed that the pion tetrahedrons are comprised of two light valence quarks and antiquarks, hence, antiquarks fill space in huge quantities and they have a central role in physics.

Migdal studied π condensation in nuclear matter and suggested that neutral and charged pions condense to superfluid in neutron stars[22]. Sinha et al invisible superfluid Aether[21] pervades the entire universe and may account for the missing matter. Sinha et al assumed that the density of visible matter in the universe is about 2* $10^{-31}\ \frac{gram}{cm^3}$ where the density of the invisible superfluid Aether is much higher and is on the order of $10^{-29}\ \frac{gram}{cm^3}$. The pion tetrahedron condensate may be the invisible superfluid Aether that may account for the missing matter with no need to add new dark matter particles and its density may be related to Einstein's equation cosmological constant Λ. However, Sinha's superfluid Aether model did not specify explicitly if its density may be non-uniform, $\Lambda(\vec{x})$, and did not specify the attraction mechanism between pairs that triggers the condensation and creates the energy gap.

6. The Electron Spin and the Electron Cloud

We hypothesized in a previous paper that electrons may be composite particles comprised of four quarks - $d\tilde{u}\tilde{d}d$.[18] We propose here that the tetrahedron $d\tilde{u}$ quarks determine the electron charge and the $\tilde{d}d$ quarks determine the electron spin. The second spin state includes instead of the $\tilde{d}d$ quarks the $\tilde{u}u$ quarks, hence the electron is comprised of $d\tilde{u}\tilde{u}u.$ Similarly, the positron two spin states are $u\tilde{d}\tilde{d}d$ and $u\tilde{d}\tilde{u}u.$

The bonding between two electrons with opposite spins may be seen as a QCD pionic bond where a pion tetrahedron, $u\tilde{u}d\tilde{d},$ is created by the electron pair. The pionic bond act as QCD glue, a mediator particle as shown below -

$$d\widetilde{u}\,d\tilde{d} + \ d\widetilde{u}\,u\tilde{u} \quad \rightleftarrows \quad d\tilde{u}\,u\tilde{u}d\tilde{d}\,d\widetilde{u} \qquad (13)$$

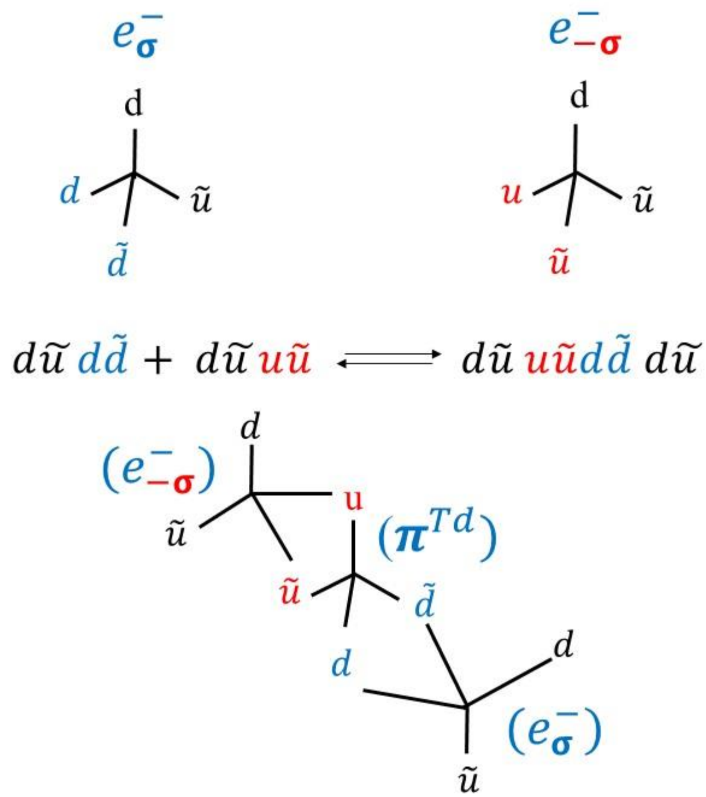

Figure 6 illustrates the pionic bond between two electrons with opposite spins mediated by a pion tetrahedron.

