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Title
Zitterbewegung and Higgs particle. A short introduction.

Abstract
As I showed in my previous writings (“Electroweak Forces Acting on TE, TM, TEM”), a field similar to the gauge boson W provides a helical motion that transforms a TEM in a TE (or TM) in a waveguide.
This helical motion in the Hestenes interpretation of electron is the zitterbewegung.
In “Electroweak Forces Acting on TE, TM, TEM” I just talk about electromagnetic fields, TEM and TE, TM.
Similarities inevitable appear, all questionable, with neutrinos and electrons / positrons.
However Hestenes in "Spacetime calculus”, speaking of the helical motion ie zitterbewegung makes more explicitly this hypothesis:
"This opens up possibilities for integrating the zitterbewegung idea with electroweak theory. Evidently that would obviate the need for including Higgs bosons in the theory, since the zitterbewegung provides an alternative mechanism to account for the electron mass."
In face of a possible elimination of the Higgs particle from the electroweak theory it appears useful to repeat my ideas in a popular way.

Zitterbewegung and Higgs particle. A short introduction.

1 - Introduction and summary

I showed in my previous writings [16] that a field similar to the gauge boson W provides in a TEM a helical motion that transforms the TEM in a TE (or TM) in waveguide.
This helical motion, in the Hestenes interpretation of the electron, is the zitterbewegung.
In [16] I just talk about electromagnetic fields, TEM and TE, TM. I noticed that a TEM is wrapped in a waveguide and becomes a TE or TM with mass and.... the Higgs particle do not appear.
Similarities inevitable appear, already appeared in [15], all questionable, with neutrinos and electrons / positrons.
Hestenes however in Spacetime calculus, speaking of the helical motion ie zitterbewegung, makes a more explicit hypothesis that, given the similarities, it seems interesting:
"This opens up possibilities for integrating the zitterbewegung idea with electroweak theory. Evidently that would obviate the need for including Higgs bosons in the theory, since the zitterbewegung provides an alternative mechanism to account for the electron mass."
In the face of a possible elimination of the Higgs particle from the electroweak theory it appears useful to repeat my ideas in a popular way.
Why we can and should speak of the electroweak force on TE, TM and TEM is extensively treated in [16], from which I also report here the references [1]...[15], but in short:
1°) the group that leaves unchanged the electromagnetic field energy momentum vector is not only the electromagnetic gauge group $\psi \rightarrow \psi' = \psi e^{i\varphi}$ (Hestenes) but the group $SU(2) \otimes U(1)$;
2°) the application of a gauge transformation $SU(2) \otimes U(1)$ in an abstract space is the way we produce and describes the unification of the electromagnetic forces and the electroweak forces.
It is obvious that should be able to see the effect of a $SU(2) \otimes U(1)$ transformation even on the electromagnetic field.
In addition, I say, not in an abstract space but in the true space.
This effect should manifest itself (and manifested) as electroweak force on the TE TM TEM fields as I showed in [16].
The exposition we're doing here is deliberately simple and (almost) without formulas.

First: go down again the geometric effect of the generators of the group $SU(2)\otimes U(1)$.
Second: I show how geometrically and intuitively operate on the fields TE, TM and TEM physical objects similar to the W and Z°, and to the photon γ.
In particular in section 2 examines the first question: there are electroweak force acting on TE, TM and TEM fields?
I try to give to this question an answer not mathematics but qualitative.
I highlight objects that act on TE, TM and TEM producing effects similar to the action of the particles W and Z°, and γ.
Then I try to translate the action of these objects in these mathematical operators to operate in a similar manner to the Z°, W and γ particles in quantum mechanics.
To this end, in Section 3 I briefly summarize the Clifford algebra so far as is necessary.
In Section 4 briefly recall the way in which the Clifford algebra and the generators of the group $SU(2)\otimes U(1)$ are involved in gauge theories.
In Section 5 discusses the geometric action of generators, namely the effect that they have in ordinary space and how it manifests itself.
With this background in section 6 discusses the gauge fields attributable to W and γ particles, and interprets the action on electromagnetic fields TE / TM.
I note that in particular the action of W result in a mechanism to give mass which is an alternative to the Higgs boson.
For completeness of exposition in section 7 discusses the gauge fields attributable to the particle Z° and interprets the action on electromagnetic fields TEM.
In the concluding section 8 discusses the reason why these events, taken together, can lead to believe a mathematical theory of electroweak interactions without the intervention of the Higgs boson.

