Theory Of Nearly Everything

Abstract

This is TONE, a Theory Of Nearly Everything. It leans on two pillars, both completely new. The first pillar - chapter 1 GRAVITATION - describes gravitation as a streaming of a grid of vacuum marbles. The Newton gravitation law is derived. The distance of the vacuum marbles is calculated at 10^-21 meter. GR is completely valid although space is not curved: absorption from the Higgs field curves spacetime, the subsequent act of gravitation curves it back. Chapter 2 EXPANSION OF THE UNIVERSE. This formulation of gravitation allows to describe its backward time evolving behavior, that is presented as a candidate for the Dark Energy. TONE‘s second main pillar is QQD - Chapter 3 QUANTUM QUATERNION DYNAMICS. It replaces the colors of QCD by imaginary units of quaternions: red = i, green = j, blue = k, cyan = -i, magenta = -j, yellow = -k, white = 1 and black = -1. The black gluon is candidate for the Dark Matter. The matrix of each quaternion unit equals the product of two Pauli matrices, except for -1. Heavily resting on both pillars is QG - Chapter 4 QUATERNION GRAVITATION. Here the vacuum marbles are filled in with pairs of spin 1 gluons. The gluon as being the strongest and fastest reacting particle, builds spacetime, the grid to which all events are attached. Higgs Mechanism 2 shows 2 vacuum marbles at the spot of a quark convert into 1 empty spot and 1 Higgs field particle that gives mass to the quark. Higgs mechanism 2 provides mass AND is the mechanism of attraction between quarks. Higgs mechanism 2 cannot give mass to sole color, but two colors together (but outside each other's time border) will always be given mass - except when they are of opposing sign. A black or white quark can appear, a quark without color: the leptons? If so then the universe might consist of quarks alone. A gluon consists of a quark and an antiquark within their time borders. In Chapter 5 INTRICACIES is shown how, in the <i>shell</i> of any quark, four quarks appearing as 2 quark antiquark pairs, all within their time borders, can form all colored gluons we know. One strong force cycle of time then must be rather 0.5 times 10^-24 s.

My article TONE is rejected by arXiv, Science and Nature.

1 Gravitation

Introduction

The choice of taking space and time smooth or corpuscular, is fallen on the latter in this TONE. The cross section of one vacuum particle is calculated to be about 10^-21 m, the quantum of time is taken as the typical strong force reaction time, 10^-23 sec.

The development of the ideas of this chapter “Gravitation” started at the beginning of 2011.

1.1 Derivation of the Gravitational Law of Newton

Let's first set up the scenery. The vacuum is proposed as an ocean of solid marbles stacked upon each other in a grid, e.g. the Cartesian grid. No open spaces large enough to fit another marble; no overlap of marbles. Constant total volume of all the marbles together.

The Higgs field, the field all massive particles absorb its mass from, is identified with the marble sea. When a particle absorbs mass from the Higgs field, it absorbs one vacuum marble, one *Higgs field particle*.

We use the field of all possible velocities (see Frame 1) To be Lorentz invariant the marble field has to be the superposition of all marble fields of every possible velocity, the superposition of all “oceans of solid marbles” that only differ a velocity, pervading each other without seeing each other. The solid marble oceans pervade the Earth too.

We assume that every particle that has mass is standing still with respect to the vacuum it couples to, the Higgs field from which it absorbs its mass. Coupling to standing-still field, absorbing from standing-still field, takes least energy (no additional kinetic energy).

For now this is the vacuum. Hanging there in outer space is the Earth.

Let's go for the first act. At a coupling - take in mind a strong force color coupling of a quark with a gluon - one of the quarks in a nucleon of the Earth absorbs a *vacuum marble / Higgs field particle*, necessary in the course of renormalization. The particle (a quark in this case) absorbs the vacuum marble from the Higgs field relative to which it is standing still, this is essential for the following picture (take rotation of the Earth and other movements to be absent).

The marble of that Higgs field particle disappears, leaving an *empty spot* there. ”Pressure from the outside” forces the marbles around to fill in the empty spot, to ”fall into it”; the particle next to the hole falls into it, leaving behind another hole, and so on. Effectively the volume of the empty spot displaces spherically to the outside, without changing volume dividing itself over an area that increases with the square of the distance to the absorbing spot. The empty spot, originally spherical, now forms a *shell of missing vacuum*. The volume of the shell is its surface times its thickness.

In fact the vacuum marble field sags spherically into the hole of the disappeared Higgs particle. The vacuum marbles never overlap and seek being stacked upon each other again, no space to fit another marble. The displacement of a shell of vacuum marbles onto an already sagged shell just below is inversely proportional to the surface of that shell, is inversely proportional to the square of the distance to the absorbing spot.

Now we yet only have to state that the displacing vacuum / Higgs field drags along with it all masses that are ”floating” in it. The masses stand still with respect to the displacing vacuum marble field and keep it like that. The dragging is 100 percent. This is gravity, the gravitational field in action. Masses fall weightless in each other’s gravitational field, as if there is no gravitation, as if they are standing still with respect to the vacuum. No force acts on any mass; no mass goes anywhere caused by a force.

According to the Newton gravitational law the gravitational *force* is inversely proportional to the square of the distance to the gravitational center. As shown, the Higgs field *displacement* is

inversely proportional to the square of the distance to the vacuum marble absorbing spot. At any place in the field a force is proportional to the displacement caused by the force:
F = ma, s = 1/2 a t^2, so at any point at one moment t is F $\sim$ a $\sim$ s.
(F = force, m = mass, a = acceleration, s = displacement, t = time, F $\sim$ s means F is proportional to s).

When mass is doubled then there are twice as much baryons present in the mass, and so the number of couplings per second in the mass is doubled too. The disappearance of Higgs particles doubles and the rate of sagging in of spheres into the hole left behind doubles too. The displacement doubles. So vacuum displacement of the gravitational field is proportional to the mass causing the gravitational field.

It doesn't really have to be marbles; the main point is *conserved fluid space*. Some volume of space inside matter disappears when Higgs field is absorbed. But all further events act as if space is conserved. The disappeared space – the hole – is filled in with the space around it without any further appearing or disappearing of space.

The presented view accounts for

1) The fact that all masses at the same time and place in the gravitational field undergo same acceleration.

2) The inversely squared proportionality of the rate of displacement with the distance and the proportionality with the masses.

3) The proportionality of the *inert mass* (resistance to change of velocity and the E = mc^2 source of energy) with the *ponderable mass* (mass that causes the gravitational field). When there are 2 times more nucleon, then there are 2 times as much vacuum marble absorptions.

In radius of a vacuum marble (see Frame 2) the gravitational constant is used to calculate the distance between neighboring vacuum marbles to be about 10^-21 m.

1.2 Introducing Dynamics

There are some setbacks in this view. When the source of gravitation suddenly would disappear, acquired displacement would remain but further displacement would stop; there would be no remaining velocity. Acceleration then appears only when approaching (or receding from) the gravitational source makes you to enter regions of larger (smaller) displacements.

The presented view so far still *does* account for the four mentioned effects, but it would do so only for the first moment of gravitational action. At the region of the Earth surface gravitational acceleration is about 10 m/s^2, rounding a = 9.81 m/s^2 at the Earth surface. When time elapses, 5 meter of vacuum sinks through the Earth surface into the Earth in the first second, dragging along with it all matter floating in it. In the 2nd second another 5 meter passes the Earth surface, displacing all matter another 5 meter. A 3rd second gives a 3rd displacement of 5 meter. Total displacement 15 meters in 3 seconds. And so on.

However, observed is, when initial at rest at e.g. 100 m above the Earth surface, the gravitational field causes a displacement of 5 meter in the first second, 15 meters in the 2nd second and 25 meters in the 3rd second, total displacement 45 m in 3 sec ($s = a \cdot t^2 / 2 = 10 / 2 \cdot t^2$). When gravitation suddenly disappears, acquired velocity remains: 10 m/s at the end of the first second, 20 at the end of the 2nd and 30 m/s at the end of the 3rd second.

The Newtonian gravitational law presented so far resembles a kind of conveyor belt, displacing only at constant pace. It is no *force*. We are now going to install F = ma, the second law of Newton.

Let's start over again. One vacuum marble in the Earth had disappeared – a state transition from all possible Higgs fields to one specific Higgs field with a hole in it. When more vacuum marbles disappear, we mark that ongoing displacement of vacuum and everything in it embodies a constant velocity, as far as observations of dragged-by objects are concerned. One can define the wavefunction of a mass m1 standing still with respect to the dragging-by and falling-into-the-Earth vacuum. Taken from the field of all possible velocities, there also is a vacuum that already moves with precisely that velocity, without having the source of this velocity in disappearing marbles. Essential now is to state that the wavefunction of a mass m1 standing still with respect to the dragging-by and falling-into-the-Earth vacuum is indistinguishable from the wavefunction of mass m1 standing still with respect to the vacuum that already has that velocity, without any source in gravitational mechanisms. So these wavefunctions superpose at every point in spacetime where marble displacement takes place. When it comes to observation – the first characteristics of m1's motion becoming apparent – in half of the cases it will turn out to be a displacement only, leaving behind no remnant velocity (mechanism of gravitation), and in the other half a velocity increment remains (due to moving vacuums without gravitation). When gravitation suddenly would disappear, half of the tiny velocities would remain. In such a way velocity increments embody an acceleration proportional to the gravitational force. We completed the Newtonian gravitational field with Newton dynamics given by F = ma.

Velocities can be put in a box. An experiment that is said Galileo Galilei has done is that he carefully studied the flight of butterflies in the sealed cabin of a ship sailing at top speed. From the butterfly flights he noticed no clues to the motion of the ship. With respect to gravitation we correspondingly state that the cabin, if free falling to the Earth surface, is dragged by the vacuum that is falling into the Earth, and that all velocities in the cabin are also dragged by unaltered. I call it "a velocity can be put in a box". Every time something has build up a velocity with respect to the Earth, we imagine a box being put around that something, and in the course of the gravitational act we observe how *the box* is dragged by.
We always can see the content of such a box. Couplings in its material content cause sagging-in shells around it to reach outside the box and betray the content to outside observers.

According to the view of this article photons have no absorption from the Higgs field and thus don't gravitate. This is a difference with GR (General Relativity).

1.3 General Relativity

State 1.
Let's try to regard the process of mass absorption from the Higgs field and subsequent rearrangement of vacuum particles a little closer. State 1, where we start from, is four-dimensional Minkowski space, as flat as can be.

State 2.
Then somewhere in space some particles *couple* and in the course of renormalization mass is absorbed from the Higgs field. In TONE this is identical to a vacuum particle being absorbed. This is state 2, a flat space with a hole in it. The hole might react as a particle but it is expected to last very very short.

It is not immediately clear whether the hole will react as a particle or not. A distance is the number of vacuum marbles on the line connecting the mass centers of two objects. When there are lesser vacuum marbles along that line, which is the case when the line crosses the hole, then these objects THUS are nearer to each other. There is no space behind the space (except for the rest of the field of all possible velocities that superposes the specific Higgs field from which is absorbed from), so it can be there is no "hole particle" to observe there.

Is there a state transition from 1 to 2? Yes: first there was no hole, at the end there is.
Is vacuum particle rearrangement involved? No, not yet.
Is there an observation? No, not by us. According to QED, every action of a particle going from a place to another place can be decomposed in still smaller displacements and couplings. But these observations – if you can call them observations – do not reach us, the Outside Observers.

state 3.
Now opposite sides of the hole glue together and the hole is gone. This is state 3.
State transition from 2 to 3? Yes. First there was a hole, now it's gone.
Observation? No, not yet.

Vacuum particle rearrangement involved? Let's first regard state 3 in Minkowski space, to be called state 3M, M from Minkowski. At first sight, both sides of the hole have displaced (towards each other) over half the diameter of one vacuum particle. But we just said there is no space behind the space. So such a displacement cannot be given meaning. The only thing we can say is: first opposite sides of the hole didn't glue and now they do. But there is a *tension* now in the structure of spacetime. For the vacuum it doesn't "feel" right. There is an unequalness of number of gluings and precise direction of the gluings from vacuum particle to vacuum particle around the former hole.

In order to release the tension, spacetime around the hole *curves* OUTSIDE Minkowski space until there is no tension in the vacuum no more. Call this state 3E, with the E from Einstein. The small area around the point that marks the former hole contains lesser space now (space that the hole took, has disappeared) while a little further away space for the moment remains unchanged. This is the recipe for a negative, saddle-like curvature.

Is there a state transition from 3M to 3E? In accepted GR (General Relativity), the most complicated curvature possible that still is isotropic, has an embedding space (minimum of flat space containing the curved space) of at least 7 dimensions. While the number of dimensions of Minkowski spacetime always is 4. So at first sight 3M and 3E are not *identical*. However, we already stated there is no space behind the space so distances between vacuum particles cannot be given meaning in TONE. Are there dimensions behind the dimensions, other dimensions behind the well-known 4 dimensions of spacetime? Getting ahead of the story, the vacuum particles are governed by *quaternions* and in TONE those are shown to extort the 4-dimensionality of spacetime (this is worked out in chapter 4.1 Filling In the Vacuum Marbles with Gluon Pairs). Quaternions need four dimensions to work. But since the space behind the space is considered not to consist of particles, it does not exist. The handhold for the dimensionality of the space behind the space is lacking. So curved state 3E without internal tension *is* identical to flat state 3M with internal tension, there is no way to conclude otherwise. So no, there is no state transition from 3M to 3E. And no, when going from state 2 to state 3, there is no vacuum particle rearrangement involved yet.

(If 3M and 3E are *indistinguishable* but not identical states, they would *superpose* and an observation would have forced state 3 to be an *accidental choice* out of the set of all possible states in superposition. However, the first observation will be the act of gravity, the rearrangement of vacuum particles. So the superposition would remain intact until the act of gravitation.)

Is state 3E described by the Einstein curvature tensor G in GR? Or is it a simpler curvature? Once again, the vacuum particles have no way to measure relative distance between neighboring (= gluing) particles. A vacuum particle only counts the *number of glues* with (by definition) neighboring vacuum particles and, I guess, the angular position of the glues over the surface of the vacuum particle. The actual present curvature seems to be free to choose. No curvature is forbidden, no curvature is compelling. So any mixture partly 3M and partly 3E seems valid too.

The most beautiful way is of course that the curvature equals G and that subsequently vacuum particle rearrangement performs the precise *inverse* of G, in doing so bringing in all GR effects described by the T tensor into the structure of spacetime.
What I mean is this. Masses and their acquired velocities undergo SR (Special Relativity) effects. SR is not in doubt. When the vacuum marble field sags in, it drags along all that is in it and that traverses it, including light rays. As a result the light paths bow and the light is red or blue shifted. So, when one Higgs absorption after the other is happening, the distortions caused by vacuum particle rearrangement do add up, tracing out the curved GR coordinate system. The developing light ray pattern *simulates* curved space. GR's *equations* are right, of course, but the *curvature* is an electromagnetic illusion, an optical illusion. Rearrangement of vacuum marbles always returns to Minkowski space. The contribution of gravity to the overall curvature of the universe is zero.

Let's insert some observations. The axis of Mercury's orbit around the sun is observed to rotate with 574 arc seconds per century. 531 of them are calculated to due to the other planets, 43 due to GR. 1/6 part of that 43 is due to the gravitation of the Sun on the gravitational energy between Mercury and the Sun. This means that also gravitational energy gravitates. (Julian Schwinger, Einstein's Legacy, page 198-199-200)
According to observation, let's just take GR to be true.

State 4.
The next state is state 4 where the vacuum particles around the point of the former hole rearrange themselves to release the tension of wrong-distributed gluings (3M) or release the tension of the curvature (3E) in order to return to flat Minkowski space. It is a small *streaming* of vacuum marbles that surrounds the hole to fill it in again. But mind, there is no space behind the space. The distance between gluing particles has no meaning. So it is the question in how far well known fluid equations in flat space can give shape to this "streaming".

This is the act of gravity, this IS gravity. This goes on until space is flat and state 1 is reached again. The full act of gravity in state 4 is the precise reverse of the curvature in state 3E. Gravitational action as it is observed - yes, now we have an observation! - described by the matter energy tensor T, is the *reversed version* of the bending of spacetime given by G. Vacuum particle absorption curves space, the act of gravitation curves it back. So T is the precise reverse of G, from which I hope this reversal includes placing a minus sign before T. It is said Einstein has added a minus sign somewhere for no other reasons than to make things work, otherwise he would obtain a repulsive gravity. The process described so far then would explain this minus sign.

There is absorbed from that Higgs field with respect to which the mass-gaining particle is standing still, that is what is assumed in TONE. The other Higgs fields from the set of all possible Higgs fields (differing only a velocity) remain unchanged. When displacement of sagging-in shells has passed by, when *rearrangement* of vacuum marbles within the volumes of the masses and subsequently in the vacuum around them has been completed and Minkowski spacetime is restored, the superposition of all possible Higgs fields is restored again, all its fields neatly filled. Reactions keep on taking place in masses and their Higgs field absorption causes new holes in the vacuum, each hole in (usually) still another choice from all possible Higgs fields. In doing so this ensures ongoing gravitation.

The grid of marbles, spanning empty vacuum, can be called a *solid state vacuum*. All vacuum marble connections are present. The gravitational field in action, the act of sagging-in, acts like a liquid. The gravitational field in action is supposed to be a *liquid Bose condensate*. The vacuum marble connections are partly present and partly disconnected. When fully disconnected, vacuum marbles will not see each other anymore. Their relative distances become undefined. They have become superposed states relative to each other. This can be called the *gaseous state of the vacuum*.

