Author name
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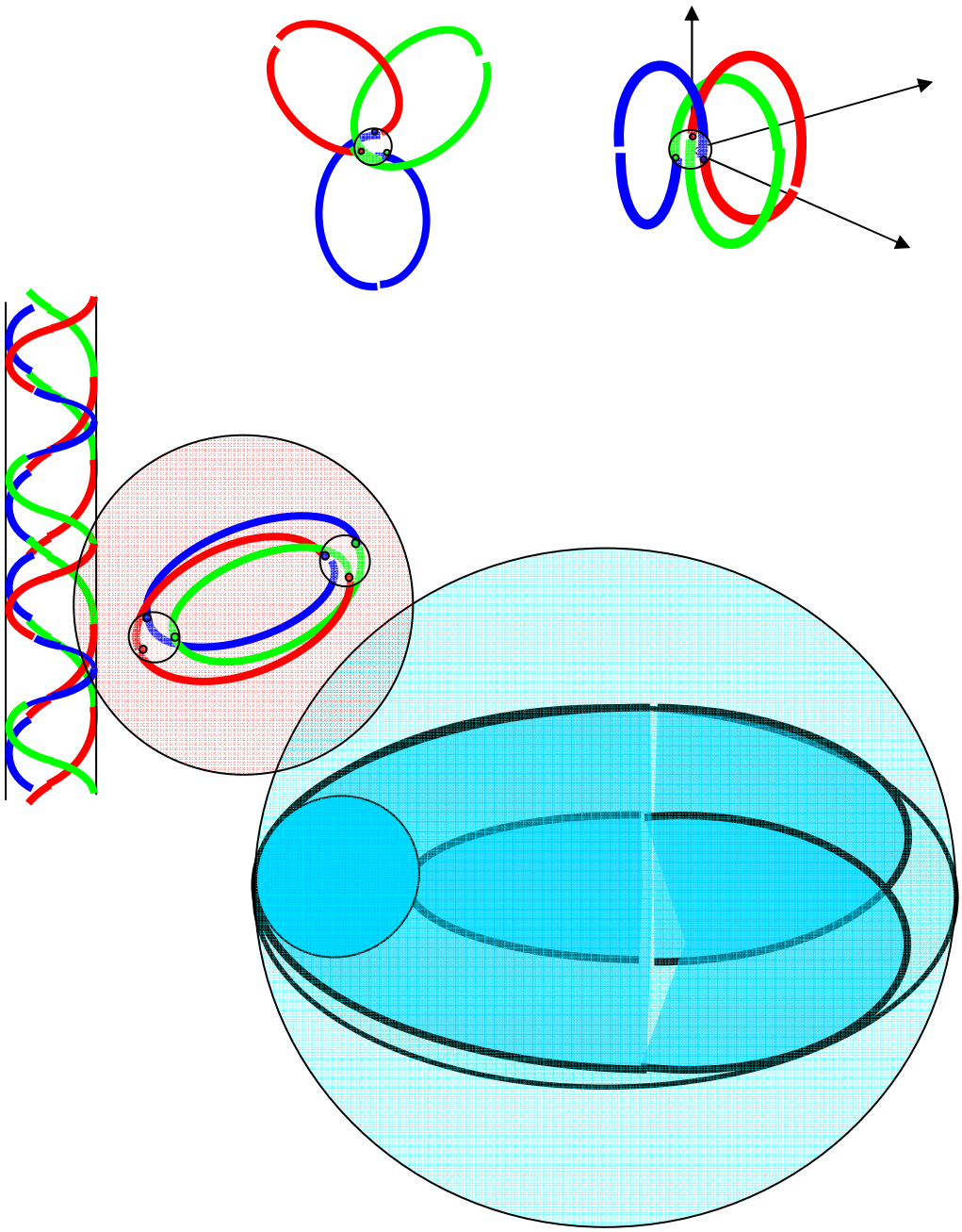
Title
The Moebius Strip: a Biology of Elementary Particles

Abstract
A book of semi qualitative ideas on electron, quarks and life. We intend to make us a purely electromagnetic image of all interactions and elementary particles, in particular electron, and quarks. This would force even the idea of a single universal vibration, a single field.
The electron is interpreted as a small electric current carrying the elementary charge, elementary mass and Planck quantum of action. With the aid of a few math we identify the electron as an electromagnetic half wave closed on a Moebius strip. This is equivalent to a full wavelength making two turns on the border. It is also probably not totally irrelevant to note that this leads to interesting numerics on the fine structure constant. We identify a quark with a confined electromagnetic wave which is not sufficient in itself to complete a closed loop in space. So quarks are pictured as 1/3 and 2/3 of a full wavelength. A space model of their combination leads in a unique way to the entire set of all and only the mesons and baryons. In a quite spontaneous way also the color theory is interpreted. Finally the various helices of quarks are interpreted as living organisms and similarities with a biological behaviour are showed.
Arguments here are of course admittedly primitive and mainly qualitative, also if supported with some math, but to my knowledge this overall conjecture has not been discussed elsewhere, and therefore may be useful for further research.