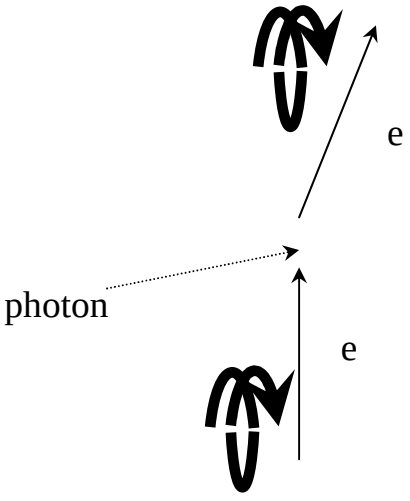
2 – The weak interactions

The first problem is: there are forces electroweak fields TE, TM and TEM?
I tried to answer with mathematics in [16].
What is not mathematics, but instead a qualitative answer?
Particles W and Z° carriers of the weak force should find their interpretation in the action of a radar target from which scattering takes place, or an obstacle in waveguide, or similar.
You can view the action of an object on an incident electromagnetic signal to end up saying: “look, this is the action of the Z° particle" or " this is like the action of the W particle "?
In [15] have established the similarities I remember here and help me with the drawings.

neutrino:
TEM
circular polarization velocity c

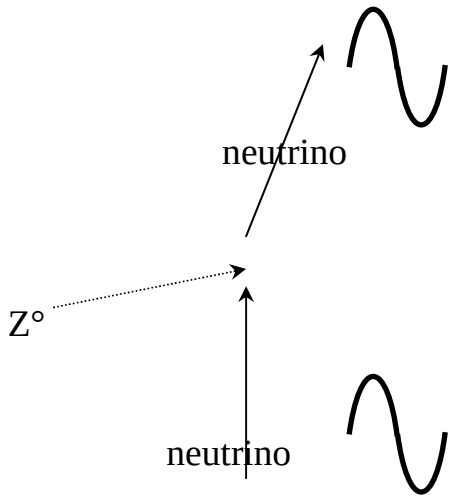
electron (and positron):
helical e. m. field (TE o TM)
circular polarization velocity V

We begin to summarize the action of the photon. It changes speed or diverts electrons

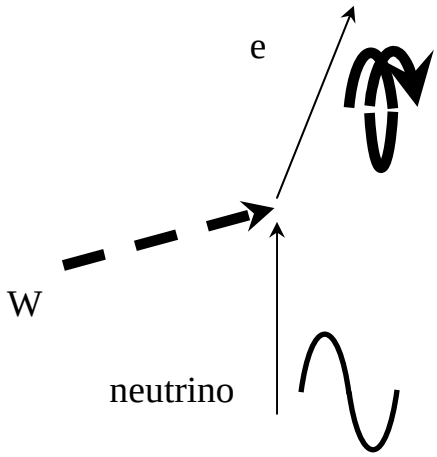


In the radar-electromagnetic analogy (considering only the action of slowing or acceleration) is a fictitious equivalent waveguide that changes in size.

(I have given this interpretation in [15]. In [16] have given a simpler interpretation of this, ie a variation of ω in the same waveguide).
We try instead to interpret the actions of the particles W and Z° carriers of the weak force.
No photon is able to act (to divert or slow down) a neutrino, and this is consistent with the fact that no waveguide acts on a TEM being by definition a TEM free from any waveguide. Neutrino may act conversely the Z°, whose action, seen in terms of action of a radar target, can be represented by a scattering from TEM to TEM with equal polarization.
The scattered TEM will be diverted and / or with increased or decreased ω if there is a Doppler effect.



The object that can do this could simply be a radar target in any motion, approach or removal.
The more complex the action of the W particle. It is able to transform into electron neutrinos or vice versa (and is therefore a particle with charge).



In analogy to radar an object that transforms electromagnetic TE / TM in TEM or vice versa exists and is .....a horn antenna connected to a waveguide. It operates the free space – waveguide transition and then the above transformations.

electron neutrino neutrino electron

It was to translate the action of these objects in these mathematical operators to operate in a similar manner to the Z° and W particles in quantum mechanics. This is the task that I have tried to solve in [16] studying the action of the group $SU(2)\otimes U(1)$ on the TE TM and TEM fields.

But now I give an interpretation virtually “graphics”.