This is the working model of gravitation we use all over this TONE and all over my website.

Now there are two ways to proceed. First, the precise description of the mechanism of gravitation given here allows us to formulate the process in backward time direction. This is the way we go in chapter 2. Second, we are going to fill in the vacuum marbles with particles we already know: gluons, gluon pairs to be precise. But we will do so with the colors of the gluons and quarks expressed in quaternions. This is the way we go thereafter, in chapter 3.

In TONE a gamma ray, and light rays in general, do not gravitate, TONE is clear about that. Photons have no net absorption from the Higgs field and thus cause no gravitational effects, despite their assigned mass according to $E = hf = mc^2$, Energy = constant of Planck x frequency = mass x lightspeed^2. But to understand this you have to read the next two chapters.

Conclusions
1.1) Space and time are quantized and are made of particles (so-called *vacuum particles*).

1.2) The gravitation law of Newton is derived in a way that fits in with a kind of Higgs field absorption AND that fits in with the premises of GR.

1.3) The Einstein equation is $G = 8*\pi*$gamma$*T$, gamma is the gravitational constant. The equation you work with, is $G * T^{-1} = 8\pi$ gamma * [1], where [1] is the 4*4 unitary matrix, describing curvature zero. This is of course the same equation as Einstein's, but the interpretation differs.

1.4) GR is valid in TONE in all its details. Except for light that doesn’t gravitate.

1.5) The action of giving mass curves spacetime. The action of gravity curves it back to zero curvature.

Discussion
1.1) A dynamics F = ma is achieved by something that I call “putting velocity in a box”; this still feels a little artificial and not completely convincing.

1.2) Are conclusions 1.3 and 1.4 right?

1.3) In how far can well known fluid equations in flat space give shape to the “streaming” of vacuum particles?

1.4) What if - just a thought experiment! - there is GR but no SR? Only Newtonian gravitation? When a light ray passes by the Earth and is deflected by the Earth gravitational field, then the deflection according to GR is twice the deflection according to Newton. Consider what is left when you remove SR from GR by lightspeed approaching infinity. As far as I understand a kind of empty theory remains. That is, you only get the Newtonian gravitation in matrix form (tensor form). All extraordinary effects like the slowing down of time in strong gravitational fields will have disappeared, isn‘t it? So, when restoring lightspeed = c, I expect SR in Newtonian gravitation also will double the angle of deflection.

1.5) At page 24 of the book *Surely you're joking, mr. Feynman* I found the following. Start with a rocket from the Earth and be back when the clock on the ground has ticked away 1 hour. Choose your path such that in the rocket elapses as much time as possible. The larger the height, the weaker the Earth gravitational field, the faster runs the internal rocket clock (GR). The larger the rocket's velocity the slower its clocks run (SR). It turns out that free fall (no acceleration except from the gravitational field) gives the maximum total elapse of time in the rocket. So you shouldn't use the rocket’s engine to navigate. At the start just give a single upward thrust such it is back after a fall of one hour.
Maybe this can be better understood as the principle of *least action*. Do not focus on maximizing elapse of time in the rocket, but focus on minimizing elapse of time on Earth, that is: in the Earth’s gravitational field.

2 The Accelerated Expansion of the Universe

Introduction

The notion that antimatter is going backward in time is not new. Especially Feynman and Wheeler have pointed this out and did a great effort to implement it in physics. However, without a proper theory of gravitation this is virtually impossible.

2.1 The Mechanism of Gravity in Forward and Backward Evolving Time

In our universe there is a *time arrow*, a preference of time direction. On itself a time arrow is not that strange. It means a number of phenomena always go together:

Attractive gravity	and never	repulsive gravity,
Absorption of Higgs field	”	emission of Higgs field,
Outward directed, “repulsive” centrifugal force	”	inward directed, “attractive” centrifugal force.

Not completely absolute:

Heat streaming from hot to cold
Light spreading from stars
Life

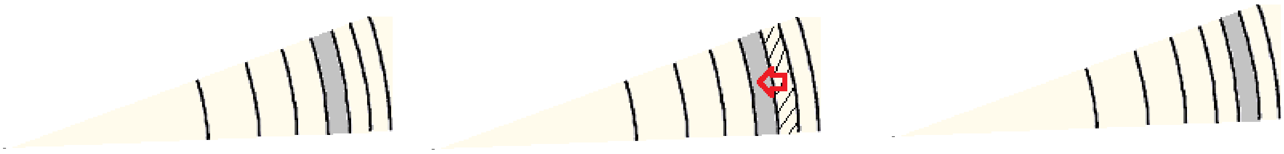
When put into motion and all connecting, all these things force each other to fit in this way. But what *is* strange is how the *first event* chooses its time direction. Time has two directions to go to, forward and backward. Imagine at the beginning of the universe two compartments of space completely isolated from each other. In each of them events set the arrow of time. Next the isolated spaces come in contact. How can it be their arrows of time always happen to line up in the same direction?

I think they don’t. In the beginning of the universe clouds of atoms start to contract. Some clouds have forward time direction while others evolve backward time direction. The clouds of forward time direction became the galaxies we now see around us. The backward time evolving clouds are created at the end of our universe – let’s suppose this is a finite amount of time in the future – and are developing towards the beginning of the universe. As observed by us, their heat emission is radiation *from* the environment *toward* them – that we thus do not observe. They are dark! Dark clouds evolving to dark galaxies where time is running backwards. As many of them as the clouds of atoms at the end of our universe can provide.

When we look at them, instead of receiving light from the scene, the retina now undergoes a (forced, stimulated) emission of the same light *towards* the scene. The eye most probably is not adapted to accompany the stimulated emissions from the retina towards the scene with a signal from the retina to the brain. You won't see anything.

The next picture (drag the cursor over the bars from left to the right) is a kind of cartoon showing the sagging-in shells in gravity and the expanding-out shells of backward time evolving gravitation (not available in pdf).

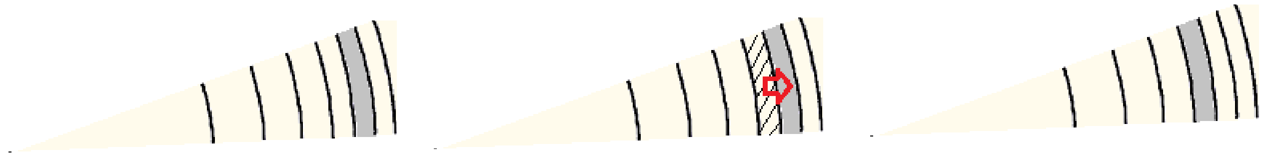
yellow = three dimensional vacuum, consisting of vacuum marbles. For convenience, regard each shell as consisting of a layer of one vacuum marble thickness.
gray = a hole in the vacuum
A = a mass center



This pictures gravitation in forward time direction. A shell (shaded) sags into the empty shell below it (gray) and drags everything with it.

Gravity (red arrow) pulls inward, the sagging-in of shells propagates outward.

In backward time direction we have *antigravitation*: a shell (shaded) expands into the empty shell above it (gray) and drags along everything in it. Antigravity (red arrow) pushes outward, the hole propagates inwards.



In gravitation vacuum streams inward, dragging along everything that “floats” in it. When this process is time reversed, one gets an outward stream that likewise drags everything along with it in outward direction: an antigravitation. However, a theorem of this TONE is:

WE ASSUME FULL SYMMETRY BETWEEN THE FORWARD AND BACKWARD EVOLVING WORLDS. (2.1.2)

Their laws of nature are identical to ours. *They* see us precisely in the same way as we see *them*. (I am still unsure about the neutrinos, if *they* see also only left hand neutrinos and right hand antineutrinos. This TONE has not been able to give more than a hint, a kind of silhouette, where the neutrinos might be found, see 4.3 Higgs Mechanism 2.)
In order to prevent their planets being dragged away from their suns, I devised a trick.

Imagine a dark planet orbiting a dark sun. At the planet we assume a hidden supply of velocity – in equal amounts in both directions, carefully adding up to zero – from which the outward stream of vacuum *erases* one. Outward flow of vacuum *removes* velocity from the planets. The complement velocity, directed towards the dark star, remains and pushes the planet a bit towards the star, thus forcing it in orbit around the star.

Dark flow *erases* velocity. A laborious formulation, but using the view of vacuum flow, I see no other way to maintain the picture of gravity sketched so far and also create the film of events in backward time direction of dark planets orbiting dark suns. At 3.5 Dark Multiplication Rules is presented how this can become.

There must be a time arrow in the vacuum itself. Where gravitational sagging-in of shells dominates, vacuum goes forward in time. Where antigravitational expansion of shells dominate, vacuum goes backward in time. Where gravitation and expansion equal each other, there is the time border.

2.2 The Time Border

For a test mass m on the time border between mass M and mass bM holds:
(b is a real number larger than 2, d is the distance between M and bM, all masses are point masses)

$G \cdot m \cdot M / r^2 = G \cdot m \cdot bM / R^2$

$1 / r^2 = b / R^2$

$r^2 \cdot b = R^2$

$(x^2 + y^2 + z^2)\, b = (d - x)^2 + y^2 + z^2$

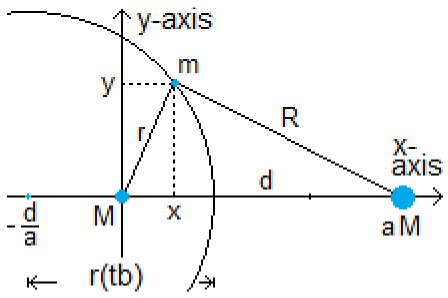
$\qquad = x^2 - 2xd + d^2 + y^2 + z^2$

$(x^2 + y^2 + z^2)(b - 1) + 2xd = d^2$

$x^2 + y^2 + z^2 + 2xd / (b-1) = d^2/(b-1)$

$(x^2 + 2 \cdot x \cdot d/(b-1) + (d/(b-1))^2 - (d/(b-1))^2 + y^2 + z^2 = d^2/(b-1)$

$(x + d/(b-1))^2 + y^2 + z^2 = (d/(b-1))^2 + d^2/(b - 1)$



(z-axis not shown)

b-1=a, b=a+1, a is larger than 1
For a test mass m on the time border between mass M and mass aM holds:
$(x + d/a)^2 + y^2 + z^2 = d^2 / a^2 + d^2 / a$

The time border (tb) is a sphere around mass M with radius $r(tb) = SQRT(d^2/a^2 + d^2/a)$ and off-center over distance d/a. (2.2.1)

Take d=1 so $r(tb) = SQRT(1/a^2 + 1/a)$ (2.2.2)

a	2	3	4	5
1/a	0.50	0.33	0.25	0.20
r(tb)	0.87	0.67	0.56	0.49
r(tb) -1/a	0.37	0.34	0.31	0.29

When a is very large then the time border is a sphere of radius
$r = SQRT(d^2/a) = d / SQRT\ a$
and M is in the center of the sphere. (2.2.3)

Historical note: $r^2 \cdot b = R^2$, so $r \cdot SQRT\ b = R$. In words: the set of points that have a fixed ratio between “the distance of a point to a given point A” and “the distance of the point to a given point B”, is a circle (circle of Apollonius). (2.2.4)

It is time now to formulate another important theorem:
DARK MATTER (BACKWARD TIME EVOLVING MATTER) IS ANTIMATTER (2.2.5)

How large is the time border around an antiquark in an antiproton at the Earth surface?
a = 3.57 * 10^51 * 3, that is the number of nucleons the earth consists of (see FRAME 2 Calculation of the radius of a vacuum marble) times 3 (3 quarks per nucleon) and d = the radius of the Earth = 6.38 * 10^6 m.

r (bubble around antiquark in antiproton)
= d / SQRT a
= 6.38 * 10^6 / SQRT(3.57 * 10^51 * 3)
= 0.62 * 10^-19 m at the Earth surface. (2.2.6)

r (bubble around antiproton) = SQRT 3 times larger than r (bubble around antiquark in antiproton) = 1,1 * 10^-19 m at the Earth surface.

For a positron a = 3.57 * 10^51 * 2000 (number of nucleons of the Earth times the number of times the electron is lighter than a nucleon).

r (bubble around positron) =
= d / SQRT a
= 6.38 * 10^6 / SQRT(3.57 * 10^51 * 2000)
= 0.24 * 10^-20 m at the Earth surface.
This is about the highest resolution the vacuum marbles can support. At the Earth surface the time borders around the positron and antiquark are that small that nearly all vacuum between the interacting particles is forward. No anti-entropic behavior to be expected in their interaction. (2.2.7)

Only when the number of clumped together antimatter atoms grows, they first conquer the space in the antiprotons, then win backward vacuum in the atom's volume, and finally occupy the space between the anti-atoms and anti-molecules. And *then* anti-entropic behavior is expected, inside the time border.
The way dark vacuum conquers bright space when the amount of dark matter grows, is quite complex. It is worked out at page 4, page 5 (skip the Diamond), page 6 and 7 of the storyline FORWARD BACKWARD TIME DIRECTION.

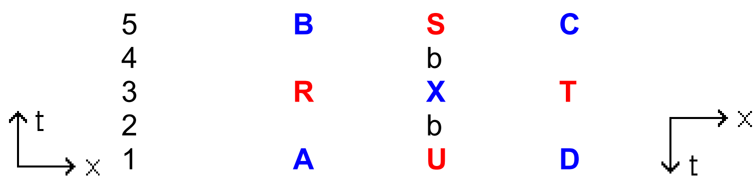
If one has followed argumentation in Chapter 1, then it is clear that in the course of absorption from the Higgs field and the subsequent action of gravity, vacuum is shrinking. While at the same time as observed by us, the backward time evolving vacuum, due to the emission towards the Higgs field, is expanding. As a consequence the time border starts moving towards forward time masses, and away from backward time masses. However, the calculation above shows the time border is not dependent of time. So let's invoke a new theorem.

WHEN VACUUM PARTICLES ARE PUSHED OVER THE TIME BORDER AS IT IS CALCULATED HERE, FROM BACKWARD TIME EVOLVING SPACE INTO FORWARD TIME EVOLVING SPACE, THE PUSHED-OVER VACUUM MARBLES CHANGE FROM BACKWARD TO FORWARD EVOLVING (2.2.8)

In doing so we assure the time border to remain stable at its calculated position. The pushed-over vacuum marble is also supposed to change into its enantiomer, see (4.1.15).

When dragged by the streaming vacuum, a particle doesn't notice it is dragged by. One single particle has its structure, its shape, relative to the vacuum. So, if the vacuum itself is mirror-imaged, I assume the shape of the single particle is mirror-imaged along with it, not noticing something had changed. When passing the time border all four xyzt coordinates are mirror-imaged, see (4.1.15). Swap of the sign of the time coordinate makes the spin of the particle to reverse. Changing the particle in its enantiomer swaps the spin back again. After all the spin of a particle doesn't change when passing the time border. This inspires to a new theorem:

WHEN REGARDING THE SPACETIME DIAGRAM, ONE SEES NOTHING SPECIAL HAPPENING AT THE TIME BORDER. (2.2.9)
There are no events at the time border that show passages through it.



bbbbb is the time border, behind the S, X and U there is another b

If the shown part of spacetime is void of everything and then a particle or object moves AX at constant rectilinear speed according to the first law of Newton, then the part of the track behind the time border that fits in with it, is CX (and not XD).

2.3 Dark Dynamics

In backward time evolving vacuum rules *dark mechanics*, the flow of gravitational field *erasing* velocity. The erasing of velocity only holds in backward vacuum as observed by us. When a dark star gravitates as the dark star observes it in its own frame, they see gravitation precisely like us. *They* see *their* stars being bright. When the wave of sagging-ins from the dark star enters the time border, the part at the other side (our side) will be *expanding-out* shells, a *repulsive gravity* indeed. We don't observe erasing of velocity at our side of the time border, neither from our own sun nor from the gravitational field of the dark star. We observe repelling gravity from dark matter far away.

Where are *they*? In galaxy clusters the individual galaxies move too fast. Gravitating *Dark Matter* (mark the capitals) is supposed to be present in the cluster to keep the cluster together. (In this

TONE, when speaking about *dark matter* or *dark behavior* or anything dark, we mean *backward time evolving matter* and -behavior and so on. We will seldom refer to the accepted Dark Matter that gravitates and is invisible.) It sounds unlikely to find repelling gravity in a place where we try to recognize an extra attraction already. A better place for backward time evolving dark galaxies seems to be in the center of the voids between galaxy clusters. The expanding shells of antigravity of dark matter can be interpreted as an expansion of space, eventually creating the voids.

BACKWARD TIME EVOLVING MATTER – *DARK MATTER* AS WE CALL IT FROM NOW ON – IS A CANDIDATE FOR THE *DARK ENERGY*. (2.3.1)
It explains the Dark Energy. It does not explain the expansion of the universe.

Can we observe a dark galaxy? Use a telescope that can collect sufficient light from a bright galaxy at the same distance to form a picture. As observed by us, the dark stars in the dark galaxies *absorb* light, instead of radiating it. Those absorbed light rays then are assumed to originate at the same places where the stars of a bright galaxy would have dropped its light. Assumed is our matter undergoes an anti-entropic *Stimulated Emission of Radiation* (SER) when the light of the dark star "arrives" there (in fact it departs there). *They* see it arriving, we call it light that is *drawn from* our matter and heads for the dark star. Nor the common observation instrument nor our eye is adapted to perceive such a stimulated emission and subsequently to sent a signal to the brain, or the computer. So take atoms or something that are at the brink of emitting an *entangled photon pair*, in a gas, a liquid, a thin sheet of solid matter. The entangled photons of a pair normally are emitted in random opposite directions, but an additional amount of stimulated emission is present towards the dark stars and dark clouds of dust in the dark galaxies far away, and in the opposite direction. It is the latter you can collect in the observation instrument to form a picture.