We assume that frequent spin conserved quark exchange reactions transform electrons to pion tetrahedrons and vice versa conserving the spin state. Hence, the electrons surrounded by the vacuum pion tetrahedron condensate form delocalized clouds where their spin state does not change, e.g. is a constant of motion, as shown in the figure below and in equations 14a-b -

$$d\tilde{u}\, d\tilde{d}(e^-_\sigma) + d\tilde{u}\, u\tilde{d}\,(\pi^{Td}) \rightleftarrows d\tilde{u}\, u\tilde{d}\,(\pi^{Td}) + d\tilde{u}\, d\tilde{d}\,(e^-_\sigma) \qquad (14a)$$

$$d\tilde{u}\, u\tilde{u}(e^-_{-\sigma}) + d\tilde{u}\, u\tilde{d}\,(\pi^{Td}) \rightleftarrows d\tilde{u}\, u\tilde{d}\,(\pi^{Td}) + d\tilde{u}\, d\tilde{d}\,(e^-_{-\sigma}) \qquad (14b)$$

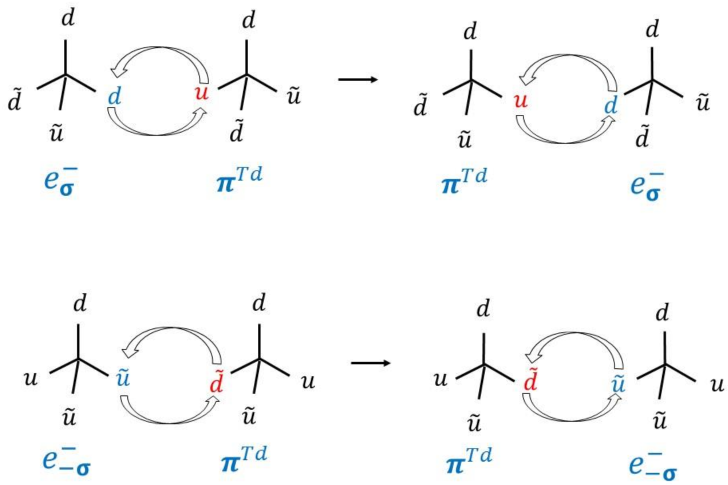

Figure 7 illustrates quark exchange reaction between electrons and pion tetrahedrons that from delocalize electron cloud and conserve the electron spin.

The following quark exchange reaction between electrons and pion tetrahedrons may convert the incoming electron spin, however, the d and $\tilde{u}$ quarks exchange will probably occur under external magnetic field only since we know that spin is conserved if no external field is applied.

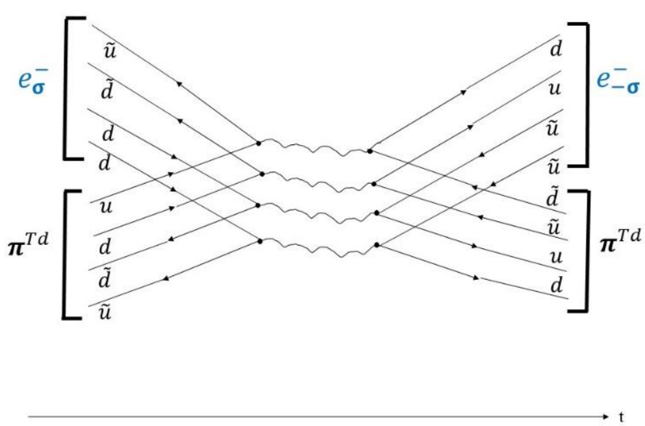

Figure 8 illustrates quark exchange reaction between electrons and pion tetrahedrons that convert the electron spin. This reaction will occur probably in external magnetic field only.