3 – The Clifford algebra

As used here the Clifford algebra we can consider an extension of the calculation with complex numbers.
Similarly we can consider an extension of vector calculus.
The extension starts (and basically ends there) with the trivial clarifying the geometrical meaning of usual imaginary unit i.
This is essentially due to Hestenes with the Space Time Algebra, Hestenes which will never express enough gratitude and admiration.
Unfortunately I'm used to my notation "engineer", but the Hestenes Space Time Algebra is the same thing. These notations, however, are comfortable now, for example, starting from i.
As we expose enough (asking of course apologize to experts).
Clifford algebra is an ordinary algebra, except that every so often here and there are also inside entities (numbers) that are non commutative.
These are the numbers $\hat{\imath}\ \ \hat{\jmath}\ \ \hat{k}\ \ \hat{\mathrm{T}}$ that (assuming) all are non commutative.
Their product ab is different from doing ba.
Appears instead $ab = -ba$.
In fact we are already accustomed to this because we consider for example the unit vectors of x, y, z axis in space. Are usually referred to as $\hat{\imath}\ \ \hat{\jmath}\ \ \hat{k}$, and $\hat{\imath}^2 = \hat{\jmath}^2 = \hat{k}^2 = 1$.
(Note: ^ has the sole function of mnemonic recall if we remember that we are thinking of a unit vector, but the reality in Clifford algebra is useless. All entities of the Clifford algebra is think of them as well, and they are, simply numbers).
However thinking $\hat{\imath}\hat{\jmath}$ not occurs to me that is equal to $\hat{\jmath}\hat{\imath}$, because looking $\hat{\imath}\hat{\jmath}$ it comes to mind..... the vector product $\hat{k}$ between $\hat{\imath}$ and $\hat{\jmath}$, and then rather we would think $\hat{\jmath}\hat{\imath}$ as $-\hat{k}$.
Therefore it is not so strange to us that there are entities with the property $\hat{\jmath}\hat{\imath} = -\hat{\imath}\hat{\jmath}$.
(Note: even though in Clifford algebra $\hat{\imath}\hat{\jmath}$ is not $\hat{k}$ but is..... $\hat{\imath}\hat{\jmath}$, and so it is written. An entity as $\hat{\imath}\hat{\jmath}$ is, and is called, a bivector while $\hat{k}$ is a vector).
But I promised myself to make a paper of popular nature, deliberately simplified and (almost) without formulas, then proceeds rapidly, and some other details refer to [16].
Return to our imaginary i.
Hestenes has brilliantly demonstrated, or better understood, that the 'imaginary' i is nothing but the bivector $\hat{\imath}\hat{\jmath}$ (attention to ^!), $\hat{\imath}\hat{\jmath} = i$. It rotates the vectors of plane $\hat{\imath}, \hat{\jmath}$ (plane x, y). Generalizing, we put $\hat{\imath}\hat{k} = j$, which thus rotates the vectors of plane $\hat{\imath}, \hat{k}$ (plane x, z), and also follows automatically $ij = \hat{\imath}\hat{\jmath}\hat{\imath}\hat{k} = -\hat{\imath}\hat{\imath}\hat{\jmath}\hat{k} = -\hat{\jmath}\hat{k} = \hat{k}\hat{\jmath}$, which rotates the vectors of plane $\hat{k}, \hat{\jmath}$ (plane z, x). This, together with the use of exponential as $e^{-\hat{\imath}\hat{\jmath}\Phi} = \cos\Phi - \hat{\imath}\hat{\jmath}\sin\Phi$ etc., it's all we need to continue.

4 – The gauge fields and the weak interactions

Electromagnetic interactions and weak interactions are unified in the Weinberg Salam theory of electroweak interactions.
With this theory shows that, besides the electromagnetic force, exerted by the photon γ, there is a weak force exerted by the particles W and Z°.
These forces apparently of a different nature are actually close relatives.
Why?
From a mathematical point of view the relationship is expressed by the fact that all arise from gauge fields generated by the $SU(2)\otimes U(1)$ transformations.
(Note: for two words of explanation of gauge fields, see [16]).
For each transformation corresponds to a field.
The transformations involved are those of the type:

$$\psi \to \psi' = \psi e^{-iUt}$$

$$\psi \to \psi' = \psi e^{-jWt}$$

$$\psi \to \psi' = \psi e^{-ijWt}$$

$$\psi \to \psi' = \psi e^{-TjiZt}$$

therefore exponential and generator of rotations $\hat{i}\hat{j} = i$, or $\hat{i}\hat{k} = j$, or $ij = \hat{k}\hat{j}$ and where necessary $\hat{i}\hat{j}\hat{k}\hat{T} = Tji$.
Now, as he says Hestenes [12], in the Weinberg Salam theory of electroweak interactions $SU(2)\otimes U(1)$ appears as an internal symmetry in an abstract space.
Instead, always says Hestenes (I freely translate his thoughts) should be possible to give a geometric interpretation in space (the real one).
I say this and say more: it must be possible to give a geometric interpretation and also show the effect on TE, TM and TEM.
See that the effect of the electroweak force not only on elementary particles (electrons, neutrinos, etc..) but also on usual fields TE, TM and TEM.
I intend to do this below, referring explicitly to the action of the generators of rotations $\hat{i}\hat{j} = i$, or $\hat{i}\hat{k} = j$, or $ij = \hat{k}\hat{j}$ and where necessary $\hat{i}\hat{j}\hat{k}\hat{T} = Tji$.