With the picture in mind of gravitation as sagging-in shells of vacuum and dark gravitation as expanding-out shells of vacuum, it is possible to imagine what happens when e.g. a small dark mass orbits a large bright mass. I worked out an estimation in paragraph <u>Dark and Bright Planets and Stars of Equal Mass</u> at page 2 of THE EXPANSION OF THE UNIVERSE. Three special cases are outstanding.

A) What happens when two planets of equal mass, one bright, the other dark, pass each other by? There is outflow of vacuum from the dark mass and inflow of vacuum into the bright mass, as we observe it. At all times the outflow of vacuum from the dark mass equals precisely the inflow of vacuum into the bright mass. As a consequence there is only a flow of vacuum between the planets. The *amount* of vacuum between the planets remains the same. They will not change each other's motion, they will not deviate each other's paths. They will pass each other by with constant rectilinear motion, their orbits just any pair of straight lines. And if they don't have any velocity relative to each other they keep it that way, hanging motionless relative to each other.

B) Everywhere dark matter meets bright matter, the time border is between them. The Large Time Border is the time border in between our cluster of bright galaxies and the most nearby cluster of dark galaxies. Imagine a small mass, bright or dark, near the Large Time Border at our side. The faint remnant of gravitation from our cluster tries to move it towards us, away from the time border. The same amount of gravitation from the dark cluster, at our side of the Large Time Border consists of expanding-out shells around the dark cluster that tries to move it with same force in the same direction, away from the time border toward us. Both gravitations work together to keep the time border void of matter. After sufficient time space at a time border will be empty.

C) The positron by its tiny gravitational field creates a spherical bubble of dark vacuum around it, with the positron off-center in it. In our frame this bubble is observed as a backward time evolving vacuum wherein the quark did *emit* a vacuum marble, a Higgs field marble. The emission causes shells of vacuum around the quark to expand (the time reversed version of sagging-in). As long as inside the bubble, this is antigravity that nevertheless *erases* velocity (if there were masses inside). Once outside the bubble, the expanding shells are repulsive gravity indeed.

When the electron approaches the positron within its time border, then the composite absorbs Higgs field particles at precisely the same pace as it emits them. The composition does not absorb nor emit Higgs field particles and thus is massless and has zero gravitational field. Since the particles have no mass, they immediately gain light speed. They force each other along the same path, because the slightest separation (10^-20 m at the Earth surface) would separate the forward and backward vacuums and then the electron and positron *would* get mass, for which the energy is lacking. By now the composite is resembling the photon too much to ignore. If so then the photon is erased from the list of fundamental particles in the Standard Model.

When an electron in an atom emits a photon, where the positron is coming from? Inside each electron, according to QED renormalization theory, there is a superposition of a horde of electron-positron pairs shielding the “naked” core. The building up of shielding necessitates the naked core to approach infinite charge and zero mass. One of such pairs from the shield may sufficiently coincide and form a photon and leave the electron. Mind the e- e+ pairs are *superpositions* relative to each other, they don't see each other. They don't form a cloud of e- e+ pairs. Besides, there are infinite of them. They won't miss a pair.

Usually, to maintain composition the spin of the particles best align and as soon as they gained light speed they stay aligned. However, since they force each other along the same path, spin alignment is no longer needed. Normally electron positron pairs appear with quantum numbers as opposing as possible. The emerging electron positron pair sets out as spin electron + spin positron = 1/2 - 1/2 = 0. So why spin 0 photons shouldn't form? I think they do and they form another grid of vacuum marbles. There is a second Higgs field, the *leptonic Higgs field*, as I would call it, see my discussion at leandraphysics dot nl slash netqed4 dot html.

If the electron and positron spin add up as 1/2 + 1/2 = 1 and -1/2 -1/2 = -1, then this is the photon as we know it. I see two main paths how this can come to be.

1) The original QED renormalization theory is about electron positron pairs shielding the naked core of an electron or positron. In case of the electron, it talked about “the positron of a pair going a little nearer to the negative charged core and the electron going a little further away from the core”, This assumes *interaction* taking place, virtual photons going from the core to our pair. The stages of the described separation process in its subsequent moments in 1 single e- e+ pair are all part of one single virtual process. Each subsequent extra photon from the core, coupling to our pair, diminishes the contribution of the matching Feynman diagram with a factor 10, because of the coupling constant being about 0.1. Therefore only the first photons coming in from the core give a significant contribution, resulting in only a small charge separation in an electron positron pair that appears in the shield.

Anyway, the electron and positron of one shield pair do absorb photons from the core. Each photon absorption swaps the spin of the e+ or e-. As soon as they are within their time borders and their spins happen to align, they become a spin 1 (or spin -1) photon and leave the electron at light speed. When energy is available the spin 1 photon becomes real, otherwise it stays virtual.

2) Two pairs appear simultaneous and all within their time borders. The spin up electron combines with the spin up positron, the spin down electron combines with the spin down positron and two photons of opposite spin leave the electron simultaneous.

If this is the photon, then also the gluon might consist of a quark and an antiquark, massless coinciding. The spin-story would be identical. The electric charges would cancel likewise. If the *taste* of a quark is u, then the taste of its antiquark must be anti-u, and u and anti-u should cancel then to zero taste. This is worked out in paragraph 5.2 below, *Four quarks in the shell*. But to understand it you need the next paragraph about colors as quaternion units.

Conclusions

2.1) If there is antimatter in our universe, then there must have formed dark backward time evolving antimatter galaxies, probably in the voids.

2.2) A mass and an antimass of equal size will not influence each other by gravity.

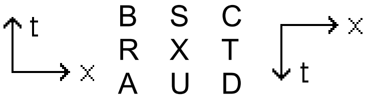
2.3) The time border is empty, no mass is collecting there.

2.4) The gravitation of antimatter acts at our side of the time border as repelling gravity, as antigravity.

2.5) The photon exists of an electron and a positron massless coinciding. Therefore the photon is wiped from the list of elementary particles.

Discussion

2.1) Fig. (2.2.8) in brief:



After traveling AX the usual choices where to go seem to be XD or CX. Here XD is the usual scifi choice of going backward in time, leading to a wealth of paradoxes. This way is not to choose. We take CX (from C to X) as a second possible way of going backward in time. I investigate this at my website, read page 4 up to page 7 in the storyline FORWARD BACKWARD TIME DIRECTION at leandraphysics dot nl slash fbtime4 dot html. Skip “The Diamond” at page 6, which is the usual scifi approach. Also in chapter 5 *Intricacies*, paragraph “5.1 At the time border” this is worked out further.

2.2) At the beginning of the universe our matter went forward in time while the antimatter went in backward time direction, starting from the Big Bang. On itself this is a direct and simple explanation why there is no antimatter in our universe. However, in this TONE antimatter as abundant as matter, is taken as source of the *acceleration* of the expansion of the universe. Therefore my guess is there is a second Big Bang in our future, most probably (but not necessarily) preceded by a Big Crunch of our universe. From that second Big Bang matter goes forward in time and antimatter goes backward in time, the latter entering our universe. Since our matter originates from the 1st Big Bang and our antimatter originates from the 2nd Big Bang, their relative amounts, their simultaneous densities, not necessarily have to match.

2.3) When I reread the paragraph just before (2.2.8) up to and including (2.2.9), then I wonder whether the effects on starlight of a shrinking part of the vacuum (forward time evolving) and of an expanding part (backward time evolving vacuum) of equal size just might cancel each other out, resulting in no net acceleration of the expansion of the universe. Mind that if there would be a kind of *remnant effect* of same size in both areas, then that remnant effect should be observed by *them*, the alleged inhabitants of the antimatter galaxies, precisely as *we* do. When there is sufficient more antimatter than matter in our universe there is an excess of expansion (as observed by us) and this might still lead to the observed acceleration of the expansion of the universe.

3 Quantum Quaternion Dynamics

Introduction

I ran into the existence of quaternions in 2012 (for quaternions, see Frame 3). In QCD there are three colors of the strong force and together they form something that has no color no more and that is called white. There are three imaginary quaternion units and multiplied together they form something that has no imaginarity no more: ijk = -1 or kji = 1. It was this resemblance that stroke me in 2012 and put me on the track.

3.1 Colors as Quaternion Units

In QCD color is a real property. In QCD, despite all attempts so far have failed, it is not forbidden to observe color. In this TONE we replace colors by the imaginary units of quaternions. Maybe a better name then would be QQD, *Quantum Quaternion Dynamics*, instead of QCD.

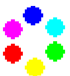
Quaternions (see Frame 3) are governed by
$i^2 = j^2 = k^2 = ijk = -1$ (Hamilton 1843) (3.1.1)
Mark this also could have been defined as
$-i^2 = -j^2 = -k^2 = kji = 1$

Complex numbers have 1 imaginary axis and 1 real axis. Quaternions have 3 imaginary axes, their units called i, j and k, and 1 real axis, spanning a 4 dimensional world.

There are three colors of the strong force and together they form something that has no color no more and that is called white. There are three imaginary quaternion units and multiplied together they form something that has no imaginairity any more: ijk = -1 or kji = 1. It was this resemblance that put me on the track.

Replace	● red	by	i	
	● green		j	
	● blue		k	(3.1.2)

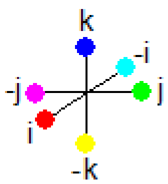
In QCD one can construct the *color circle*. Six colors and white, a kind of “seventh color”, in the center.


(3.1.3)

From (3.1.2) and the colorcircle we replace the anticolors.

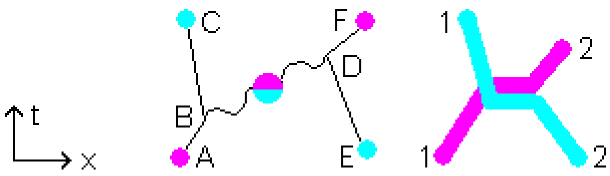
Replace	● cyan	by	-i	
	● magenta		-j	
	● yellow		-k	(3.1.4)

In QQD we use the axes system of the imaginary quaternion units, instead of the colorcircle.



(3.1.5)

Mark this specific projection resembles the color circle a lot.



In the Feynman diagram above quark 1 emits a gluon at point B. The gluon takes away the magenta from the quark and carries it off in its upper color. “Taking away” sounds as a subtraction, but in quaternions “taking away” is *dividing by*.

Taking away magenta = / [magenta] = / -j = · j   (3.1.6)

A correlated pair of colors cyan – anticyan appears. The cyan is given to quark 1 and the anticyan – red that is – is carried off by the gluon in its lower color. In accepted “color stream representation” of QCD it is depicted as its anticolor cyan. “Adding” looks like an adding but in quaternions “adding” is *multiply by*.

Adding cyan = · [cyan] = · -i   (3.1.7)

The gluon [magenta/cyan] now has the potential to *add* a magenta to quark 2 (gluon's upper color) and to *remove* a cyan from it (the gluon's lower color). Therefore the gluon now is
[magenta/cyan] = · [magenta] / [cyan] = · -j / -i = · i · -j = · -k [yellow]
Like in complex numbers, to divide -j by -i is the same as to multiply -j by i. In complex numbers there is no difference between i · -j and -j · i, but in quaternions there is: -j has to be *left-multiplied* by i.   (3.1.8)

The notation · [magenta] / [cyan] = · -j / -i comes closest to depicting gluons as upper and lower color, [magenta/cyan]. Magenta in the upper color, cyan as lower color and the border between them as the break line.

In quaternions you can calculate the gluon, e.g. i · -j = -k. In the gluon table (not shown) all 36 possible gluons are calculated. You may have a glance at it but we shall seldom use the table. In QQD we don't recognize the color source-and-goal restriction of gluons as is common in QCD. In quaternions every color can emit every other color, only restricted by that eventually the outcome cannot be afforded or is forbidden. The color of the gluon is taken as a quaternion unit only and we seldom bother about its color origin or color goal.

WE HAVE TO *RIGHT MULTIPLY* THE QUARK BY THE GLUON.   (3.1.9)

IN A REACTION EQUATION INVOLVING EMISSION AND ABSORPTION OF A GLUON OF COLOR k (TAKE THE COLOR TO BE k) THE k HAS TO BE ASSIGNED TO THE *COUPLING*, IN FACT ONE k AT BOTH ENDS OF THE GLUON.   (3.1.10)

3.2 Three Colors Together

In QCD we had [red] + [green] + [blue] = ○ and [cyan] + [magenta] + [yellow] = ○. In QQD this becomes:

[red] · [green] · [blue] = i · j · k = -1   (3.2.1)
[cyan] · [magenta] · [yellow] = -i · -j · -k = 1   (3.2.2)

[blue] · [green] · [red] = k · j · i = 1   (3.2.3)
[yellow] · [magenta] · [cyan] = -k · -j · -i = -1   (3.2.4)

In QCD the color product end state of red, green and blue, and also of cyan, magenta and yellow, equals white.
In QQD we generalize this to:
THE COLOR PRODUCT END STATE OF RED, GREEN AND BLUE, AND ALSO OF CYAN, MAGENTA AND YELLOW, EQUALS +1 WHITE ○ OR -1 BLACK ●, BOTH ARE COLORLESS STATES.   (3.2.5)

So (3.1.2) and (3.1.4) are extended by

Replace ○ white by +1
● black -1 (3.2.6)
however black never played a role in QCD.

For 3 colors applied together (baryons) eq. (3.2.1) and (3.2.3) superpose, yielding a color sum end state 1 -1 = 0. So the contribution in the wavefunction is zero. The baryon is colorless. (3.2.7)

For 3 anticolors applied together (antibaryons) eq. (3.2.2) and (3.2.4) superpose, yielding a color sum end state 1 -1 = 0 too, no contribution in the wavefunction either from this possibility. The antibaryon is colorless. (3.2.8)

So this might yield another rule:
THE COLOR SUM END STATE OF RED, GREEN AND BLUE, AND ALSO OF CYAN, MAGENTA AND YELLOW, EQUALS ZERO. (3.2.9)

Zero color can never be achieved by quaternion unit multiplication only. Whatever multiplication order you take from no matter which quaternion units, their multiplication always yield a quaternion unit again. Zero is not a quaternion unit.
For baryons in first occasion the sum end state is i + j + k (or i -j -k and so on, see below). So for baryons, zero color sum end state can only be achieved by superposition of wavefunctions.

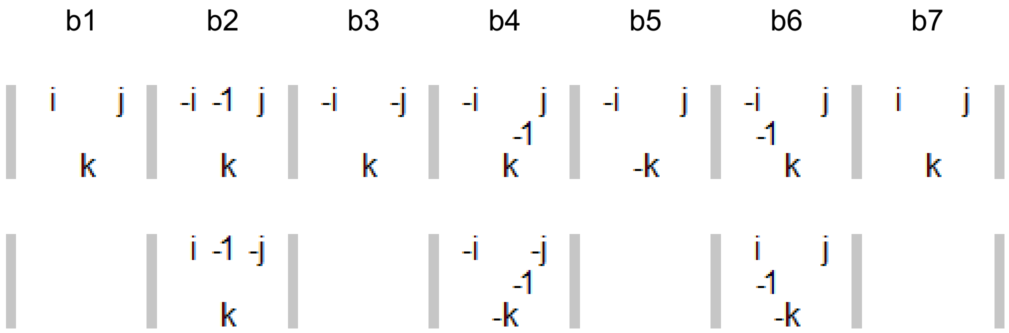
Let's generalize this to all color compositions:
THE SUM END STATE OF A COLOR COMPOSITION IS ALWAYS ZERO. (3.2.10)

This is all not too different from electrostatics between e.g. an electron and a proton. Their electric charges sum up to zero, but when *applied together* in the law of Coulomb they multiply to -1, in this case, and not to zero.

What if we experiment a little with the original color sum equation? In a baryon we have red + green + blue = white. We did set red = i, green = j, blue = k, white =1. Then red + green + blue = white becomes i + j + k = 1. This is the quaternion q = -1 + i + j + k. Two baryons colliding then should be the multiplication
(–1 + i + j + k) (-1 + i + j + k) = -2 -2i -2j -2k = -2 (-1 + i + j + k)
What is this? Minus two times a baryon? The original two baryons? Why the minus sign?
Try this at the excel document baryoncollision.xls. Two yellow sections next to each other are two colliding baryons. Just fill in the yellow sections of one line, click somewhere else and in the blue section appears the result of the multiplication. (3.2.11)

3.3 Black Glueball Exchange

In baryons
IF kji = 1 is color neutral THEN -k · -j · i = 1 is color neutral too. In the next cartoon i, j, k, -i, -j and -k are quark colors, 1 and -1 are gluons.



The transition from b1 (baryon 1) to b3 is caused by -1 going from i to j (b2) OR by -1 going from j to i (b2 below). The emitting color is divided by -1 and the absorbing color is multiplied by -1. The two possibilities b2 and b2-below cannot be distinguished and superpose.

The transition from b3 to b5 is caused by -1 going from -j to k (b4 up) OR by -1 going from k to -j (b4 below). Also these two possibilities superpose.