The annihilation reaction of electrons and positrons depend on their spin states –

$$d\widetilde{u}\,d\tilde{d} + u\widetilde{d}\,u\tilde{u} \quad \rightleftarrows \quad 2\ d\tilde{u}u\tilde{d} \qquad (15a)$$

$$d\widetilde{u}\,u\tilde{u} + u\widetilde{d}\,d\tilde{d} \quad \rightleftarrows \quad 2\ d\tilde{u}u\tilde{d} \qquad (15b)$$

However, if the electron and positron have the same spin state, the result are not two pion tetrahedrons but other tetrahedrons with the same spin state a $d\widetilde{d}\,d\tilde{d}$ and a $u\widetilde{u}\,u\tilde{u}$ -

$$d\widetilde{u}\,d\tilde{d} + u\widetilde{d}\,d\tilde{d} \quad \rightleftarrows \quad d\tilde{u}u\tilde{d} + d\widetilde{d}\,d\tilde{d} \qquad (16a)$$

$$d\widetilde{u}\,u\tilde{u} + u\widetilde{d}\,u\tilde{u} \quad \rightleftarrows \quad d\tilde{u}u\tilde{d} + u\widetilde{u}\,u\tilde{u} \qquad (16b)$$

We hypothesize that these are energetic unstable tetrahedrons that split fast to two $\boldsymbol{\gamma}$ rays, which can be seen as electromagnetic waves that propagate in the underlying pion tetrahedron condensate.

Similarly, we propose that protons and neutrons, which are also fermions having two spin states have similar $\tilde{d}d$ or $\tilde{u}u$ quarks in their center. The protons and neutrons may be the pentaquarks shown below –

$P_{\boldsymbol{\sigma}}$ u $d\ \tilde{d}d\ u$

$P_{-\boldsymbol{\sigma}}$ u $d\ \tilde{u}u\ u$

$N_{\boldsymbol{\sigma}}$ u $d\ \tilde{d}d\ d$

$N_{-\boldsymbol{\sigma}}$ u $d\ \tilde{u}u\ d$

Figure 9 illustrates protons and neutrons as pentaquarks with spins determined by the $\tilde{d}d$ or $\tilde{u}u$ pairs.

Confusing indeed, the fermion spin may be a quantum characteristic of the comprised particles, electrons, protons and neutrons and not of individual quarks that in any case cannot be observed separately.

Nature tends to duplicate its tricks. The difference between a proton and a neutron composition is only a single quark, a d quark in a neutron is replaced by a u quark in a proton. Similarly, the difference between an electron and a pion tetrahedron is only a single quark. A d quark in the electron is replaced by a u quark in the pion tetrahedron and vice versa as shown below.

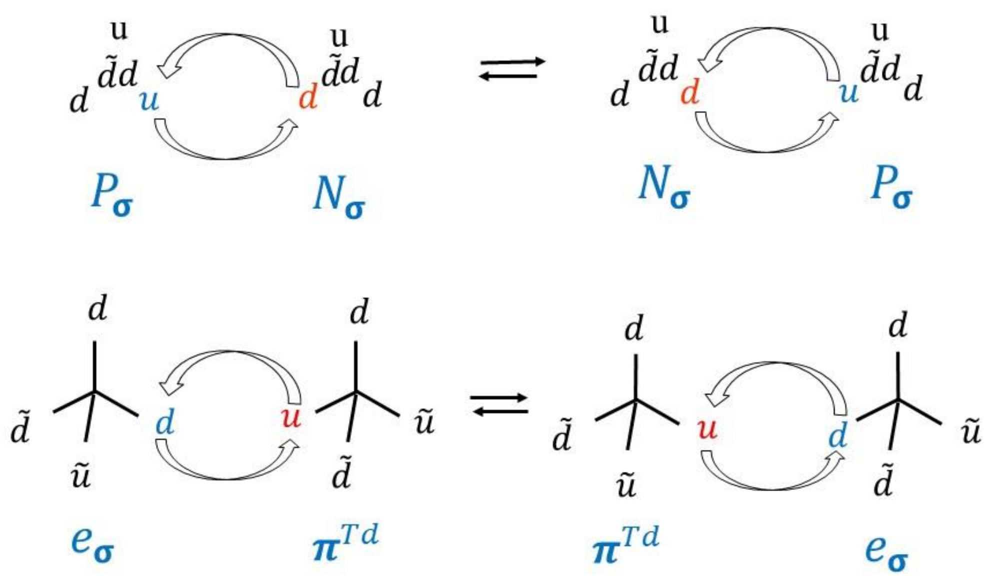

Figure 10 illustrates protons and neutrons exchanging the d and u quarks and similarly the electron and pion tetrahedron exchange the same d and u quarks.