The Moebius Strip

a Biology of Elementary Particles



Contents

Preface

After several attempts I decided to write a book.
Rather tell you more.
I decided to write a book twice.
The first time I decided in 2000, and the preface here is basically the same. I wrote it and then I have not done anything.
In 2009 I have greatly simplified the content, eliminating the most tedious.
We come now to the book in its current form.
It has the character of a fantasy tale, written for clues, using a technique that has actually many books, that present questions that arise through the reader chapter by chapter, and then continues for subsequent responses or indeed clues.
I was not easy to decide the structure of the book. Sometimes I thought to present mathematical treatment, where I can. Other times I'm convinced it was better to remove all formula and number. Then I decided for this structure. I would say that it is best also to highlight that present *hypotheses*. The hypotheses are suggested or supported by clues.
If desired, the book can be regarded as the intrusion of a radar engineer in the world of physics and elementary particles.
It was not easy for me to even decide the title.
What we speak, in fact? You might say: "the structure of the electron.
But over the years I've written notes, in naming gradually with summary sentences that were also worthy of synthesizing a title.
One of them was: "Everything is light". If I used this phrase as the title, I would say that to highlight one particular angles of view from which this work can be seen.
In fact the way I got the idea that the world we know consists of a single thing. I will not expand much more than this concept, as has been the subject of philosophical reflection since ancient times and then was taken in a thousand sauces even in modern times. However I am an engineer and therefore I need to say something more than a feeling, something more precise.
I actually did not start from this idea, no longer interests me that much, because a debate in these terms would be more a matter of philosophy. We have arrived by reasoning on the hypothesis of a purely electromagnetic constitution of matter, particularly of elementary particles and more particularly the electron.
Those who think about things, which resemble the various "Theories of Everything" circulating on the Internet is inevitably considered a heretic in physics.
Accordingly, it is used sometimes by them invoking some alternative physics and quote with some contempt, as defensive, what is called *Official Science*. This I think is not possible for the simple reason among many that we have nothing more intelligent to replace. In fact, new theories serve consistently expressed through mathematical physics.

Potentially the equivalent of a physical theory of everything is the demonstration that the electron is made of pure electromagnetic field. The remaining, particles and the rest of the matter, following close behind.
There is no satisfactory physical theory on the electron. I decided to tell something very popular, the attempts being made. Mostly about my personal ramblings, trying to titillate the reader with flights of fancy.
Story also briefly the work of David Hestenes.
Hestenes never said the phrase "everything is made of electromagnetic field", but made a number of assumptions on the electron we are very close.
I am pleased that in the meantime, in 2000, Hestenes had Oersted Award for teaching physics (thereby placing them next to Sommerfeld, Oppenheimer, Richard Feynmann and other guys) because often who think of these things is treated as a visionary.
The fact that with this award Hestenes has had official recognition makes it matter.
Although it may be that the award has been given *despite* his work on the electron.
But back to the book.
Reading it will sometimes get the impression of an autobiography, but this is not the intention. It is useful to me, or inevitable, to follow the way in which I raised some ideas, and this gives the impression of autobiography. Actually I just try to follow a certain order of exposition.
As I said after a first draft I have completely changed the content, reducing and simplifying. Now the book contains only a few ideas more or less science fiction on the electron and quarks.

October 2009
Giuliano Bettini

Preface to English version

The electron one hundred years on.

As a preface to the English version I would like to introduce a subtitle, suggested to me from Riccardo Rauber, I mean this *"the electron one hundred years on"*.
As a matter of fact, in 1910, while a professor at the University of Chicago, Millikan published the first results of his oil-drop experiment in which he measured the charge on a single electron.
So time is gone in order to try say something new.
I was always very impressed by these words of Erwin Schroedinger in his famous book "What is life":
"A scientist is supposed to have a complete and thorough knowledge, at first hand, of some subjects and, therefore, is usually expected not to write on any topic of which he is not a master. (.....) This is regarded as a matter of noblesse oblige.