5 – Action of the generators $\hat{i}\hat{j} = i$, $\hat{i}\hat{k} = j$, $ij = \hat{k}\hat{j}$ and $\hat{i}\hat{j}\hat{k}\hat{T} = Tji$.

Why generators $\hat{i}\hat{j} = i$, $\hat{i}\hat{k} = j$, $ij = \hat{k}\hat{j}$ and $\hat{i}\hat{j}\hat{k}\hat{T} = Tji$ are involved?
We need to make extensive tour that starts from $\psi\hat{T}\psi^*$.
The expression

(1) $\psi\hat{T}\psi^*$

provides the energy momentum four-vector of the body in question (here the mode under consideration, TE, TM, TEM) as described by the spinor ψ.
We can interpret the action of ψ in (1) such as "kick-start" the body, describing both the correct values of energy and momentum.
We operate now one of the $SU(2)\otimes U(1)$ transformations, eg $\psi \to \psi' = \psi e^{-i\Phi}$.
If ψ is replaced by ψ' the (1) becomes:

(2) $\psi'\hat{T}\psi'^* = \psi(e^{-i\Phi}\hat{T}e^{+i\Phi})\psi^*$

From this we understand that if the transformation is such that:

(3) $(e^{-i\Phi}\hat{T}e^{+i\Phi}) = \hat{T}$

ie leave $\hat{T}$ unchanged, nothing changes in (1) because:

(4) $\psi'\hat{T}\psi'^* = \psi(e^{-i\Phi}\hat{T}e^{+i\Phi})\psi^* = \psi\hat{T}\psi^*$

$SU(2)\otimes U(1)$ is precisely the group of all transformations that leave $\hat{T}$ unchanged.
As a result, they do not change anything in the energy and momentum of the body, for all conditions of motion.
So, you say, do nothing?
The fact is that they do not change energy and momentum of the body if they are global changes, as in (1), ie with constant, coordinates-independent, angles.
If they are local transformations, for example with time-dependent angles, then things change.
But there's more.
Consider the effect of transformations not only on $\hat{T}$ but also on $\hat{i}$ $\hat{j}$ $\hat{k}$.

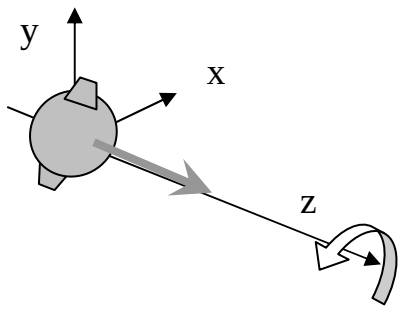
The unit vectors $\hat{i}\ \hat{j}\ \hat{k}\ \hat{\mathrm{T}}$ are the unit vectors of the x, y, z axes and time axis but, following Hestenes, consider it as axes "stuck" to the body. Thus they are also a trio of unit vectors which indicates the body attitude, while $\hat{\mathrm{T}}$ indicates the proper time. Any spinor ψ determines the rotations on them. Particularly if ψ is unitary the unit vectors

(5)

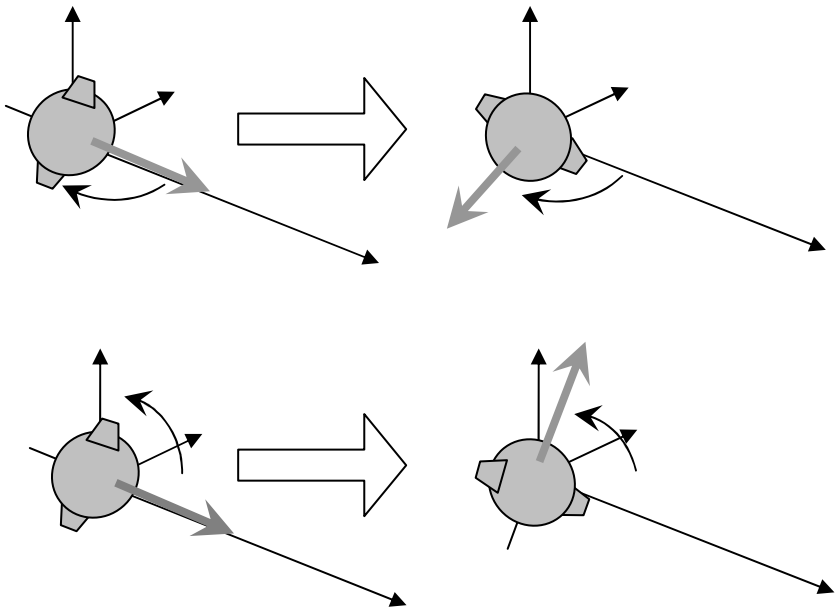
$$\psi\hat{i}\psi^{*} = \hat{e}_1$$
$$\psi\hat{j}\psi^{*} = \hat{e}_2$$
$$\psi\hat{k}\psi^{*} = \hat{e}_3$$
$$\psi\hat{\mathrm{T}}\psi^{*} = \hat{e}_0 = \hat{u}$$