7. The Hypothesis Summary

The non-uniform pion tetrahedron condensate and electron cloud hypothesis summary is:

1. **The pion tetrahedron condensate** $-$ the $u\tilde{d}d\tilde{u}$ pion tetrahedrons fill space, condense and form the QCD ground state condensate. The $u\tilde{d}d\tilde{u}$ pion tetrahedron mass may be calculated by measuring the β decay rate variability[9].
2. **The pion tetrahedron polarization integral** – the vacuum polarization Feynman integral does not diverge since it has the rotational ellipsoid shape for two quark and antiquark loops and the limit of infinite number of pion tetrahedrons, the vacuum polarization integral vanish and the pion tetrahedron condensate is stable[10].
3. **The chiral symmetry breaking** $-$ the $u\tilde{d}d\tilde{u}$ pion tetrahedrons have two chiral states and may flip their state via gluon exchanges dynamically and hence the chiral symmetry is broken.[20]
4. **The stable sub-particles** - the stable particles are the light $u\,,\ d,\ \ \tilde{d}\ and\ \tilde{u}$ quarks and antiquarks that comprise the electrons, protons and neutrons with two spin states determined by $u\tilde{u}\ or\ d\tilde{d}$ pairs.
5. **The spin and the electron cloud** – the source of spin is the $u\tilde{u}$ and $d\tilde{d}$ quark pairs included in electrons, protons and neutrons. We assume that frequent spin conserved quark exchange reactions transform electrons to pion tetrahedrons and vice versa for both electron spin states. Hence, electrons form delocalized clouds, and their spin is conserved.
6. **The pionic bond** – the electron pairing mechanism with opposite spins in atoms and molecules forming chemical bonds and Cooper pairs are enabled by creating a pion tetrahedrons that act like a glue mediator.

7. **The matter and antimatter symmetry** - there are equal number of quarks and antiquarks in the universe. The missing antimatter particles may be hidden under the event horizon surfaces of black holes. The neutrons, protons and electrons may be created from the QCD pion tetrahedrons by the black hole laser effect and they are ejected to space from the black hole event horizons.[17]
8. **The transition state particles** – the unstable transition state particles are comprised of various combinations of the u , d, $\tilde{d}$, $\widetilde{u}$ quarks and antiquarks, for example the unstable heavy quark flavors may be: $s = du\tilde{d}d\widetilde{u}$, $c = u\widetilde{u}\, d\tilde{d}u$, $b = du\tilde{d}d\widetilde{u}\, u\tilde{d}d\widetilde{u}$, $t = u\widetilde{u}\, d\widetilde{d}\, uu\tilde{d}d\widetilde{u}$.[20]
9. **The non-uniform condensate density -** the pion tetrahedrons form a non-uniform condensate with an atmospheric density drop and the condensate transfer force via collisions like ideal gas kinetics by quark exchange reactions via gluons.
10. **The source of gravity** – the attraction between particles and antiparticles is the source of gravity, the pion tetrahedrons density in space vary according to the gravitational field and the gravitational force is transferred by collisions with the pion tetrahedron condensate. Far from the galaxies' centers in KBC voids the condensate density is extremely low and the MOND limit crossover is obtained due to the dilute condensate.
11. **The matter reactors** – the Active AGNs act as matter reactors that increase the density of the QCD tetrahedrons by duplicating the $u\tilde{d}d\widetilde{u}$ pseudo-Goldstone bosons in their ergoregions that act as laser cavities, hence, the expansion of the universe may also be due to the black hole laser effect that increases the matter quantity in the universe.[17]

The differences between classical and quantum mechanics may be due to the antimatter discovered by Dirac[23] which is part of the invisible Aether superfluid[22]. The central roles of antimatter and the non-uniform pion tetrahedron condensate Aether were not anticipated by general relativity and quantum mechanics. Their central roles are not fully understood still and the KBC giant voids and the non-uniform pion tetrahedron condensate Aether need further study.

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