(.....) We feel clearly that we are only now beginning to acquire reliable material for welding together the sum total of all that is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it. I can see no other escape from this dilemma (lest our true who aim be lost for ever) than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them -and at the risk of making fools of ourselves".
I mulled long time over this phrase and I conclude that, probably not being able for *"welding together"*, etc., surely I have no problem in order to this *"risk of making fools of ourselves"*.
So after several attempts I decided to write this book.

June 2010
Giuliano Bettini

Chapter 1
Introduction

1.1 The idea of an undivided Whole

I wrote "Whole" with a capital letter because sometimes it is written so. The capital gives a sense of importance, the sense of a philosophical theory on the final constitution of the world, of things and ... just Everything.
It is not my intention to talk about this.
I mention these ideas because they have gone through science, religion and more generally human thought over the millennia. It will inevitably be thinking this if they want to make a connection with an electromagnetic theory of the electron, or of all matter.
I repeat that it is not my intention to deal with this.
Although there is no doubt that an electromagnetic theory of electron a philosophical impact *has it*.
Leaving aside religion, but to remind the main philosophical and scientific attempts to bring the world to a single "entity".
I will mention only two, Einstein and the ancient Indian writings of the Upanishads.
Probably who more approached in a purely scientific way these unitary concepts was Albert Einstein, with his unified field theory.
Brutally simplifying we can say that there was in Einstein ultimately the desire to describe all of reality through a single total field

".....with respect to the pure gravitational field part. The only indication that can be drawn from experience is a vague intuition that within the total field something must be contained similar to Maxwell's electromagnetic field "(A. Einstein).

In ancient times the idea of a single substance is strongly supported in the Vedas, we can consider the books of wisdom of India. In the Upanishads, part of the Vedas, the idea of a single substance is repeated several times.
Say for example the Upanishads (Chandogya Up. 6.15.3):

"Whatever this subtle essence, the whole universe is made of it, it is true reality, it is the Atman. It is you, Svetaketu”.

That said, now occupies the narrower issue of the constitution of the electron.
What can you say about the hypothesis that the electron is *made of* electromagnetic field?

1.2 The electromagnetic field

If your cell phone do not works and "there is no coverage", that is the electromagnetic field.
I will therefore assume that the reader knows more or less what is or what is meant by electromagnetic field.
For those who do not know, it’s enough to think that are waves, like those that transmit radio or television. Or the light and X-ray. Or radar signals. These waves are called electromagnetic waves because they are electric and magnetic. Inseparably send a wave of electric field and a wave of magnetic field.
Since the electromagnetic field arises from electrons that move, could not be illogical to think of a single substance. In fact at beginning it was so.
The attempt to interpret the electron as something made only by electromagnetic field is not new. Max Jammer [1] reported the first work back in the late '800 and early '900. This was the idea of many famous scientists of those times. Even in 1920 Einstein, as Popper points out [2], literally writes: *".. according to our present conceptions the elementary particles are .... nothing more than condensations of the electromagnetic field ... "*.
To say that the thing was still relevant in 1920.
Some took very seriously these efforts, others criticized them, others smiled.
All attempts failed.
Sommerfeld [3] points out how and why, bringing even a famous phrase of Einstein *“the electron is a stranger in electrodynamics”*.
It should be noted that these initial attempts imagined the electron made only of its electric field, static field, motionless, just what attracts the positive charges, but does not vibrate, does not oscillates, it is not an electromagnetic wave such as radio waves or light.
For the simple reason that no one dreamed in those days to associate wave properties to an electron.
The electron was a particle, not a wave.
But when these properties of wave appeared, assumed by De Broglie and then theorized by quantum mechanics, the situation was complicated and simplified at the same time.
Quantum mechanics associated a "psi" wave to each particle. Thus a collateral debate of this kind was born:
all particles have an associated wave or *are* waves?
The situation gets more complicated.
Among those who were rooting for the waves was Erwin Schroedinger.
He went over and this was much mocked.
He thought more or less explicitly that everything was made of waves, and that they were linked and that therefore there was no individuality, but all had one thing [4].
“I'm not entirely sure that the identity that we feel as a person, as an individual, is real, it is not an illusion. It is in any case a common misconception in the East, with