form a set of axes rotated with respect to $\hat{i}\ \hat{j}\ \hat{k}\ \hat{\mathrm{T}}$.
(Note: if ψ is a Lorentz rotation, it "sets off" the body. If, however, is one of the $SU(2)\otimes U(1)$ rotations , which is precisely the group of all transformations that leave $\hat{T}$ unchanged , nothing happens, at least for $\hat{T}$).
With reference to (1) and (2) a moment's reflection shows us that any of the $SU(2)\otimes U(1)$, Eg $e^{-i\Phi}$, can be interpreted as (or if you want it is) a rotation applied before ψ acting. We can talk with a little imagination of a rotation applied before ψ has set in motion the body. This aspect is very important.
Confine ourselves to $SU(2)$ rotations in space , with generators $\hat{i}\hat{j} = i$, $\hat{i}\hat{k} = j$, $ij = \hat{k}\hat{j}$:

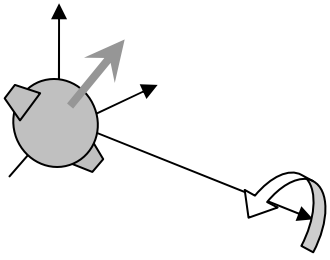
Thus we can identify any of the $SU(2)$rotations leaving $\hat{T}$ unchanged as a change in attitude of the body at rest.
We proceed from here, for an explanation of course approximate and debatable, but it has the merit to provide a visual picture of the action of gauge fields and how they determine the electromagnetic force and weak force.
Reasons for an electromagnetic field in circular polarization.
We take first an image of the field as a body to which it is stuck a system of axes $\hat{i}\ \hat{j}\ \hat{k}$ and especially $\hat{k}$ represents the axis of rotation. Implicitly admits that the body or the field rotates around the $\hat{k}$ axis because of a term $e^{-i\omega t}$ in ψ.
In the Hestenes interpretation of the electron $\hat{k}$ is the spin axis.
A figure representing the body as a small satellite spinning around its axis. Spinning is produced by the term $e^{-i\omega t}$.



One by one we can now interpret the action of the various fixed angle rotations, global transformations of $SU(2)$.
We hypothesized to be able to assimilate these $SU(2)$rotations leaving $\hat{T}$ unchanged (and then do not interact with the energy momentum vector) to a change in attitude of the body at rest.
We perform any of these changes in attitude, placing the satellite into a new position, rotated by fixed angle from the previous.



It appears reasonable enough think that when the body has changed attitude, however this does not change its total energy, when it is stationary, nor his momentum, when in motion. In fact what will happen?
Just the body will revolve around a different axis (and admit that this fact does not change its rotational energy).
As a gyroscope in space, or as a satellite spinning in space, the body will continue its motion with the conservation of momentum, energy and angular momentum.



The body will revolve around this new axis

But the situation changes (and changes to interpretation) when the angles are such a function of time.

6 - γ and W particles.

Let us begin with the simplest that is .... the electromagnetic force, in contrast to the next we'll see who is the weak force.
It is generated by a transformation $\psi \to \psi' = \psi e^{-i\varphi(t)}$ or more explicitly $\psi \to \psi' = \psi e^{-iUt}$.
This, included in the Dirac equation, produces a decrease of ω to $(\omega - U)$.
Neglecting to retrace all the technical details have already been examined elsewhere ([15] and [16]), so U eventually appears as an energy / ω additive (or subtractive as here) that someone has communicated to the field (the body).
So here we have an immediate interpretation that even needs to be done because ..... is ready. The attitude of the body is unchanged but there is an additional rotation.

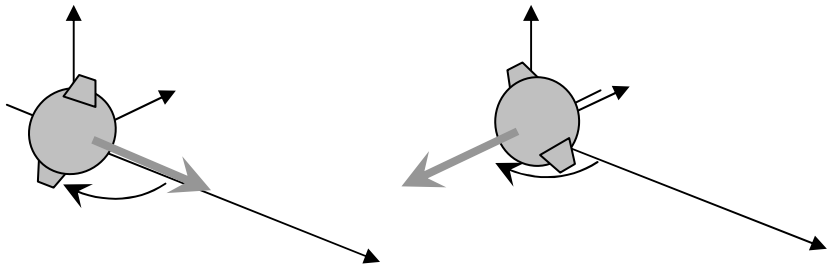
An additional rotation, bringing the rotation that was already there to be quicker or slower, change the energy of the body.

It is what happens to a field in a waveguide if something if someone changes their ω.
It's also precisely what the effect of potential on a charged particle, in quantum mechanics the effect of photon γ on the electron.