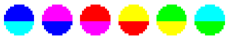
In QCD most of the states b1 up to b7 are colored states, forbidden as end state. However, in QQD each state equals +1 or -1 when multiplied (e.g. b3 is -i · -j · k = -1, or = 1 in a different multiplication order). These are all permitted end states in QQD. Then in each of the baryon states the -1 can escape: -1 itself is colorless and it leaves behind a white or black antibaryon. However, in ground state energy is not available, but when energy is sufficient to provide the free -1's mass, then yes. IF this can be, THEN in the mentioned example baryon b1 is converted into antibaryon b4-below. THE CONSERVATION OF BARYON NUMBER THEN IS VIOLATED BY 2. (3.3.1)

We consider now the single -1 gluon emission only. Starting from b1, an ordinary baryon, there are 6 different ways to arrive at a b3-like state. (i > j meaning “-1 gluon going from i to j”)
i > j, j > i, j > k, k > j, k > i, i > k
and 3 ways to remain in the b1 state:
i > i, j > j, k > k.
All -1 emissions have same chance, and so have all -1 absorptions.

At b3 there are 7 ways to stay in a similar state (with 1 plus-color and 2 minus-colors)
-i > k, k > -i, -j > k, k > -j, -i > -i, -j > -j, k > k
and 2 ways to return to the original baryon state:
-i > -j, -j > -i.

The total number of steps is 6 + 3 +7 + 2 = 18, yielding a net number of steps of 6 – 2 = 4 towards the “ one + and two – ” state. So when starting with a population of b1-likes one soon ends up with a population of b3-likes, with only a few b1-likes. The ratio of plus-color abundance to minus-color abundance then is 1 : 2 or 1/3 : 2/3. Is there a connection with the -1/3 and +2/3 electric charge of the d- and u-quarks in a baryon? (3.3.2)

(In anticipation to Quaternion Gravitation, even when the reactions shown above would not take place, then a baryon state b1 will absorb one (-1 -1) vacuum marble to arrive at state b3. Subsequently it will remain in that state as argued. But no, our forward time evolving vacuum does not contain (-1 -1) pairs.)

IF we would still work with gluons with an upper and a lower color THEN in -k · -j · i = 1 some of the 12 so-called “unused gluons” would be used there,  and . E. g.  and  would swap i and -j. (3.3.3)

Black gluon exchange in mesons

1 2 3 4 5

| i i | i -1 -i | -i -i | i -1 -i | i i

| i -i | i -1 i | -i i | i -1 i | i -i

I offer my excuses for the confusing use of the term “dark matter” for what is usually known as dark energy. But in this TONE and all over my website, the expression “dark” is reserved for everything evolving backward in time. We shall refer to the usually Dark Matter, the invisible matter that keeps the outer rims of galaxies in orbit, and that keeps the galaxies within their clusters, by writing the words with capitals or just saying DM.

I wonder whether glueballs can be candidate for Dark Matter. The white glueball (quaternion value 1) can easily be absorbed by any quark, so it can be expected to be not abundant enough. But in a baryon (3 quarks) the absorption of a black glueball (quaternion value -1) will turn the color of the absorbing quark into its opposite while leaving the color of the other two quarks unchanged, yielding a baryon with net color. This is not observed.

Then again, if one of the two unchanged quarks emits a black glueball that is absorbed by the other unchanged quark fast enough, then both quarks change their color to their opposite too, leaving a white baryon again. That is, the three quarks would be e.g. antimatter for their color but matter for their electric charges. The color change on itself does not change the electric charge or taste, so the baryon is not registered as an antibaryon now (of vice versa). This would not be as QCD is originally set up, but is it forbidden? My guess is this reaction is rare if not forbidden.

So the primordial black glueballs should have no choice than to roam around then. IF the black glueball has mass, THEN it is candidate for Dark Matter. The larger the mass of the black gluon, the lesser black gluons will be formed usually (maybe only at the Big Bang), and the sparser the mentioned black glueball exchange within the baryon will occur. More about the black glueball in the next chapter, paragraph 4.1.

3.4 Quaternion Units as Product of Pauli Matrices

According to https://en.wikipedia.org/wiki/quaternion (somewhere in the middle) quaternions can be represented as 2 x 2 matrices.

$$a + bi + cj + dk = \begin{pmatrix} a + bi & c + di \\ -c + di & a - bi \end{pmatrix} \qquad (3.4.1)$$

Mark the upper row in the matrix contains already all necessary variables (a, b, c and d). The second row is “junk”, extra machinery necessary to keep the matrix running. When you take a, b, c and d and set three of them at zero and set the fourth at 1 or -1, then you get the quaternion unit matrices.

$$1 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad i = \begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix} \quad j = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \quad k = \begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix} \qquad (3.4.2)$$

$$-1 = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \quad -i = \begin{pmatrix} -i & 0 \\ 0 & i \end{pmatrix} \quad -j = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \quad -k = \begin{pmatrix} 0 & -i \\ -i & 0 \end{pmatrix} \qquad (3.4.3)$$

According to https://en.wikipedia.org/wiki/special_unitary_group SU(2) is the following group:

$$SU(2) = \left\{ \begin{pmatrix} \alpha & -\overline{\beta} \\ \beta & \overline{\alpha} \end{pmatrix} : \ \alpha, \beta \in \mathbf{C}, |\alpha|^2 + |\beta|^2 = 1 \right\} \qquad (3.4.4)$$

where the overline denotes complex conjugation.

When you substitute alpha = a + bi and beta = c' + di and c' = -c, then you get eq. (3.4.1) again. SU(2) then is the 3-dim surface of a 4-dim sphere in a 4-dim space with 2 real and 2 imaginary dimensions. While quaternions cover all of a 4-dim space with 1 real and 3 imaginary dimensions. That is not the same. But the matrices are the same and therefore I dare to state:

QUATERNIONS ARE SU(2) (3.4.5)

There are three Pauli matrices: sigma 1, sigma 2 and sigma 3, here denoted as s1, s2 and s3.

$$s1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad s2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad s3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \qquad (3.4.6)$$

When two Pauli matrices are multiplied, one always gets a quaternion unit.

	s1	s2	s3
s1	1	i	-j
s2	-i	1	k
s3	j	-k	1

(3.4.7)

(3.4.7) means s1 · s2 = i, s1 · s3 = -j, and so on. Seven quaternion units 1, i, j, k, -i, -j and -k are formed, but -1 isn't.

$$1 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad -1 = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$$ see (3.4.2) and (3.4.3)

	1	-1
1	1	-1
-1	-1	1

(3.4.8)

"SU(2) has 2 real dimensions and 2 imaginary dimensions" in just above (3.4.5) is satisfied in "(quaternion unit) = (Pauli matrix) x (Pauli matrix)" from (3.4.7) when you take axes 1 and i from the first Pauli matrix orthogonal to the axes 1 and i from the second Pauli matrix. IF the Pauli matrices here can be orthogonal THEN quaternion 1ijk space can be SU(2).
In QM orthogonal states exclude each other. It is one or the other, but not both. Are the Pauli matrices states here? In quaternions there is some ambiguity. A quaternion can define a rotation as well as a point in 1ijk space. But these are not quaternions, it are Pauli matrices, a kind of "square roots" from quaternions, a kind of factorization.
What are the Pauli matrices here? How to proceed?

Everywhere in this TONE you can replace every quaternion unit by the appropriate Pauli matrix product and then there is no quaternion anywhere in this TONE no more. While the structure of the involved formulas remains unchanged: there appear no extra i's or minus-signs during the exchange. Nevertheless, the quaternion calculation formalism remains intact as long as you always and everywhere keep the Pauli matrices of one product together. A Pauli matrix usually means a particle, e.g. an electron. Two Pauli matrices in multiplication usually mean two particles in interaction, e.g. a collision. Two Pauli matrices *staying* in multiplication then mean two particles in continuous interaction, like in a composite.

As is worked out in paragraph 5.2 Four Quarks in the Shell, the gluon might be composed of a quark and an antiquark massless coinciding within their time borders. Now it is tempting to identify the quark as well as the antiquark with a Pauli matrix, which product yields a quaternion unit, a color of the strong force – a gluon. But each of these two quarks has color too and each color consists of two Pauli matrices. So this is not that easy.

ijk = -1 according to (3.1.1).
i = s1 · s2,
j = s3 · s1,
k = s2 · s3 according to (3.4.7). So
ijk = s1 · s2 · s3 · s1 · s2 · s3 = -1
-1 can be formed from 6 Pauli matrices in multiplication. (3.4.9)

3 GLUONS MERGE EASIER TO 1 GLUON THAN 2 GLUONS DO. (3.4.10)
This is worked out at page 7 of NET FORCES IN QCD in my website.

$i^2 = j^2 = k^2 = -1$ according to (3.3.1), so
s1 · s2 · s1 · s2 = s3 · s1 · s3 · s1 = s2 · s3 · s2 · s3 = -1
-1 can be formed from 4 Pauli matrices too, two gluons that are. But as said, 2 gluons merge less easy than 3 do. (3.4.11)

3.5 Dark Multiplication Rules

In anticipation to Quaternion Gravitation we already give the *dark multiplication rules*, the computing rules as they hold in backward time evolving vacuum as observed by us, from our frame of reference. The clue leading to this rules is at paragraph Dark Multiplication Rules at page 2 of THE EXPANSION OF THE UNIVERSE, but first: to understand it one has to read Quaternion Gravitation, and second: it is not a very strong clue. One might say as well the dark multiplication rules are given by intuition – just a set of rules I think that works in dark vacuum.

DARK	$-1 \cdot -1$	$= 1 \cdot 1$	$= -1$	
DARK	$-1 \cdot 1$	$= 1 \cdot -1$	$= 1$	
DARK	$-i \cdot -i$	$= i \cdot i$	$= 1$	
DARK	$-i \cdot i$	$= i \cdot -i$	$= -1$	
DARK	$1 \cdot i$	$= -1 \cdot -i$	$= -i$	
DARK	$1 \cdot -i$	$= -1 \cdot i$	$= i$	(3.5.1)

When applying (3.5.1) one gets (3.5.2) and (3.5.3).

$$\textbf{DARK} \quad \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \qquad (3.5.2)$$

		s1	s2	s3	
	s1	-1	-i	j	
	s2	i	-1	-k	
DARK	s3	-j	k	-1	(3.5.3)

(3.5.3) means **DARK** s1 · s2 = -i, **DARK** s1 · s3 = j, and so on.

Conclusions

3.1) In QQD colors are imaginary. It turns out that only composites of colors can be observed with a color end state that has no imaginary component no more. (Color sum end state zero and color product end state 1 or -1.)

3.2) In QQD gluons are colors too. Where in QCD a color (of a quark) is multiplied by a Gell-Mann matrix (a gluon) in order to yield another color (of the quark), then in QQD the gluon is a color too. In QQD a color times a color always yields a color again (a quaternion unit times a quaternion unit always yields a quaternion unit).

3.3) A Gell-Mann matrix (a gluon) is a kind of Pauli matrix. In QQD the gluons are the product of TWO Pauli matrices. In QQD colors in general are the product of two Pauli matrices. Except for -1 of course.

3.4) According to (3.1.10) a gluon maybe rather is a line segment than a particle. It has its color at both ends of the line segment.

3.5) IF the Pauli matrices that compose a quaternion unit can be orthogonal THEN quaternion 1ijk space can be SU(2).

3.6) The time border around each quark at the surface of the Earth is calculated as a sphere of 10^-21 m. As long as the quarks do not near within this sphere, their reactions on Earth work out forward time evolving, quarks as well as antiquarks.

3.7) In backward time evolving vacuum the rules of multiplication are different. This is taken as the cause of all dark behavior like the so-called “erasing of velocity” in chapter 2 *The Acceleration of the Expansion of the Universe*. However an effort to calculate this has not yet been undertaken.

3.8) Mass absorb from the Higgs field, antimass emits to the Higgs field.

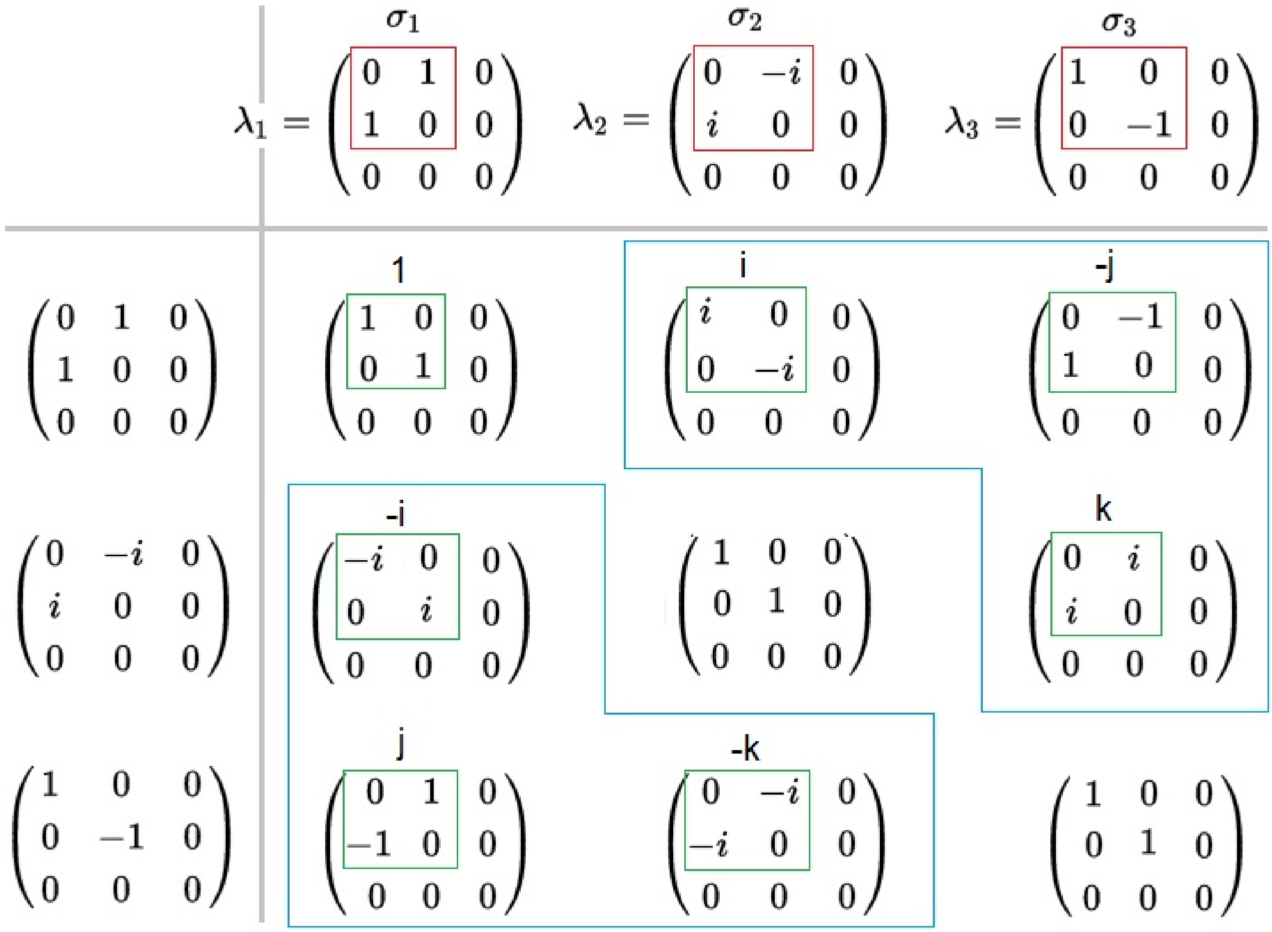
Discussion

3.1) Do 3 gluons indeed merge easier than 2 gluons do? Is (3.4.10) right?

3.2) When I contacted prof. Piet Mulders from VU University, Amsterdam, I found him be willing to read my paper (proposal to a paper) about Gluons as Quaternions. Besides other remarks he judged the chance of publication to be zero because the mapping on SU(3) was missing.

I showed him that the product of two Pauli matrices always yields a quaternion unit, but he stipulated that *really* eight 3x3 matrices are needed and that I *really* should show the connection with the Gell-Mann matrices.

As a reply I came upon with the following scheme.



This scheme shows the first 3 (out of 8) Gell-Mann matrices, lambda 1, lambda 2 and lambda 3 and their products. These products are the matrices I propose as gluons. The red frames are the Pauli matrices. The green frames are the quaternion units, except for -1. The large blue frames together are one subset. Lambda 4 up to 8 (not shown) are not to be used.

I proposed to take as 8th gluon

$$-1$$

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Prof. Mulder replied that the matrices I proposed indeed are symmetries, but they don't obey the commutation relation [A,B] = C no more, where C is a Lie-algebra. The group decays in a number of subsets that cannot represent all of QCD no more and you have to perform quite some acrobatics to repair this. This doesn't make things simpler nor easier, he said.

My proposition is to replace the classic gluon with 3 entries for color by a 2x2 matrix for each color, so 2 entries that are. I am not familiar with Lie-algebra's, I am afraid. I cannot judge this commentary. So for the moment I proceed with my findings so far.

3.3) If the Pauli matrices that compose a quaternion unit are orthogonal, do they exclude each other then? And what does that mean?

3.4) Dark multiplication rules work between antimatter particles. When two anticolors -j and -k of two antiquarks react -j * -k and -k * -j, shouldn't then the minus-signs multiply according to the dark rules? In dark multiplication rules - * - = - and so -j * -k = -i and -k * -j = i?

3.5) The reaction -k * k consists of half matter and half antimatter. In the bright rules it is -k * k = 1, while according to dark multiplication rules it is -k * k = -1. So since there seem to be no decision ground, shouldn't the result be neither 1 nor -1?