Buddhists, with the masters of the Upanishads, that this is an illusion, that we are not really spiritual individual, but all come, in fact, by the same person".
Undoubtedly, however, for those who wished to build the electron with an electromagnetic wave, the situation became more attractive: there was already a psi wave associated with particles, so why not suggest it was an electromagnetic wave?
Skipping today, David Hestenes [5] interprets the electron as an entity in which an oscillating electromagnetic field, similar to De Broglie pilot waves, has sit. The electric charge possessed by the electron is attributed to a point charge, without mass, rotating on a circle. The mass and spin of the electron are attributed to the "electromagnetic self - interaction" of this point charge with their field. In short the mass and the spin have electromagnetic origin.
The idea of waves connecting all matter in an undivided whole is strongly supported by others, including David Bohm. Bohm's ideas are sometimes expressed by him in a very technical, through an interpretation of quantum mechanics [6]. At other times his ideas are far more explicit. Talbot recalls how [7] Bohm thinks that the tendency we all have to fragment the world and ignore the connection of all things is responsible for most of our problems.
This not only science but also in our everyday life and society.
For example, we think we can extract from the earth all that is valuable without damaging the rest. We think it is possible to treat individual parts of our body without it as a whole. We think we can handle various problems of our society, crime, poverty, drugs without seeing the problems of society as a whole. Bohm argues passionately that our current perspective, to see the world fragmented into parts, not only does not work, but can also lead to extinction.
You must honestly feel that physics puts little or no problems. It has a clear picture, at least within the limits of existing theories. There are four fundamental "forces" electromagnetic, weak, strong and gravitational. There are particles that transmit the various types of forces, photon, intermediate bosons, gluons, and gravitons [8] and there is not a world fundamentally made of electromagnetic field. Who cares as it works on the margins.

But returning to this day what can we say of the electromagnetic field?
With a little imagination it is something impressive.
We can take a lot away with a reflection on mathematical methods in physics.
Let's start with a book on Einstein's relativity [9]. Reading it, one is impressed by how apparently a physical theory might emerge like magic from mathematics.
Specify certain mathematical rules (tensors, the Lorentz transformations, etc.), the famous formula E = mcsquare of relativity comes easily as a simple consequence.
How do you explain this?
We can explain: the physical theories are expressed with mathematics and mathematics is basically a descriptive language, but a bit special, it is done for formulas and once released some initial assumptions or formulas a number of other formulas or deductions are created.
These future deductions are not debatable: are required.

Therefore, if our initial assumptions or rules are lucky or it were matched in relation to objective (which is the description of the physical world), then just born different formulas and even unexpected. Will mean that those might conflict with what happens in the physical world will force us to rethink the theory from the beginning. Reflecting we realize that in the case of relativity that is entered as the starting information is simply this: the velocity of light is constant.
Passing the so-called Special Relativity to the more complex theory of General Relativity, many equations are complicated and change but not so Maxwell's equations of electromagnetic field. They stand still as Maxwell's equations.
What the hell is in Maxwell's equations so as to make them resistant also to a change of environment such as that addressed by General Relativity? What is the speech that they do?
Maxwell's equations are the equations of the electromagnetic field. Perhaps in writing we hit something particularly smart or particularly simple, such that it is so strong. For those who are fond of mathematical physics, Maxwell's equations appear strangely elegant. He said Hertz [10]:
"You can not consider this surprising theory without at times feeling that the mathematical formulas that it contains have an independent life in itself, its own raison d'etre, containing a deep wisdom that goes beyond the intentions of their own discoverer".
But "purpose of science is not surprising but the research," says Ernst Mach. So instead of surprised we try to understand.
We said that the initial message that makes so powerful the Theory of Relativity summarized in a nutshell is:

“the speed of light is constant”.

What is the initial message entered into the Maxwell equations? What is their content?
Maxwell obtained these equations by writing two volumes, with genius and hard work, and brilliant electrical and mechanical interpretations. Today we give a more concise interpretation that was not accessible at the time of Maxwell.
Maxwell's equations in vacuum are nothing but the Cauchy Riemann conditions, ie the conditions that define analytic functions in four dimensions [11] [12]. With them we have held:

“'is something in spacetime such that the change of every small part means a variation of everything”.

The property on change is a propertiy of two-dimensional analytic functions. I quote this sentence from Silov [13]

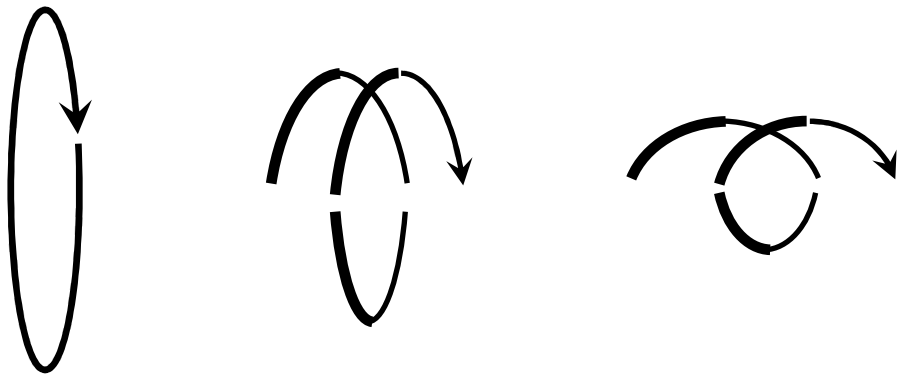
"We can then compare an analytic function to a body whose characteristic property is to react collectively to any action of any part of it".