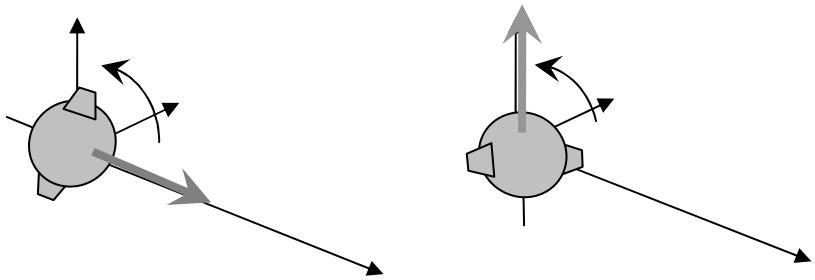
Let generators $\hat{i}\hat{k} = j$ and $ij = \hat{k}\hat{j}$.
These, as stated Hestenes (I translate) "does not leave $\hat{k}$ unchanged".
We can clearly see the effects of a gauge transformation with $\hat{i}\hat{k} = j$ and $ij = \hat{k}\hat{j}$.
We recall first that in the theory of weak interactions in these two generators is attributed to the action of the W particle and therefore it is this fact that we explain.
Stresses that the action of the W particle is, among others, can transform into electron neutrinos, or vice versa.
In an analogy with TE, TM, TEM briefly and succinctly as we would say "give mass to TEM" or vice versa "bring TE and TM at the speed of light".
From a purely electromagnetic point of view is to provide a TEM of a cutoff frequency (which it did not), or rather free from its cutoff frequency a TE or TM thereby transforming them into TEM.
Well let's see what circumstances to interpret geometrically the action of $e^{-\hat{i}\hat{k}\rho} = e^{-j\rho}$ and $e^{\hat{j}\hat{k}\nu} = e^{-ij\nu}$ (the signs are of convenience) on $\hat{k}$, still considered as the axis of rotation of the body.
For brevity write the action of the exponential as being "one side".

For $\rho = \nu = \frac{\pi}{2}$ we see immediately that $e^{-\hat{i}\hat{k}\rho}$ brings $\hat{k}$ on $\left(-\hat{i}\right)$, and $e^{\hat{j}\hat{k}\nu}$ brings $\hat{k}$ on $\hat{j}$.

$e^{-\hat{i}\hat{k}\rho}\hat{k} = -\hat{i}$ →



$e^{\hat{j}\hat{k}\nu}\hat{k} = \hat{j}$ →



We can consider equivalent the action of two generators in that both lead $\hat{k}$ on the transverse plane (as well as would a combination of them).

Obviously for $\rho,\nu \le \frac{\pi}{2}$ worth between.

For constant ρ,ν these are constant changes in attitude and this does not change the total energy of the body, when it is stationary, nor his momentum, when it is in motion.

The body continues its motion with the conservation of momentum, energy and angular momentum.

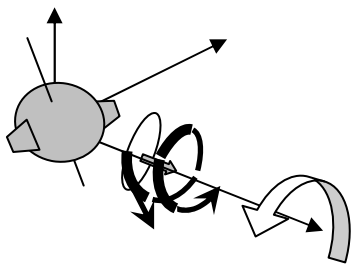
Let instead for example $e^{\hat{j}\hat{k}\nu} = e^{-ij\nu} = e^{-ijWt}$ ie the angle of rotation ν around the x axis becomes a function of time $\nu = Wt$.

We can see that something will happen more complicated.

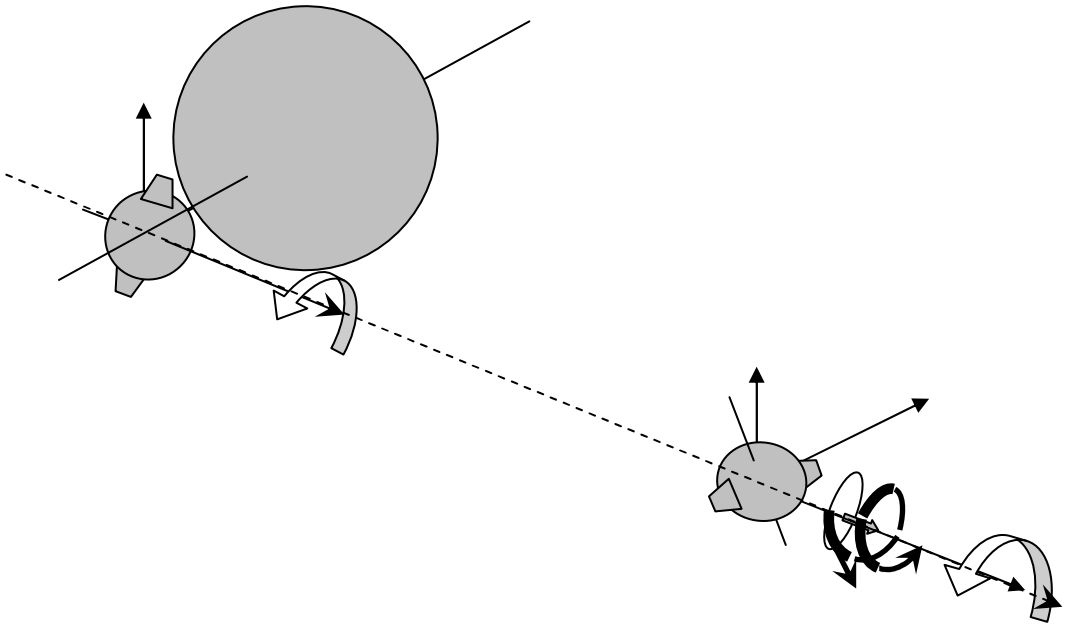
Mathematics gives us the answer:

Satellite slows its movement along z and acquires a precession motion of $\hat{k}$ around z axis.

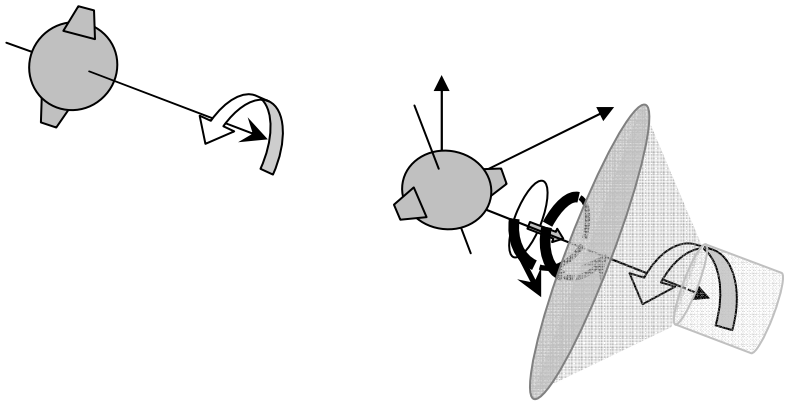
Essentially part of its energy of motion goes into energy of rotation.



And it's what happens to a field in the waveguide: the field has gained mass or energy at rest.
For $W = \omega$ motion stops completely. Energy is all set in rotation (in the waveguide the field is at the cutoff frequency).
With this, we translated graphically the action of the W particle (in electromagnetism transformation from TEM to TE, TM and vice versa, due to a horn antenna) ie the action of gauge transformation $\psi \rightarrow \psi' = \psi e^{-ijWt}$.
We can push the image up to give the action of W to a collision that communicates a spin side. W is depicted in the drawing as a heavy particle.



If this is the mechanism to give a neutrino mass, we can imagine that anywhere else in regions of space or time the presence of a large amount of W particles may have transformed neutrinos in mass. Currently there is not around a significant amount of W, given also the very short life.
In any case, this mechanism would provide an alternative to the mass of the Higgs particle. The mass is due to the helical motion, in the Hestenes interpretation of electron the zitterbewegung
In electromagnetism the transformation from TEM to TE, TM is more imaginative attributable to the action exerted by the walls of the horn antenna.



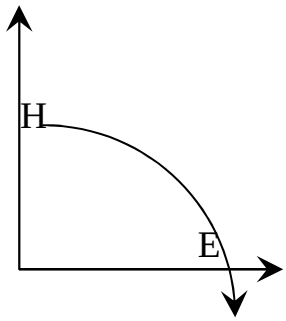
7 - The Z° particle.

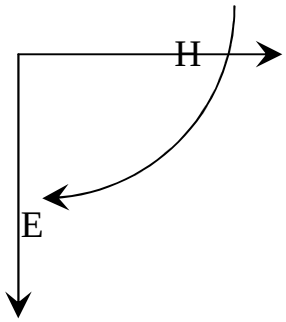
For completeness of exposition in this section discusses the gauge fields attributable to the particle Z° and interprets the action on electromagnetic fields TEM.
In the theory of weak interactions, the action of the Z° particle is expressed through the joint action of the gauge fields generated by transformations with generators i and Tji acting in an abstract space.
The action is in short like this:

joint action of i and Tji, with coupling charges for ν_L (neutrino, left) and $\overline{\nu}_R$ (anti-neutrino, right) of opposite sign.