3.6) In leandraphysics dot nl slash grav3 dot html (3.26) says that two gluons of opposite sign do not react.

3.7) When an u-quark of color k and an anti-u-quark of color -k approach within their time borders, their mass absorption and emission cancel and the assemblage gains lightspeed. So the decision whether k * -k is bright or dark is avoided.

3.8) In leandraphysics dot nl slash netqcd5 dot html, in the first paragraph *The proton,* is stated the force between quarks that are very near to each other, is zero, which seems to fit in with decision avoidance.

3.9) How does conclusion 3.6 work out near the far away time border between a galaxy cluster and an antimatter galaxy cluster?

3.10) Is the black glueball candidate for Dark Matter? Do primordial black glueballs have no choice than to roam around? What is the mass of the black gluon? More about the black glueball in the next chapter, paragraph 4.1.

4 Quaternion Gravitation

Introduction

We are going to fill in the vacuum marbles with *pairs of spin 1 gluons*. Why gluons? The gluon is a well-known particle, we don't have to introduce a new particle. And it is the strongest and fastest reacting particle (highest number of reactions per second). Mind we are building *spacetime*, the grid to which all events are attached. If the particle making up the grid, was a weaker and slower reacting particle then the fastest reacting particles most of the time would have no spacetime background and at the sparse moments they had, the strongest particles as they are, would tend to rip the background apart, which is not observed.

4.1 Filling In the Vacuum Marbles with Gluon Pairs

Current QCD presents the gluon as a particle with color charge, reaction time of 10^-23 sec and spin +1 or -1. In my description the gluon gets a fourth property: it embodies a tiny bit of space (when in pairs).

The proton traversing the vacuum acts as if it doesn't react with the vacuum. The vacuum is chosen to consist of vacuum marbles, vacuum particles. IF the proton reacts with the vacuum then the wavefunction F of the proton times a vacuum particle must equal F, so the vacuum particle must be 1.

F · 1 = F (4.1.1)

So the vacuum *can* consist of gluons that are 1. If so then each quark of the proton reacts with the vacuum 10^23 times per second (typical strong force reaction time). In each reaction the quark absorbs a vacuum marble (Higgs mechanism), thus causing the tiny gravitational field of the proton, according to the mechanism described earlier.

Gluons that are 1 are called *glueballs*. But colorless gluons don't glue, the vacuum they form will not cohere. So it must be *colored gluons*, i, j, k, -i, -j or -k, these gluons glue, gluing 3 dimensional space together. But there is no color in the vacuum. When there was, like the color i, then F · i = iF which does not equal F no more. It must be *pairs of colored gluons* that equal one: i · -i = j · -j = k · -k = 1.

So the vacuum should consists of the gluon pairs (i -i), (j -j) and (k -k).

Gluons are massless. Supposed is the composition of two gluons is still massless, the composition has no net absorption from the Higgs field (this is worked out further down).

The quaternion units are 1, i, j, k, -1, -i, -j, -k (for quaternions, see Frame 3). What seems more natural than to complete the colors of the vacuum with the “colorless color pair” (1 -1), a white-and-black gluon pair? But 1 · -1 = -1 · 1 = -1 and so F · -1 = -F. So it is no, the pair does not add to the vacuum superposition. Instead (1 1) as well as (-1 -1) should add to the vacuum superposition because 1 · 1 = -1 · -1 = 1. We conclude:

The vacuum consists of the pairs (i -i), (j -j), (k -k), (1 1), (-1 -1) (4.1.2)

i · -i = j · -j = k · -k = 1 · 1 = -1 · -1 = 1 (4.1.3)

The *net color sum* of the pairs with color within neatly adds up to zero:

i -i = 0
j -j = 0
k -k = 0 (4.1.4)

But in the pairs (1 1) and (-1 -1) the colors add to two: 1 + 1 = 2 and -1 -1 = -2. This is colorless (no i, j or k) but not valueless. What does this mean? Is this the arrow of time? Its length? The new theorem (4.1.12) seems to suggest so. (4.1.5)

The vacuum particles of (4.1.2), do they have antiparticles? We construct the antiparticles by replacing every gluon in (4.1.2) by its opposing color, i by -i, j by -j and so on. It is the same as multiplying every particle by -1.

(-i i), (-j j), (-k k), (-1 -1), (1 1) (4.1.6)

which happen to be precisely the same particle pairs as in (4.1.2). The vacuum particle pairs are their own antiparticle, like the photon. Photons don't annihilate each other nor themselves, despite they are their own antiparticle.

There are two ways now to proceed.

First way. As a new theorem we accept:
THE BLACK GLUEBALL IS THE ONLY GLUON WITH MASS. (4.1.7)

Then the pair (-1 -1) would consist of two massive gluons NOT canceling out each other's mass within their time borders, since the constituting -1's have same time direction. The (-1 -1) pair would be ruled out as vacuum particle, leaving only 4 particles as vacuum particles:

(i -i), (j -j), (k -k), (1 1) (4.1.8)

Second way.
THE BLACK GLUEBALL ON ITSELF IS MASSLESS, BUT WHEN TWO BLACK GLUEBALLS ARE TOGETHER THEY GAIN MASS (this is worked out in Higgs mechanism 2). (4.1.9)

Yes, that would do! The difference between forward and backward time evolving vacuum can be given feet on the ground now. As observed from us the backward time evolving vacuum consists of:

(i -i), (j -j), (k -k), (-1 -1) (4.1.10)

As observed by us, forward time people, (4.1.10) is a massive vacuum, a vacuum with a massive component. The energy for that is not available. So in our vacuum (4.1.10) will not occur, only (4.1.8) will. Therefore time will run forward only. The secret of time.

The vacuum particles from the vacuum superposition are no longer all their own antiparticle now. (4.1.8) are the antiparticles of (4.1.10) and vice versa. Moreover, multiplying (4.1.8) with -1 (the time-reversing factor) yields (4.1.10), multiplying (4.1.10) with -1 yields (4.1.8) again.

A massless (1 1) vacuum marble can convert to a massive (-1 -1) by black glueball exchange. This is a forbidden conversion since the energy for massive vacuum is lacking. (4.1.11)

A new theorem:
1ijk QUATERNION SPACE CORRESPONDS WITH xyzt SPACETIME.
IMAGINARY COLOR SPACE ijk CORRESPONDS WITH REAL SPACE xyz.
REAL QUATERNION AXIS 1 CORRESPONDS WITH IMAGINARY TIME AXIS t.
1, i, j, k not only are *colors* but are *dimensions* as well.
Then multiplying by -1 reverses time as well as converts matter (i, j, k) in antimatter (-i, -j, -k), and changes the x-axis by -x, y by -y and z by -z, or vice versa. It changes the *parity*. Now you have constructed the CPT theorem. (4.1.12)

Shall we experiment a little? Start with the well-known time dilation formula from SR (Special Relativity)
$t' = t / SQRT(1 – v^2 / c^2)$
t = time in frame 0, t' = time in frame 1, t'' = time in frame 2, and so on. All frames differ a velocity. Frame 0 sees frame 1 to have velocity v, frame 1 sees frame 0 to have velocity -v. Displacement s = vt, s' = -vt'. 1ijk-space = quaternion space, xyzt-spacetime = our well-known spacetime. Take in mind two *events* A and B and set the Origin in A.
$t' = t / SQRT(1 – v^2 / c^2)$
$(1 – v^2 / c^2) t'^2 = t^2$

$t'^2 - v^2 t'^2 / c^2 = t'^2 - s'^2 / c^2 = t^2$
$(c\,t')^2 - s'^2 = (c\,t)^2 - 0^2 = ...$
The 0^2 means s = 0, we just set s at zero.

SR states the interval $(c\,t)^2 - s^2$ is a constant for all frames:
$(c\,t)^2 - s^2 = (c\,t')^2 - s'^2 = (c\,t'')^2 - s''^2 = (c\,t''')^2 - s'''^2 = ... =$ constant
In fact this is all there is to SR. It is called the *invariance of the interval*. When there was no SR then in an x-t-diagram would have hold the theorem of Pythagoras, $(c\,t')^2 + s'^2$ = constant for all frames. The t-axis and the axes x, y and z would be perpendicular to each other in all frames. Lengths along the t axis would have been treated just like lengths along x, y or z. So only this minus sign is the difference between Newton spacetime and Minkowski spacetime. Can quaternions provide this minus sign?

Take time t to be real and take displacement s' to be the length of quaternion q = fi + gj + hk. A rectangle with sides a meter and b meter has surface ab m^2. A length of b meter squared is $b^2\,m^2$. Likewise squaring length fi yields $(fi)^2 = f^2 i^2 = -f^2$. Quaternion unit i is regarded as measurement unit like the meter, and so are j and k. Then
$s'^2 = f^2 i^2 + g^2 j^2 + h^2 k^2$
$= -f^2 - g^2 - h^2$ (4.1.13)

$(c\,t')^2 - s'^2 = (c\,t)^2$
$(c\,t')^2 + f^2 + g^2 + h^2 = (c\,t)^2$
Which is the ordinary Pythagoras theorem in 1ijk-space.
IF YOU TAKE TIME AS REAL AND TAKE SPACE DIMENSIONS AS IMAGINARY AND TAKE SR FOR GRANTED, THEN 1ijk QUATERNION SPACE REACTS AS xyzt SPACETIME, AS FAR AS SPACETIME COORDINATES AND THE DISTANCES BETWEEN THEM ARE CONCERNED.   (4.1.14)

I sometimes call this the “real-imaginary swap”. It has to be admitted that other properties like surface and volume are not directly recognized as working the same in 1ijk and xyzt space.

Multiplying (4.1.8) which is (i   -i), (j   -j), (k   -k), (1   1) by -1 in fact yields:
(-i   i), (-j   j), (-k   k), (-1   -1)
When a vacuum particle is a shape, an object, and 1ijk-space *is* xyzt-spacetime, then all four coordinates of that object will change sign when multiplying by -1. The time swap makes it run backward in time. The first two space dimension swaps will cancel each other. The third space dimension swap changes the object in its enantiomer, its mirror image.   (4.1.15)

4.2 Higgs Mechanism 1

The gravitational field has spin 2. Take the vacuum marbles of the gravitational field to consist of gl ↑ gl ↑ (spin +2) and gl ↓ gl ↓ (spin –2). Here gl = gluon, ↑ = spin +1, ↓ = spin -1. The marbles of gravitation are called *gravitons*, referring to the concept of a “bose condensate of gravitons”.

The Higgs field has spin 0. Take the vacuum marbles of the hadronic Higgs field to consists of gl ↑ gl ↓ and gl ↓ gl ↑ (spin 0). The marbles of the Higgs field are called *Higgs field particles*.

Suppose one of the two gluons from graviton gl ↑ gl ↑ absorbs a graviton gl ↓ gl ↓. Three gluons merge easier than two gluons, see page 7 of NET FORCES IN QCD.

(gl ↑, spin +1) + (gl ↓ gl ↓, spin –2) --> (gl ↓, spin –1)   (4.2.1)

The other gluon from the pair gl ↑ gl ↑ remains unaffected. The disappeared graviton leaves an empty spot at the place it had occupied. So the two gravitons change into one empty spot and one Higgs field particle of same volume (is assumed) as the graviton:

gl ↑ gl ↑ + gl ↓ gl ↓ --> gl ↑ gl ↓ + empty spot   (4.2.2)

Then the Higgs field particle gl ↑ gl ↓ is absorbed at the coupling of a quark in the course of renormalization, leaving another empty place there.
So finally 2 gravitons did convert to 2 empty spots and 1 Higgs absorption.   (4.2.3)

If two gravitons gl↑ gl↑ and gl↓ gl↓ would just swap a gluon, one gets gl↑ gl↓ and gl↑ gl↓. Now there are two Higgs particles in one single stroke to be absorbed in the course of renormalization.
Here 2 gravitons convert to 2 empty spots and 2 Higgs absorptions. (4.2.4)

I cannot judge whether this can yield a heavier particle or not. If so, one is tempted to think at a higher generation. But then again, if so then where is the third generation?

In (4.2.1) and (4.2.2) graviton 1, to give them names, had absorbed vacuum marble graviton 2 and in doing so acquires the energy of graviton 2 added to its own energy. It is not precisely the Higgs mechanism because it had absorbed a graviton and not a Higgs field particle. It has caused one empty spot that will be filled in from the outside and this is one bit of gravitation. A vacuum locally acquiring energy, a local *excited state of vacuum*, is not yet defined, maybe not even possible. So we conclude this reaction will not take place in empty space. But I think it does occur in the neighborhood of a quark ready to give that quark its mass. (4.2.5)

Then there doesn't have to be a separate Higgs field in empty space. There don't have to be two fields, a gravitational field AND a Higgs field. When a Higgs vacuum marble emerges, it is absorbed immediately thereafter. The hadronic vacuum of gravitons then is one single grid. The Higgs field, the Higgs field particle, only does exist as a short-living intermediate state between the gravitational field and any coupling anywhere. The link between space and matter. (4.2.6)

The quaternion consideration. A vacuum marble like (i -i) consists of two gluons, i and -i. We start with two neighboring vacuum marbles, e.g.

(i -i) (i -i) (4.2.7)

Now we assume the right gluon of the first vacuum marble (-i) to absorb the entire second vacuum marble (i -i). The left gluon of that first vacuum marble is unaffected. If we rename (i -i) (i -i) as (i a) (b c) then there are 6 multiplication orders: abc, acb, bac, bca, cab, cba. In gluon-gluon reactions there is no preferred multiplication order and so the 6 possible outcomes superpose. In this case they all give same outcome -i, so the superposed possibilities merge to one possibility again.

-i · i · -i = -i · -i · i = i · -i · -i = i · -i · -i = -i · i · -i = -i · -i · i = -i (4.2.8)

The result is, as far as the colors are concerned, that the first vacuum marble is unchanged and the second vacuum marble is absorbed, leaving behind a hole in the vacuum, in accordance with the spin consideration.

(Quaternion multiplication has the *associative property*. As long as you don't change the order of multiplication, it doesn't matter whether you first multiply the last two gluons and then multiply by the first gluon, or multiply the first and second gluon and then multiply with the third one.)

The vacuum now is a superposition of (i -i), (j -j), (k -k) and (1 1) from (4.1.8), each in spin state gl↑ gl↑ or gl↓ gl↓. So 8 fields altogether. (4.2.9)

4.3 Higgs Mechanism 2

Suppose, at the spot of a quark in a baryon two gravitons from the vacuum – four gluons altogether – couple as follows.

(gl↑ gl↑) graviton 1
(gl↓ gl↓) graviton 2
--- +
(gl↑ gl↓) Higgs field particle -->

(gl↑) (gl↓) two independent gluons (4.3.1)

Two gluons of opposite spin merge, one gluon from graviton 1 and one gluon from graviton 2. Then the remaining two gluons, also of opposite spin, merge too. There are two possibilities for this, I I and X (one above the other or crosswise). To end up with spin1 gluons we need to assume “one spin from one gluon from graviton 1 to annihilate with one spin from one gluon from graviton 2”. This is thought to take place at the location of a quark, the quark mediates this spin conversion. Take in mind a baryon, three quarks together. If this conversion also detaches the gluons from each other, then you have two independent gluons of opposite color. Then one gluon can go to the second quark and the other to the third quark.

So 2 gravitons disappear from the vacuum, reducing it by their volume, and 2 gluons appear. Vacuum converts into matter. (4.3.2)

	1	2	3	4	5
graviton 1	(i -i)	(i -i)	(i -i)	(i -i)	(i -i)
graviton 2	(i -i)	(j -j)	(k -k)	(1 1)	(-1 -1)
	----------------	----------------	----------------	----------------	----------------
	(i · i -i · -i) + (i · -i i · -i)	(i · j -i · -j) + (j · i -j · -i) + (i · -j -i · j) + (-j · i j · -i)	(i · k -i · -k) + (k · i -k · -i) + (i · -k -i · k) + (-k · i k · -i)	(i · 1 -i · 1)	(i · -1 -i · -1)

(Mind there are two ways to multiply, I I and X, one above the other or crosswise. The +signs indicate outcomes that superpose. Red indicates a forbidden contribution.)

	1	2	3	4	5
Higgs	= (-1 -1) + (1 1)	= (k k) + (-k -k)	= (j j) + (-j -j)	= (i -i)	= (-i i)

(The I I outcomes in number 1 are (-1 -1). In our forward time evolving vacuum this vacuum particle is assumed to have mass, see (4.1.7) and (4.1.9). Then this contribution is forbidden.)

	1	2	3	4	5
two gluons	= (-1) (-1) + (1) (1)	= (k) (k) + (-k) (-k)	= (j) (j) + (-j) (-j)	= (i) (-i)	= (-i) (i)

Table (4.3.3)

The wavefunction of the Feynman diagram of the baryon is provided with color in page 2 of QQD. Higgs mechanism 2 in this wavefunction must be something like the following (quaternion parts only). The baryon start state is quark of color i, quark of color j and quark of color k (k-quark not shown). Then a vacuum particle (-k k) appears.

i · j
= i · -k · k · j
= i · -k · j · -k

This is quark i that absorbs a gluon -k and quark j that absorbs the other gluon -k. Mark when it would have been quark i that *emits* a gluon -k and quark j that *absorbs* the gluon -k, then the equations are precisely the same.

= j · -i

or likewise leading to end state

= -j · i

When the electron absorbs from the leptonic Higgs field, it gains mass. But here there are *two* particles, quark i and quark j, that absorb from the (hadronic) Higgs field. So we assume both particles to gain mass.

Finally 2 gravitons convert into 1 empty spot and 1 Higgs particle at the spot (nearly) of a quark, and the Higgs particle converts to 2 separate gluons.

This might be all there is to the exchange of gluons in the baryon. It might be a quark never *emits* a gluon, they only absorb gluons, in pairs made on the spot. For every gluon pair that is absorbed, there disappears the volume of 2 gravitons from the vacuum.

(Between (3.1.5) and (3.1.7) is stated “The gluon takes away the magenta from the quark and carries it off in its upper color” and “A correlated pair of colors cyan - anticyan appears.” So in the definition of the gluon reaction itself in QCD the emergence of a kind of vacuum particle - the cyan red color pair in this case - has been there already from the start.)

Maybe the processes superpose. The QCD view where a gluon goes from one quark to the other leading to a swap of the colors of the quarks, superposes with the vacuum marble absorption process just described. But mark, the reaction of gluon exchange between quarks would be pure then, without absorption from the vacuum. When there is no marble absorption from the vacuum, there is no Higgs field absorption nor gravitation either, anyway not in this website. So pure gluon exchange between quarks would be massless and gravity-less – the Einstein assumption that $E=mc^2$ mass is proportional to gravitational mass (that is the mass causing the gravitational field) remains fulfilled.

Decisive might be the energy involved. If you have choice OR to provide the energy for an intermediating gluon, albeit only for a short time, OR you can get it for free from the vacuum, just being there to be absorbed, then the choice seems easy. The lowest energy one will be chosen most often.
So the possibilities *do* superpose, but the gluon-interchange reaction from QCD will contribute only little. (4.3.4)

So the Higgs mechanism prevails over direct gluon exchange. But direct gluon exchange was in QCD the very mechanism by which quarks attract each other. So we have to conclude:
HIGGS MECHANISM 2 NOT ONLY PROVIDES MASS BUT ALSO IS THE MECHANISM OF ATTRACTION BETWEEN QUARKS. (4.3.5)

Consider table (4.3.3), the outcome of nr 2, (k) (k) + (-k) (-k). Two gluons appeared, where do they go? We start with a baryon with colors i, j and k, to denote as baryon (i j k). When (k) (k) emerge at the quark with color k then one (k) arrives at the quark of color i and the other (k) at the quark with color j. Then ik = -j and jk = i (mark we had to *right-multiply* the quark by the gluon) The quarks in the baryon then have colors -j, i and k. Then -j · i · k = -1, so this is a permitted state. When i and k would exchange a black glueball then (-j i k) converts to (-j -i -k) which is an antibaryon. (Paragraph *3.3 Black Glueball Exchange* had already argued baryons usually might be in a quark-antiquark mix of net color white, or black).
So, as far as the colors are concerned, this reaction converts a baryon into an antibaryon. While the subsequent reaction will turn the antibaryon back into a baryon. Note this alternation doesn't affect the electric charge of the baryon, nor its taste, spin or mass. It's only a color-thing and colors, unlike the four other properties, cannot be observed directly.
Multiplication order in -j · i · k is not defined so all orders superpose, always yielding 1 or -1.

The possibilities for a second set of separated vacuum particles (k) (k) or (-k) (-k) next to arrive at baryon (-j i k) are:

A	B	C	D	E	F
i · k = -j	i · -k = j	i	i	i · k = -j	i · -k = j
-j · k = -i	-j · -k = i	-j · k = -i	-j · -k = i	-j	-j
k	k	k · k = -1	k · -k = 1	k · k = -1	k · -k = 1

Table (4.3.6)
In each of the sets A up to F the first column (i -j k) is the baryon – there is no specific order of i, -j and k in the baryon. The second column is (k) and (k), or (-k) and (-k), the gluons that react with the baryon.

After reacting, A and B are baryons again. In A: when the end states -j and -i would interchange a black glueball, they would convert to j and i, resulting in baryon (i j k). So (-i -j k) holds as a baryon state.
In A up to F there is absorbed 1 vacuum particle (Higgs mechanism), the vacuum is reduced by the volume of 1 vacuum particle (1 bit of gravity).
(Black glueball exchange can also be mimicked by the absorption of a (-1 -1) vacuum particle, that yields the same effect. Alas, according to (4.1.8) the (-1 -1) is no part of our forward time evolving vacuum.)

In C the (k) (k) gluon pair is assumed to emerge at the quark of color i. The gluons then go to quark -j and k respectively. This results in a meson-like composition (i -i) and a quark of color -1. We know black gluons, but what is a black quark? A nice estimation is given at qg4 dot html in my website, that is page 4 of QG, the storyline Quaternion Gravitation. The absorption of the (k) (k) is the Higgs mechanism, so both the -i (formerly -j) and the -1 (formerly k) acquire mass.

Still in column C. Suppose the baryon is a proton and the i and -i (formerly i and -j) are an u- and d-quark. Then our -1 must be an u-quark of spin +1/2 or -1/2. There are two possibilities: it escapes or it doesn't. When it doesn't, the color -1 quark maintains its spin 1/2, taste u and electric charge +2/3, no reason to assume otherwise. Because -1 doesn't glue, the -1 quark is no longer bound by color, only by electric charge. So I expect it to enlarge its distance and form a halo around the (i -i) meson, a zero-color quark-cloud around the remaining two quarks, like the electron does around the nucleus. Well, I guess it would work a lot better when the i and -i were both u and the d circles around them. So let's do it that way.
Regard Higgs mechanism 2 working between the quarks. Two separate gluons (former vacuum particle) have to go to two quarks but when one of them is at large distance the gluon that has to reach for it, has to travel too long a distance. When distance of d to the two u quarks starts to increase, it becomes increasingly difficult to provide the black d quark with mass. The black d quark has color value -1 and is not attracted by the two u quarks by color force. We concluded in (4.3.5) that attraction between quarks is the Higgs mechanism. So the Higgs mechanism doesn't work between the black d quark and the two u quarks. The black d quark is massless. It will not be kept in orbit. It escapes after a short transition time and gains lightspeed.
A particle of -1/3 electric charge as the d is, is never observed, only integer charges are. Massless electric charge has never been observed. So the charge must somehow have been redistributed. The easiest way is to assume it had transferred its electric charge to one of the two u's, -1/3 + 2/3 = +1/3, leading to the meson of charge +1/3 +2/3 = +1 electric charge. The escaping particle then has no electric charge.

Could the escaping color -1 black quark be a black glueball? The sole black glueball is massive according to (4.1.7), but massless according to (4.1.9). Quarks have spin 1/2, the black glueball as well as the meson have integer spin. No, it cannot be the black glueball. Unless it gives a spin 1/2 to another particle like a neutrino?
THE MECHANISM OF CHARGE REDISTRIBUTION IS YET UNKNOWN.

Can the escaping black quark become the electron, or the neutrino? When the charge redistribution gives the electric charge to the black quark it is the electron, and when the charge redistribution gives the electric charge to the u anti-u meson, it is the neutrino? And both are given mass by Higgs mechanism 1? Moreover, usual particle physics needs the electron and the neutrino simultaneously, and not only one of them at the time.

It is the W+, W- or Z0 particle that splits in an electron-like particle and the fitting type of neutrino. An effort to describe W+ and W- as a colorless quark is at *Mark the = pairs in the 3rd and 4th scheme are interesting* in "Four quarks in the shell".

An nice effort to describe the leptons as colorless quarks is at leandraphysics dot nl slash qg4 dot html

We observe no massive sole quarks. For Higgs mechanism 2 to work, it needs TWO particles. Sole quarks cannot be given mass by Higgs mechanism 2. So if Higgs mechanism 1 wouldn't work (although I don't see a reason why it shouldn't) then sole quarks are massless. (4.3.7)

There seems to be a rule that
ELECTRICALLY CHARGED PARTICLES HAVE MASS. (4.3.8)
So the sole quark from (C) has electric charge zero. Or has mass. Or both.

Before we forget, let's state as a rule:
FRACTIONAL ELECTRIC CHARGES ARE NEVER OBSERVED, ONLY INTEGER CHARGES CAN EXIST OBSERVABLY. (4.3.9)

There is a hint to a mechanism for the mass of the -1 gluon, the black glueball. First, each color consists of two Pauli matrices, see (3.4.7). Second, each gluon consists of two quarks massless coinciding, this is worked out in paragraph *5.2 Four Quarks in the Shell*. Maybe there is a connection between these two things somehow. Although colors of quarks also consist of two Pauli matrices, and it is difficult to make a quark to consist of two quarks. Anyway, the -1 color of the black gluon consists of at least 4 and maybe more likely 6 Pauli matrices. That are 2 or 3 colors in multiplication which mean 2 or 3 color carrying particles in continuous interaction, indicating a composite. Between two or more colors together Higgs mechanism 2 can work and so it will. There is no fundamental -1 massless gluon. The -1 gluon as particle in forward time evolving vacuum exists as massive composition only. (4.3.10)

Higgs mechanism 2 doesn't work nor for sole quarks nor for sole gluons. We draw the conclusions
SOLE COLOR CANNOT BE GIVEN MASS BY HIGGS MECHANISM 2 (4.3.11)
and
TWO OR MORE COLORS TOGETHER ARE ALWAYS GIVEN MASS BY HIGGS MECHANISM 2 (4.3.12)

No rule without exceptions. For (4.3.11) that is: color -1 might have mass. For (4.3.12) there are the vacuum particles that must be massless. The three vacuum particles (i -i), (j -j) and (k -k) are regarded as a particle and an antiparticle. One color goes forward in time while the other goes backward, one color has forward vacuum around it, while the other has a tiny parcel of backward time evolving vacuum around it, with a tiny time border between the vacuums (tiny at the Earth surface). One particle emits towards the field, while the other absorbs from the field. The total absorption from and emission to the Higgs field is zero. When the colors of one vacuum particle had approached each other within the volume of the time border around the anticolor, then they coincide massless. (4.3.13)

And this also is the reason why the gluon is massless: it consists of a quark and an antiquark massless coinciding. Like the photon consists of an electron and a positron massless coinciding. (4.3.14)

Take in mind vacuum particle (i -i). For convenience, look at the vacuum particle as if it is a meson with quarks of colors i and -i, but then gluons of color i and -i instead of the two quarks. The i is at B and the -i is at D, see spacetime diagram below. When Higgs mechanism 2 is at work as described in table (4.3.3), and a pair of gluons like (k) (k) or (-k) (-k) appears at X with the intention to give the i and the -i mass, then i absorbs one (k) while -i *emits* the other (k) as it is observed by us, forward people. The emission cancels the absorption, emitting towards the Higgs field is gaining mass too, backward time evolving mass. As long as i and -i remain within their time borders, the composition of the two remains massless.
Between the two gluons i and -i in our vacuum particle it looks to us as if just one gluon goes DXB from the -i to the i (instead of (k) going to i and the other (k) going to -i). But it isn't, not completely. In fact both (k) are created at the time border and both go *from* the time border *to* their goal, as observed in their respective local frames. (4.3.15)

	5	**B** i		**S**		**C**	
	4			b			
	3	**R**	(k)	**X**		**T**	
t	2			b			x
x	1	**A**		**U**	(k)	**D** -i	t

SbXbU is the time border, hidden behind the letters S, X and U there is another b. Mind the opposite time arrows at both sides of the time border. Chosen is to represent the particles as they are observed by us (and not as they are locally observed). The (k) at their side is by them observed as (-k). The -i at D as we observe it, would by them have been denoted as an i.

The vacuum particles (i -i), (j -j) and (k -k) don't have a time arrow, unlike their constituent gluons. In contrast to (1 1) and (-1 -1) that ARE the time arrow. (4.3.16)

The 1's in (1 1) and the -1's in (-1 -1) have same time direction. So Higgs mechanism 2 works between them. It is nice that the mass of vacuum particle (-1 -1) is explained now but now it is a problem how (1 1) stays massless. (4.3.17)

This provides a way to understand the existence of gluon-gluon reactions a little better. It was always a little uneasy to imagine how two lightspeed particles can react. Neither of the particles has time elapsing, so there seemed to be no frame where the reaction can take its space and time.

Gluon 1 has no mass, neither has gluon 2. But when gluon 1 and gluon 2 are at about 0.9 fm mutual distance, then color force is at maximum. For one single moment the gluons form a pair. There are two colors together and Higgs mechanism 2 sees its chance to work. The gluons didn't see each other, but the vacuum does. For one moment both gluons of the pair get mass. For that single moment both gluons have no lightspeed no longer. They have time to react and so they do. The resulting merger gluon number 3 then is massless as the original two gluons were.

Gluons 1, i, j and k go forward in time. Gluons -1, -i, -j and -k go backward in time; when they are present in our vacuum they obtain a tiny shell of backward time evolving vacuum around them. In their own frame the -1 is just a 1. Remember, there is no pair of Pauli matrix multiplication yielding -1. While there is one in their own frame. The entire -1 gluon goes backward in time and is enveloped by a time border, so the two Pauli matrices it consists of react dark, see (3.5.2) and (3.5.3). But then also the Pauli matrices within -i, -j and -k react dark. (4.3.18)

Changing the order of the two Pauli matrices that compose a gluon, is changing between gluon i and antigluon -i, or j and -j, or k and -k. So as a rule we state that
IF YOU HAVE TWO PAULI MATRICES IN MULTIPLICATION, THEN CHANGING MULTIPLICATION ORDER IS THE SAME AS CHANGING MULTIPLICATION RULES FROM BRIGHT TO DARK, OR FROM DARK TO BRIGHT. (4.3.19)

I have no physical interpretation for multiplication order of only two factors, nor for quaternion units, nor for Pauli matrices. I do have an interpretation for changing between dark and bright multiplication rules. So it seems clear the last prevails.
Changing multiplication order just like that is not recognized as a state change. There is tried multiplication order as *time order of interaction*. A disadvantage for lower-than-lightspeed particles then is that a multiplication order that yield 1 in one frame might become a different multiplication order that yields -1 in another frame. So no, multiplication order is not the time order of occurrence.

So it might be that changing multiplication order of the Pauli matrices constituting one color is forbidden because forward time vacuum (bright multiplication rules) cannot be changed in backward time vacuum (dark multiplication rules) just like that. An i is not allowed to change into a -i just by changing multiplication order of its constituting Pauli matrices.

Let's continue our treatment of table (4.3.6).

A	B	C	D	E	F
i · k = -j	i · -k = j	i	i	i · k = -j	i · -k = j
-j · k = -i	-j · -k = i	-j · k = -i	-j · -k = i	-j	-j
k	k	k · k = -1	k · -k = 1	k · k = -1	k · -k = 1

In D results meson (i i) and a white quark, massive because of Higgs absorption. It is massive only at the first instant of its moment of creation. After that moment the white quark is massless as argued. Like in C, the white quark becomes a halo, a white-quark cloud around the meson (i i) and then it escapes (needs charge redistribution). The meson has value i · i = -1.
States that transform into each other by internal gluon exchange, superpose. Two possibilities are remarkable:

1. When one of the i-quarks interchanges a black glueball with the white quark, then the meson becomes (i -i) and the white quark becomes a black quark, precisely as in C.

2. When one of the quarks of color i interchanges a gluon -i with the other quark of color i, then both i's become 1. (I still use the term “gluon exchange” but (4.3.5) indicates the Higgs mechanism prevails over gluon exchange. The results are the same so when we talk about gluon exchange we mean the Higgs mechanism as described.)
We have three 1's now, three colorless quarks, the baryon is ready to decay completely. But the quarks still have electric charges +2/3, +2/3 and -1/3, these have to be redistributed first, see (4.3.8) and (4.3.9). The easiest way seems to be that one of the color 1 particles gets +1 electric charge and the other two become electrically neutral. No color force no more between the

remaining particles, no electric force either. The baryon decays in its 3 former quarks. Three particles without color, one with +1 electric charge and thus mass, all have spin 1/2, the remaining two masses unknown. I do not directly recognize this. What particles can it be? Mind the mechanism of charge redistribution is unknown.

E: Resulting are a meson (-j   -j) and a black quark. Convertible by black glueball exchange to meson (j   -j) and a white quark, like in F.

F results in meson (j   -j) and a white quark.

We forgot so far to treat nr 3, 4 and 5 of scheme (4.3.3). Number 3 is analogous to number 2. Number 4 is a vacuum particle that has split in (i) and (-i). Number 5 is forbidden.

The description so far shows that the existence of baryons (3-quark systems) leads to the existence of mesons (2-quark systems). The mesons of this page are always accompanied by a color +1 or -1 particle. It does not show why the meson is unstable, nor the existence of other generations. Higher generation baryons all decay into another *baryon* and a meson.

Conclusions

4.1) The gravitational field is the Higgs field. Absorption from the Higgs field gives mass to particles at the same rate as it forms holes in the vacuum. Hence the proportionality of inert mass (resistance to velocity change) and ponderable mass (source of the gravitational field) as mentioned in point 3 at the end of paragraph 1.1.

4.2) Higgs mechanism 2 provides the mass of the particles AND is the main mechanism of attraction between quarks.

4.3) Direct gluon exchange might not exist.

4.4) Sole color cannot be given mass by Higgs mechanism 2. When sole color is massless, it will gain light speed. Therefore we don't observe massive particles with sole color.

4.5) Two colors will always be given mass by Higgs mechanism 2. Therefore we only observe 2-quark and 3-quark massive systems.

4.6) IF the white and black quark with and without electric charge are the leptons, then the leptons are wiped from the list of elementary particles.