Examine the effect of these two generators, and not in an abstract space, but now in real space.
Generator i acts as already seen, that does not alter $\hat{k}$ and rotates vectors on the x, y plane.
Generator Tji is not a space rotation: it has a more complex effect, but we briefly explain this:

Tji **not alter $\hat{k}$ but on the x, y plane changes the electric fields in magnetic fields (and magnetic in electric, but opposite sign).**





Both generators then work their way rotations on x,y plane.
Consider on TEM the joint action of a transformation:

(6) $$\psi \rightarrow \psi' = \psi e^{-TjiZt - iUt}$$

TEM in polarization “right” has in itself an exponential factor:

(7) $e^{-i\omega t+ik_z z}$

The effect of the transformation (6) has a particular effect, that only the math shows us a complete [16].
The effect is as follows:
k_Z and ω undergo a modification changing according to the formula

(8) $(k_Z + Z)^2 = (\omega - U)^2$

So, from an initial condition in the absence of fields with $k_Z = \omega$, must be that k_Z and ω undergo a modification that satisfies (8).
From a physical point of view the ω of a TEM can actually increase or decrease through the interaction with an object (or a target).
For example, consider the following situation: a TEM that propagates around z interacts with a moving target that communicates a Doppler ω_d and continuing in forward scattering with (for example) an increase in frequency from ω to $\omega + \omega_d$.
However, if we consider the problem from a physical point of view, the ω of a TEM can increase or decrease, but must do maintaining the condition of equality between ω and k (which means propagation at speed c = 1). It follows from (8) that the action of U and Z is not permissible with the signs that appear there, that is (for positive U and Z) with an increase of k_Z and a decrease of ω.
Therefore the only possible hypothesis is that under the transformation (6):

a) U and Z appear both, and not separately only the one or only the other;
b) U and Z have equal value and opposite sign and then
c) there are "coupling charges" to U and Z opposite.

We appear coupling charges to U and Z opposite. Is thus the solution for a TEM right:

(9) $(k_Z + Z)^2 = (\omega + U)^2$

This solution is now physically compatible and is the action a moving target which imparts a Doppler ω_d with an increased frequency of TEM from ω to $\omega + \omega_d$. The action of this object is so identified with the field produced by the gauge transformation (6).
Now consider the solution TEM "left" (no more right, but left).

Interacting with the same target first and then under the action of the same gauge fields produced by the transformation (6) we find [16] the following solution:

(9) $(k_Z - Z)^2 = (\omega - U)^2$

This leads to the absurd situation where the same target to communicate a positive doppler to TEM right and a negative Doppler to TEM left, which is not physically reasonable.
Are we supposed to coupling charge of the TEM left to U and Z is completely opposite to those of TEM right.
This situation is analogous to that which occurs in the theory of weak interactions for the coupling between the Z° particle and neutrinos:

a combined action of i and Tji and coupling charges for ν_L (neutrino, left) and $\bar{\nu}_R$ (anti-neutrino, right) of opposite sign.

In conclusion, and distinguishing facts from interpretations, we saw as a fact what is the action on TEM of the gauge transformation (6), and have revealed a possible interpretation in terms of analogy with the action of Z° on neutrinos

8 - Conclusions

We examined the geometric effect of generators of the group $SU(2)\otimes U(1)$.
We have also shown how geometrically and intuitively act, on TE, TM and TEM, physical objects similar to the W and Z° particles, and the photon γ.
In particular we see the action of the $SU(2)\otimes U(1)$ gauge fields on the above-named modes (TEM etc.). Have identified the physical objects that implement these actions of gauge fields.
Were finally shown similarities, all obviously questionable and require study, with the physical action of γ, W, Z° on neutrinos and electrons.
I would insist and clearly distinguish facts from interpretations.
a - $SU(2)$ and/or $SU(2)\otimes U(1)$ gauge fields acting on modes (TEM etc.) in the manner we described (here in an intuitive way, in [16] in a mathematical way).
This is a fact.
b - We have highlighted the possible similarities with the action of γ, W, Z° on neutrinos and electrons.
These are interpretations.
However, there are a series of coincidences that can be significant.
We start from a premise: a TE or TM field in waveguide is in many respects similar, if not identical, to a relativistic particle. The similarities concern the presence of mass, spin, tunnelling and so on. Moreover, a receiving horn antenna transforms a TEM (massless) to TE or TM (with mass). But these are trivial facts, known forever, it was only to take note explicitly. But mathematically speaking:
a) a field in waveguide admits a representation with the Dirac equation as well as for the electron (see [15]);
b) the action of a receiving horn antenna is attributable to a gauge transformation with $\hat{i}\hat{k} = j$ and $ij = \hat{k}\hat{j}$ (see [16]);
c) in the theory of electroweak interactions the action of the W particle is attributed to these two generators.
These events, combined, can lead to consider a mathematical theory of electroweak interactions without the intervention of the Higgs boson.
A theory in which the zitterbewegung provides an alternative mechanism to account for the electron mass.
Precisely a theory that can be developed initially with reference to the case “visible” of electromagnetic fields, and then reported as part of elementary particles.

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