Discussion

4.1) Are 1, i, j, k not only colors but dimensions as well? Is (4.1.12) right?

4.2) Does the black glueball have mass? Or two black glueballs together? If so, then why the (1   1) vacuum particle stays massless?

4.3) When a color consists of two Pauli matrices in multiplication, then is changing multiplication order the same as changing multiplication rules from bright to dark, or from dark to bright? Is (4.3.19) right?

4.4) What is the mechanism of electric charge redistribution?

4.5) Is the white or black electric charged quark respectively the electron and the positron?

4.6) Is the white or black quark without electric charge the neutrino?

4.7) Suppose they are (4.5 and 4.6 are true). A white and a black electric charged quark (an electron and a positron) within their time borders form the photon, see in 2.3 Dark Dynamics. Can a white and a black quark without electric charge (neutrinos) within their time borders form a photon that has no electromagnetic fields?

4.8) Where is the chirality? Experimentally only the neutrino's $\nu\uparrow$ and $\bar{\nu}\downarrow$ do exist.

5 intricacies

5.1 At the Time Border

I we say that a color +1 gluon passes the time border, then there are two ways for this expression to get meaning.

1) If *they* send what is to them a color +1 gluon toward the time border along CX (from C to X, see space time diagram below), then a color -1 gluon is *drawn from* our matter at A and goes to the same spacetime point X at the time border. The -1 gluon (what to us appears as a -1 gluon) is a +1 gluon as *they* observe it, enveloped by a tiny parcel of backward time evolving vacuum – that is, backward time evolving as we observe it. The drawn gluon itself judges itself to go from X to A, immersed in a tiny bubble of forward vacuum. Both line segments are in line with each other, together precisely forming one single line through the time border without a kink, just as if there was no time border there. The drawing at A is as such that at X wavefunction AX and the wavefunction CX suit perfectly to each other (same amplitude and phase).

5	B		S		C
4			b		
3	R	-1	X	+1	T
2			b		
1	A	-1	U	+1	D

The line of b's is the time border. Behind the S, X and U there is another b. Not to scale. Colors don't move over larger distances than a few fm, so normally that's the scale of a color scene. But these are colorless colors +1 and -1, therefore ABCD may contain just one vacuum particle as well as encircle a large group of galaxies.

(5.1.1)

2) If the time border itself at X radiates a color +1 gluon to *them* at D and a color -1 gluon (that is a +1 gluon from *their* world enveloped by a tiny parcel of backward time evolving vacuum) to us at B.

If at X the wavefunction of AX suits perfectly to the wavefunction of XB, then there is a third possibility, combining the previous two. The situation then can be regarded as a rebound of both particles from the time border: *their* +1 goes CXD while our -1 goes AXB. The source particle is *their* +1 going CX, while our AX -1, XB -1 and XD +1 all three are *drawn* into existence by the CX.

It seems we can maintain the option that a massless -1 as one gluon made of two Pauli matrices does exist, when the Pauli matrices multiply by dark multiplication rules. The -1 black glueball exists as a +1 from backward time evolving vacuum, enveloped by a time border.

5	B		S		C
4			b		
3	R	(k)	X	(-k)	T
2			b		
1	A	(-k)	U	(k)	D

(5.1.2)

I wrote an entire storyline, FORWARD BACKWARD TIME DIRECTION, about the subject. Read page 4 up to page 7. Skip “The Diamond” at page 6, it's nonsense.

5.2 Four Quarks in the Shell

QCD renormalization theory says there is (a superposition of) a horde of color-anticolor pairs, shielding the “naked” color of the quark. In QED the electron's field is *diminished* by the electron positron pairs that surround the electron's core, so the core needs to be stronger to yield same outside field. In QCD the color pairs tend to *increase* the color field, so the core must have smaller

strength to yield same color field to the outside.
Used is the picture of the quark as a *color shell* of diameter 0.9 fm, the distance where the strong force is at maximum. To the outside the force drops exponentially with distance, to the inside proportional to distance, in the center the force is zero.
Let us assume the virtual color-anticolor pairs in the shield of a quark can be *gluon pairs* as well as *quark-antiquark pairs*.

The color coupling constant is about 1. Therefore 4 quarks appearing in 2 quark antiquark pairs, all within their time borders, all seeing each other, count with same importance as 4 quarks in 2 quark antiquark pairs superposed to each other (and thus not seeing each other) at same mutual distance. (a)

We suppose the 4 quarks to appear within their time borders, at the Earth surface within 10^-19 m or 10^-4 fm. Quarks have maximum attraction at about 0.9 fm, so the 4 quarks hardly attract each other. They don't form pairs under strong force attraction.

Emerging quark pairs always consist of a quark and an antiquark with opposite *taste*, *color* and *spin*. Electric charge already is “in” the taste, e.g. when the taste is u then electric charge is +2/3 times the electron charge. When the taste is d then the electric charge is -1/3. When the tastes are opposite, the electric charges are so too.

Impulses don't have to be opposite. If one quark from the pair has a small impulse and the other quark has a large impulse in a different direction, the impulse sum is in the direction of the frame of reference in which the quarks do have precisely opposite impulse.

As is argued at the end of paragraph 2.3 Dark Dynamics, when a quark and an antiquark of the same kind near each other within their time border, they can form a composite that absorbs from the Higgs field (the quark does do that) precisely as much as it emits towards the Higgs field (by the antiquark). The resulting particle is massless and in TONE is supposed to be the gluon.

All 4 quarks appear within their time borders. We assume the two pairs to emerge simultaneous within a length of time of 10^-23 sec. A, B, C and D are quarks, A B is one pair, C D is the other pair. We do not yet bother which is quark and which is antiquark.
A C
B D
The double pair forms 2 gluons (2 times 2 quarks massless coinciding) which can be done in 3 ways: AB CD, AD BC and AC BD (denoted as “II” column pairs, “X” crosswise pairs and “=” row pairs).

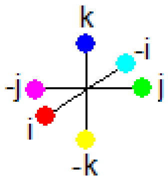
A and B have opposite spin and so do C and D. Suppose A and C have spin +1/2. When combining II or when combining X, the double pair can form two spin 0 gluons: quark spins +1/2 -1/2 = 0. In II the two spin 0 gluons necessarily are colorless. But in X they might form a pair of colored spin 0 gluons. (b)
In fact, as will be described just below, in 18 from 25 cases the two gluons in X have color and in 7 cases they are white-white or black-black.

Colorless and tasteless spin 0 gluon pairs – if formed – will be absorbed by the vacuum, enlarging the vacuum with their volumes. There is vacuum everywhere, so this will be set into action immediately.
The gluons don't react with the vacuum gluons at the place they are, mutual distance being too small. Instead they react with the ring of gluons at a distance of 0.9 fm mainly. Somewhere on the ring it presses itself between the other vacuum particles.
The energy of the spin 0 gluon is converted into a tiny parcel of space. The ground state real quark – I mean the real quark in which shield all this is taking place – cannot afford to loose this energy. So, if this takes place, immediately thereafter the vacuum re-emits the spin 0 gluon pairs.

When combining = the 4 quarks form two spin 1 gluons:
quark spins +1/2 +1/2 = +1 and -1/2 -1/2 = -1. (c)

A single gluon emerging consists of two quarks massless coinciding. The two quarks have opposite spin and color, yielding sole white spin 0 gluons. White gluons don't glue. So 4 quarks making up 2 gluons is the only possibility for *colored spin 1 gluons* to appear.

The two quarks from single gluons see the core of the quark in which shield they are emerging, since they shield the core by amplifying its strength. (We say “core” but we mean “color shell”.) This “seeing” goes by means of gluons and we assume it are spin 1 gluons. Then every gluon swaps the spin. If a single quark-antiquark pair appears and a gluon from the core swaps the spin of one of them, then spin 1 gluons might be formed. This cost (at least) one cycle of time, which is enough for the constituting quarks to move 3 fm apart. At the Earth surface this is large enough to move far out of the reach of each others time borders. So here on Earth sole emerging quark pairs will not form single spin 1 gluons at a reasonable rate, I expect.



And what about the colors? Let's go into quaternions. And use the gluon table. Regard the 2 pairs again. Each pair consists of a color and an anticolor. For each pair that emerges, there are 4 possibilities: [red] [cyan] and [green] [magenta] and [blue] [yellow] and ○ ●. The result per pair is to be taken as the “application” of both colors one after the other. One has to multiply the colors with each other and in quaternions multiplication order makes a difference. So which order is to be taken? Set e.g.:

A	[red]	C	[green]
B =	[cyan] and	D =	[magenta]

[red] [cyan] = i · -i = [green] [magenta] = j · -j = 1 = ○, so AB as well as CD will form a white gluon. Multiplication order is not important. But how for the other combinations?

[red] [magenta] = i · -j = -k = [yellow]
[magenta] [red] = -j · i = k = [blue]

[green] [cyan] = j · -i = k = [blue]
[cyan] [green] = -i · j = -k = [yellow]

[red] [green] = i · j = k = [blue]
[green] [red] = j · i = -k = [yellow]

[cyan] [magenta] = -i · -j = k = [blue]
[magenta] [cyan] = -j · -i = -k = [yellow]

We didn't need to worry. It are all combinations of i and j – with or without a minus sign in front – and the multiplication always will yield k, one with a minus sign in front and the other without. All possible arrangements and orders of the quarks of color i and j (with or without a minus sign in front) yield the gluon pair k -k. Two different pairs of color-anticolor that appear, always yield two times the third possible color-anticolor pair.
What if the two pairs of quarks are the same?

A	[red]	C	[red]
B =	[cyan] and	D =	[cyan]

[red] [red] = i · i = -1 = ●
[cyan] [cyan] = -i · -i = -1 = ●

[red] [cyan] = i · -i = 1 = ○
[cyan] [red] = -i · i = 1 = ○

[red] [red] and [cyan] [cyan] are quark-quark and antiquark-antiquark respectively. The pairs are made of matter only, or antimatter only, there is no time border between them and so no massless coinciding. So these possibilities don't form gluons.

The particle and antiparticle in a pair that emerges in the shell cancel each other out. When do colors cancel each other? [red] + [cyan] = i + -i = 0, the colors and anticolors happen to add up to zero. But in quaternions we don't add colors, we multiply them. Then [red] [cyan] = i · -i = 1 and indeed 1 is the neutral element with respect to multiplication. Similar for j and k. But black and white multiply to ○ ● = 1· -1 = -1. Therefore we take ● ● = -1 · -1 = 1 = ○ and ○ ○ = -1 · -1 = 1 = ○ to be the colorless color pairs that appear in the shell, instead of ○ ●.
So when AB and CD is the same pair of colors the result is a *superposition* of the black pair and the white pair.

A few other reactions:

A [red]   C ○ ●

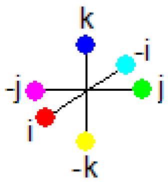
[red] ○ = i · 1 = i = [red]

[red] ● = i · -1 = -i = [cyan]

B = 🔵 and D = ○ or ●   🔵○ = -i · 1 = -i = 🔵   🔵● = -i · -1 = i = 🔴

○○ = 1 · 1 = 1 = ○   ○● = 1 · -1 = -1 = ●   ●● = -1 · -1 = 1 = ○
○○ = 1 · 1 = 1 = ○   ○● = 1 · -1 = -1 = ●   ●● = -1 · -1 = 1 = ○

As you see, the pair ○● doesn't occur.



And last but not least there is *taste*. In the 1st generation there are two tastes available for hadrons: u and d. There u has always +2/3 electron charge, d has always -1/3, anti-u = u̲ has -2/3 and anti-d = d̲ has +1/3 electric charge. As to speak, charge is “in” the taste. There are 4 possible u and d distributions for the quark pairs AB and CD that emerge in the shell. Keep in mind we assigned spin +1/2 to A and C, and spin -1/2 to B and D.

A	C	u	u̲	d	d̲	u	d̲	d	u̲		
B	D	u̲	u	d̲	d	u̲	d	d̲	u		(d)

In the first, and similar in the second pair of pairs, II-pairs as well as = are possible, there the tastes cancel out. But X would form charged gluons and that are no gluons. Moreover, X are particle-particle pairs or antiparticle-antiparticle pairs, in which massless coinciding is not possible. (e)

In the third and fourth pair of pairs situation is even worse: only II can form gluons (colorless spin 0 gluons only) and X and = would yield charged gluons.

The = pairs in the 1st and 2nd scheme are the only possibility to form colored spin 1 gluons, the gluons that mediate the strong force.

Mark the = pairs in the 3rd and 4th scheme are interesting: they form pairs of spin 1 particles of unit charge and the pairs can have net color or may be white or black.

IF u and d have different mass - and I think they have, at least because of the difference in electric charge - THEN the Higgs field absorption of the one do not cancel the Higgs field emission of the other precisely. The quarks cannot coincide massless, the particle will have some remnant mass. The quarks are within their time borders; they will not separate because the presence within the time border gives some mass reduction. Separation means the quarks have to be supplied by their complete mass; that thus might be huge. Admit, the particle *has* some resemblance to the W+ W- particle. But well, why W has mass 80385 MeV while the π meson consisting of the same quarks then, has mass 140 MeV?

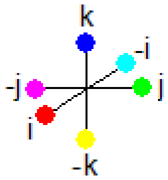
For the photon we assumed it consists of an electron and a positron massless coinciding, and on its turn, here in TONE the electron and positron are assumed to be a quark of color -1 and +1. In accepted QCD the coupling constant of W+ W- and the photon are nearly the same. This means that also the W+ W- is formed from colorless quarks, u- and d-quarks of color white and u̲- and d̲-antiquarks of color black. The W+ W- then is a kind of massive photon. (a)

A meson can spontaneously convert to W+ W- or Z0, and vice versa. The quarks in the meson have opposite colors, i -i or j -j or k -k. This means that the W+ W- also will consist of colored quarks. The W+ W- then is a kind of meson.(b)

W+ W- then should be the superposition of (a) + (b). The mass (amount of net absorption from and emission to the Higgs field) of (a) will differ from the mass of (b). Is that an objection? Let's assume here in TONE the = pairs in the 3rd and 4th scheme are the W+ W- particle.

Finally one of the colored spin 1 gluons formed from the 4 quarks in the shell, can be absorbed by the real quark in which shield all this is happening, changing its real color. The other color then can be reabsorbed too (yielding no change at all) OR escape to another real quark. This can happen in mesons as well as in baryons.

Also possible is that both gluons leave the real quark where they are born, each of them going to a different quark - in baryons only, baryons have 3 quarks. The mother quark then doesn't change color, but the other two do.



And now for the chances. The 4 quarks in the shell emerge in 2 particle-antiparticle pairs, one pair is AB and the other is CD. From (a) there is a chance of 1 out of 2 for emerging 4 quarks all seeing each other within their time borders. (chance 1 = 1/2)
And a chance of 1 out of 2 for the pairs just to superpose, despite they appear at precisely the same spots. (chance 2 = 1/2)

A	C	u	$\underline{u}$	d	$\underline{d}$	u	$\underline{d}$	d	$\underline{u}$	
B	D	$\underline{u}$	u	$\underline{d}$	d	$\underline{u}$	d	$\underline{d}$	u	(d)

The best way to proceed now is to start with the taste. We are in chance 1. When written down as in (d) there is a chance of 1 out of 2 for the first or second pair-of-pairs to form. (chance 3 = 1/2)
And there is a chance of 1 out of 2 for the third or fourth pair-of-pairs to be formed, yielding colorless spin 0 gluon pairs only. (chance 4 = 1/2)
(For convenience we assumed the u is as likely to appear as d, which might be wrong)

When in chance 3 (1st and 2nd pair-of-pairs in d), there is a chance of 1 out of 2 for II-pairs, yielding sole colorless spin 0 gluons. (chance 5 = 1/2)
And a chance of 1 out of 2 for =pairs to be formed. (chance 6 = 1/2)
And no chance for X-pairs to be formed.

We now shift to spin and color. Set A at spin +1/2 and B at spin -1/2. When in chance 6, there is a chance of 1 out of 2 for C spin +1/2 and D spin -1/2. (chance 7 = 1/2)
And a chance of 1 out of 2 for C spin -1/2 and D spin +1/2. (chance 8 = 1/2)

As long as we have no reason to assume otherwise, we assign an equal chance to the 5 possible color-anticolor pairs to emerge. In the scheme at the right we see 25 possible combinations, 18 have color and glue, and 7 are white-white or black-black pairs from which the gluons don't glue.
18/7 = 2.57, 7/18 = 0.39, 25/18 = 1.39, 18/25 = 0.72, 25/7 = 3.57, 7/25 = 0.28.
In chance 7 there is a chance of 18 out of 25 for a pair of colored spin 1 gluons, the particles that make up the strong force. (chance 9 = 18/25)
When in chance 8, there is a chance of 7 out of 25 for a pair of colorless spin 1 gluons (black-black or white-white). (chance 10 = 7/25)

When 4 quarks in 2 pairs emerge within their time borders, the chance for two colored spin 1 gluons (two opposite colored spin 1 gluons) is:
Chance 1 x chance 3 x chance 6 x chance 7 x chance 9
= 1/2 · 1/2 · 1/2 · 1/2 · 18/25 = 18/400 = 0.045 or about 5 percent.

This percentage is making up the entire strong force. For spin 1 colored gluons, what we interpreted so far as one reaction in one cycle of time, up until now taken as 10^-23 s, must be about 1/0.045 = 22 reactions, 22 cycles of time – from which only one of them is yielding colored spin 1 gluons. One strong force cycle of time then must be rather 0.5 · 10^-24 s. In that time a light speed gluon covers only 0.15 fm.

5.3 gluNons

We have to introduce a new concept: the gluNon, a composite of N gluons that are kept together by color, but nevertheless do not, or not directly, merge to one color, N = 1, 2, 3, ... Colorless gluNons are called *glueNballs*.

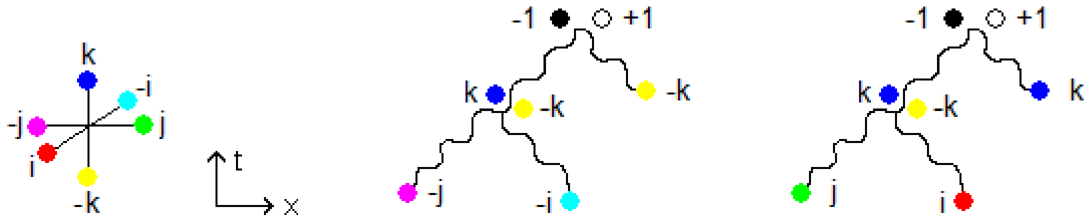
The *glu1on* is just the well-known gluon.

In this TONE the vacuum is proposed as a sea of colorless pairs of gluons, *glue2balls* that are.

Glu3ons and *glue3balls* would be massive because of Higgs mechanism 2. As soon as energy is available, the massless glu1on *plus* the energy concentrated in its parcel of space time, superposes with the massive glu3on state. It does so for only one instant. After that single moment the massless glu1on state and the massive glu3on state depart from each other.

Is this mechanism candidate for the next GENERATION of elementary particles? Because of its mass, the glu3on will have range. But gluons already have range. (3.50)

Consider gluons i, j and k in one glu3on. Since kji = +1 and ijk = -1 (both are colorless) it's a glue3ball.



The k and -k colors shown next to each other in the picture do not represent two different particles but only one particle in two superposing states. Likewise the black and the white colors. From +1 or -1 there is a like chance to convert back to ANY glu3on state. These are only two of them.

For a pair of gluons to remain massless, the signs in front of the gluons have to be opposite. One gluon has to be a particle (i, j, k or 1) while the other gluon is an antiparticle (-i, -j, -k or -1). At first glance the colors don't have to be equal, only the sign in front has to be opposite. Then you have e.g. the pair (i -j) that forms i · -j = -k or -j · i = k. These two multiplication orders superpose and cancel each other out.

Conclusions

5.1) If the gluon is made of a quark and an antiquark, massless coinciding, then the gluon is wiped from the list of elementary particles.

5.2) IF the W+ W- particle consists of two quarks within their time border, their masses partially reduced, THEN the W+ W- particle is wiped from the list of elementary particles.

5.3) One strong force cycle of time is about 0.5 * 10^-24 s (instead of 10^-23 s).

Discussion

5.1) Why then the W+ W- particle (80385 MeV) is heavier than the pi meson (140 MeV)?

5.2) Where is the Z-particle?

5.3) Is the gluNon concept capable of yielding the generations?

FRAME 1 The field of all possible velocities

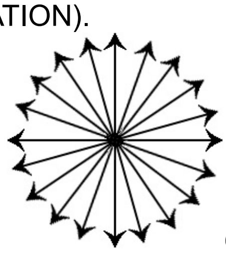
Let us define the field of all possible velocities by creating it. For convenience, situate yourself free floating in empty space. Take a sufficient small part of space to work in so that curvature is negligible. Define yourself as standing still. Choose a straight line L through your location. Lay down a long row of blocks standing still to you along L - anyway, if not endless, make it as long as possible. This is row 1. Choose a lowest velocity increment *d*v, e.g. one quark diameter per million years in 1 of the 2 possible directions along L. Increase your velocity with one *d*v. You move now with constant speed along row 1. In this new state, define yourself as standing still. Lay down another long row of blocks along L standing still to you; this is row 2. Then again increase your velocity with one *d*v. Again define yourself as standing still and lay down a long row of blocks - row 3 - along L standing still to you. The velocity of row 2 relative to you is -*d*v but the velocity of row 1 relative to you now is $(-dv - dv) / (1 + -dv * -dv / c^2)$, according to special relativity. And so on, up to an infinite repetition in both directions along L (or anyway parallel to L). Repeat the whole procedure for all possible directions L can point at. Now there is one row of blocks comoving with each possible velocity. You have made the field of all possible velocities.

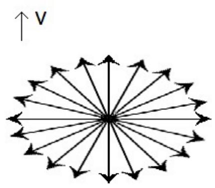
Changing velocity then is the same as jumping to another row of blocks. To whatever velocity you change, you always find one row of blocks standing still to you and the wide array of rows of blocks with different speeds around you will always look the same, by virtue of the specific way we created it. So *this* field of all possible velocities exists, is velocity invariant and is Lorentz invariant too. It has to be, there is just no other way, due to the specific way we created it.

Compare an endless stairs of identical steps, each step one foot wide and one foot high. You stand on one step. Due to ordinary perspective you see steps smaller when further away from you. The steps loose dimension in the distance, in both directions of the stairs. Now imagine every step corresponds to a velocity. The step you're standing on corresponds to standing still and two subsequent steps differ one *d*v. The stairs now is the set of all possible velocities along one line L. Identify the visual reduction of each step with the precise SR-caused velocity decrement of the velocity of the corresponding step. Raising (or descending) one step doesn't change the appearance of the stairs; you will not notice any difference. Every step will adopt the precise velocity decrement of its nearer neighbor when one step nearer. And of its further neighbor when one step further away. When raising or descending the stairs, the set of all possible steps remains the set of all possible steps.

If you choose to use a finer grid of velocities, e.g. 1/10 *d*v, and start the procedure, then after 10 increments you don't end up at precisely one *d*v total increment, but a tiny little bit slower, because of the mentioned special relativistic summing of speeds. The finer grid is a better approximation, so you can't use any part of the old grid any more. You have to do it all over again, all the steps of creating the field of all possible velocities. So you better choose *d*v from the beginning small enough for all your purposes.

In doing so, reaching up to infinite small *d*v, the impulse of the blocks becomes more and more definite and the blocks spread out all over space (uncertainty relation). This saves us, construction workers, the effort to repeat the whole procedure for every point in space. We could do with one block per row. (I wonder if one row of blocks isn't just one *element of the wavefunction*, see page 1 of the storyline GRAVITATION).


(1)



(2)

Regard the field of velocities of one single velocity magnitude in all directions (1). (We depicted a plane only, but imagine it to be a sphere of velocities.) When one is speeding by this field with velocity v, the field is Lorentz contracted (2). Blocks in the direction of v will be nearer to each other, while blocks in the direction perpendicular to v will not be affected. As an overall result the block density will increase. If each block had a tiny mass, the field would become more massive. The field is stronger.

FRAME 2 Calculation of the radius of a vacuum marble

This pop-up frame calculates the relative distance of the marbles the vacuum consists of. This distance is calculated about 10^-21 m.

Length in meter m, surfaces in square meters, time in second s, mass in kilogram kg, acceleration at earth's surface = 9.81 m/s^2

Surface of sphere = 4πr^2 = 2πr * 2r = circumference * diameter

Earth surface = (4 * 10^7) * (1.28 * 10^7)

Volume of spherical shell that sags into the Earth every second
= Earth surface * thickness shell
= Earth surface * 1/2 * 9.81 * t^2, where time t = 1 s
= Earth surface * 9.81 / 2
= (4 * 1.28 * 9.81 / 2) * 10^(7 + 7)

mass of the earth = 5.97 * 10^24 kg = (5.97 / 1.67) * 10^(24 + 27) protonmasses.
This is the number of nucleons the earth consists of.

We regard all neutrons in the earth as protons and we skip all electrons. The mass difference between the neutrons and protons increased with the mass of all electrons is supposed to be (more than) canceled out by the *mass defect* of all those nuclei.

Each nucleon consists of 3 quarks. Each quark reacts 10^23 times per second via the strong nuclear force (gluon couplings). Per reaction we assume two vacuum marbles to be absorbed.

The number of reactions per second for electromagnetism (charge-photon couplings) is at least 1000 times smaller, so we skip all photon couplings and their associated Higgs field absorbtions. Mark the electron mass is roughly about 1000 times smaller than the quark mass.

The number of vacuum particles (Higgs or gravitons, which are assumed to be of equal volume) absorbed per second in the earth =
(2 * 3 * 5.97 / 1.67) * 10^(24 + 27 + 23)

The volume of one vacuum marble then is the volume of the shell divided by the number of particles absorbed per second.

Volume vacuum marble = (4 * 1.28 * 9.81 * 1.67) / (2 * 2 * 3 * 5.97) * 10^(7 + 7 - 24 - 27 - 23) = 1.17 * 10^-60 = (1.05 * 10^-20)^3; that is a cube with sides of 1.05 * 10^-20 m or a sphere of radius between 10^-20 and 10^-21 meters.
So along a proton diameter - a little smaller than 10^-15 meter - fit about 100,000 up to a million vacuum marbles.

Volume of spherical shell that sags into the earth every second / mass of the earth =
= (4 * 1.28 * 9.81) / (2 * 5.97) * 10^(7 + 7 - 24)
= 4.21 * 10^-10 m^3 / kg ≈ 4π/3 * 10^-10

So if per sec per kg there disappears a volume of about 10^-10 times the volume of a sphere of radius 1 m and the vacuum drags along with it all objects in it, then there is simulated a force between masses of
F = 6.67 * 10^-11 * (mass 1) * (mass 2) / distance^2

FRAME 3 Quaternions

Complex numbers have 1 imaginary axis and 1 real axis. Quaternions have 3 imaginary axes, their units called i, j and k, and 1 real axis, spanning a 4 dimensional world.

Quaternions are governed by $i^2 = j^2 = k^2 = ijk = -1$

ij = k	jk = i	ki = j
ji = -k	kj = -i	ik = -j

Quaternions have the *associative property*, pqr = (pq)r = p(qr); p, q, r are arbitrary quaternions. You can multiply first pq and then times r, or calculate first qr and then times p, as long as you don't change multiplication order.

Quaternions don't have the *commutative property*. To "left-multiply" is different from "right-multiplication". Swapping multiplication order often changes sign. rq is not equal to qr, mxm is not equal to m^2 * x.

To playfully learn to work with quaternions, see excelquaternions.xls, an EXCEL sheet made by Gerald Tros, nuclear physicist and friend of mine. At tab page "quaternion matrices" is shown an easy way to convert quaternions to matrices and matrix calculation.

Quaternions are extremely strong in rotations. Any quaternion q = a + bi + cj + dk is a point in 4-dimensional 1ijk-space (pronounce 1-i-j-k-space), but in that space any quaternion q also is one specific rotation (a, b, c, d are real numbers). That is, q * m * 1/q rotates arbitrary quaternion m over a certain angle α around a certain axis through the Origin O.

q * m * 1/q has more than one solution, but one of them has the magical property that this expression as well as q * n * 1/q (n is another arbitrary quaternion) are both rotations over the same angle around the same axis. So q indeed is one specific rotation.

(a + bi + cj + dk) (e + fi + gj + hk) =

(ae - bf - cg - dh) +
(af + be + ch - dg) i +
(ag - bh + ce + df) j +
(ah + bg - cf + de) k

Multiplication of two quaternions. Regard the 16 terms ae, bf, cg, etc without the - signs. Regard the second factor in each term. Start upper left and "walk around the square" gives EFGHGFEFGHGFE. The diagonals are EEEE and HHHH. In the minus sign distribution I recognize "chess play horse jumps". Start at -bf for the first jump via -cg and -dh to -dg, then from -dg to -bh or -cf. The division scheme has similar structure.

(a + bi + cj + dk) / (e + fi + gj + hk) =

[(ea + fb + gc + hd) +
(eb - fa - gd + hc) i +
(ec + fd - ga - hb) j +
(ed - fc + gb - ha) k] / ($e^2 + f^2 + g^2 + h^2$)

So 1 / (e + fi + gj + hk) = (e - fi - gj - hk) / ($e^2 + f^2 + g^2 + h^2$) and so 1/i = -i, 1/j = -j, 1/k = -k.

And also is i/j = 1/j * i = -j * i = k. When i dividing by j, then you have to left-multiply i by 1/j.

In the expression q * m * 1/q is q = a + bi + cj + dk, q = cos(α/2) + (bi + cj + dk) * sin(α/2), α = angle of rotation; bi + cj +dk = axis of rotation. So i rotates over 180 degrees and i^2 rotates over 360 degrees.

When rotating the world according to quaternion q and then rotate the world according to another (arbitrary) quaternion r (eventually around a different axis and different angle) then the result is one single rotation rq about still another different axis and angle.

Mirroring x is given by uxu, u is a quaternion of length 1 (the distance of u to the Origin O is 1).

For 2 * 2 complex matrices of quaternions, see page 9 in the storyline QQD.

Mold a 4 * 4 real matrix multiplication into a quaternion multiplication as follows.
- Write quaternion a + bi + cj + dk as a row of four real numbers a b c d.
- Extend the row a b c d into the 4 * 4 matrix

a	b	c	d
-b	a	-d	c
-c	d	a	-b
-d	-c	b	a

The last 3 rows consist entirely of copies of the values in the first row. Except for the minus-signs, of course.
- Likewise quaternion e + fi + gj + hk becomes the matrix

e	f	g	h
-f	e	-h	g
-g	h	e	-f
-h	-g	f	e

- When these two matrices are matrix multiplied, the upper row of the product matrix is the product quaternion (a + bi + cj + dk) (e + fi + gj + hk). The last three rows of the product matrix consist of copies of numbers from the first row in the same way as in the matrices of a b c d and e f g h shown above. The product matrix is a quaternion matrix and is ready for use in further quaternion multiplication.
- Use an excel-sheet to multiply the shown 4 * 4 matrices, see baryoncollision.xls

Acknowledgments

Since I was 13 or 14 years old (I was born at 26 June 1956), **Rudolf van Battum** emphasized the existence of a frame of reference that falls along with gravity in such a way that in it no gravity is observed anymore. In my mind I embodied this frame by a system of free falling clocks and I realized the clocks, the frame, the vacuum, has to fall into the Earth from all sides. And more than once I wondered how such a coordinate system would work when vacuum would disappear in the Earth as if it was sucked away by a drain or something. But since I couldn't imagine how such a drain could become, I lost interest every time until the start of 2011.

I owe much to **Habib Rejaibi** for his 9-lessons course “Web Design” in 2006, where I learned to make my own website in html.

I thank **Vincent van der Noort** for his article “Why the 4-dimensional space is the most beautiful of all spaces: quaternions”. It was this article (in Dutch) that in 2012 made me aware of the existence of quaternions.

Also I thank **Gerald Tros** for his excel-sheet about quaternions, especially the demonstration of his algorithm for quaternion multiplication independent from matrix multiplication (Dec 2013), and for bringing in my attention the Pauli and Gell-Mann matrices.

I thank prof. **P.J.G. Mulders** from VU University, Amsterdam for his advice and patience with a not too well educated person like me (2014, 2016).

Thanks goes to **Rongchao Ma** for his 2017 contact without which the Introductions, Conclusions, Discussions and Epilogue would not have been there.

Last but not least I thank mr. **Bijleveld** for being my only physics school teacher that brought physics in a lovingly and interesting way (1969-1970), **Chris Sijtsma** and **Klaas van Aarsen** for their discussions on physics and once being my friends (1985-1990), and **Janet Ossebaard** for putting the right questions at the right moment (2005). Without her questions my site would never have come to existence.

References

Gerard 't Hooft, *Gauge Theories of the Forces between Elementary Particles*, Scientific American, June 1980, used for the part starting with “When an electron in an atom emits a photon, where the positron is coming from?” and the part “Four quarks in the shell”.

Howard Georgi, *A unified theory of elementary particles and forces*, Scientific American, April 1980 for my early understanding of quarks, gluons and colors in QCD.

Vincent van der Noort, *Waarom de vierdimensionale ruimte de mooiste van alle ruimtes is: quaternionen* (Why the fourdimensional space is the most beautiful of all spaces: quaternions), part of a series of lectures in http://oai.cwi.nl/oai/asset/18770/18770D.pdf (Symmetrie Vakantiecursus 2011 – Cwi)

https://en.wikipedia.org/wiki/special_unitary_group for the matrix of SU(2) and the Gell-Mann matrices.

https://en.wikipedia.org/wiki/quaternion for the matrices of the quaternions.

Epilogue

If you have followed all the wipes carefully, you might have noticed that if they all come true, this leaves the quark as the only elementary particle existing. And that includes the vacuum structure, the structure of space and time itself. (Mind, a particle resembling W+ W- is mentioned only in 5 INTRICACIES, “Four quarks in the shell” at Mark the = pairs in the 3rd and 4th scheme are interesting. A candidate for Z is still missing.)

I used to work the first two hours of each day on physics at my website leandraphysics dot nl, formerly physicsleandra dot com. Usually I got some ideas and work them out this way in a couple of months. Then always a pause occurred, sometimes short, often longer. I remembered having worked a period that never has been that long before. Thereafter was the pause but it was shorter than usual. Then the ideas of chapter 4 came, Quaternion Gravitation. For about two months things developed well but I start longing for the next pause. Then I got headaches and could not concentrate anymore and I knew I had to stop. After a few weeks I started to assemble TONE, that you are reading now.

That was in 2016-2017. Since then I emailed TONE to over 200 physicists, but so far no one reacted as regards content.

- January 2021

END OF TONE