So this is the background information we put in Maxwell's equations in vacuum when we write that: *"the electromagnetic field is an analytic function"*.
This explains, perhaps, the wonder of Hertz, the aesthetic beauty of the equations and their general validity [n1].

In summary:
mathematical physics is providing a link between a well-known physical phenomenon, the electromagnetic field in empty space, and philosophical ideas of a "subtle essence" constituting the world, dating back to the Vedas thinkers.
We could say to one of these thinkers: “a subtle essence as you want, I do".
But it can make all things?

1.3 The trapped light

Provisionally identify the subtle essence of the Upanishads with the electromagnetic field.
How material particles or all matter could be formed by the electromagnetic field?
The electromagnetic field in vacuum runs constantly at the speed of light.
But the particles can either travel or stay in place.
How can something always run at the speed of light and at the same time be? One way is, at least in imagination, and is run in a circle.
How, therefore, the electromagnetic field could give rise to matter?
A clue is provided by a circularly polarized electromagnetic field that propagates in a circular waveguide.
It under the circumstances, or by its frequency of vibration, is still in place or travelling.
The two situations are briefly described in figure



The electromagnetic field when it propagates, it travels within the waveguide following an helical path. The extreme conditions are infinitely large frequency, where the helix is very long and the field travelling at the speed of light, and the so-called "cutoff" of the waveguide, when the helix is increasingly shortened, the field ends with turn on itself, and stands there. The other helices are in-between.
We can think of a single photon is in these conditions.
Frequency and energy become synonyms, related by Planck's constant.
Happens, I state without proof, that both the frequency and the energy obey the relativistic formula linking mass energy and momentum of a material particle. The mass is precisely ..... the field energy at rest, ie the energy of the trapped field that revolves around itself. Light trapped.
This is an indication that there might suggest. The electromagnetic field in the waveguide already behaves as expected for a relativistic particle. A trapped electromagnetic field is behaving like a particle.
Furthermore this model would give us for free a visual interpretation of why the disappearance of mass free energy:
released from the bond, the field goes into electromagnetic radiation.

Of course here there is the waveguide that acts as a constraint to hold the field. In the vacuum, for a material particle, we should imagine an equivalent situation. But no one knows who or what can justify forcing a field to rotate in a circle. You do not know how to write equations to justify the constraint.
A simple way to solve it is to think that we can not justify it, but *it exists*.

1.4 “The electron is a stranger in electrodynamics”

So we might begin to interpret the electron, one of the basic particles of matter, assuming it is made of electromagnetic field.
But ... "the electron is a stranger in electrodynamics".
This sentence has been said by Einstein I don’t know if as a fact or paradox, and contains a basic concept. In fact we can not, for example by *electronics*, which could involve semantically a science of electrons, to explain *the electrons*. Simply, for electronic, or electrodynamics, and for electrical engineering, and more particularly the discipline of mathematical physics called electromagnetism, electrons *are there*. Why the hell they are, nobody knows.
If you want to say something more, must for example turn to quantum mechanics, which however she also does not explain what the electron.
David Bohm explains well in his book [6] such as quantum mechanics makes us do the math, but do not say to much about what things are.
I quote in italics his thoughts:

(....) one of the leading physicists of our time, M. Gell-Mann, has said “Quantum mechanics, that mysterious, confusing discipline, which none of us really understands but which we know to use”(.....). All that is clear about the quantum theory is that it contains an algorithm for computing the probabilities of experimental results (....). Or to put it in more philosophical terms, it may be said that quantum theory is primarily directed towards ***epistemology*** *which is the study that focuses on the question of how we obtain our knowledge (and possibly on what we can do with it). It follows from this that quantum mechanics can say little or nothing about reality itself. In philosophical terminology, it does not give what can be called an* ***ontology*** *for a quantum system. Ontology is concerned primarily with that which* ***is*** *and only secondarily with how we obtain our knowledge about this (....).*

In summary, even quantum mechanics tells us little or nothing about what the electron.
However, the electrons are, they know the properties, even if you can not describe the structure. Balls are? Points having no size? The question then was further complicated by their dual behavior, particle and wave. Corpuscles are? Are waves?
A reasonable hypothesis that could be done cheaper on the electron would be: "it is electromagnetic field”. A lump, a denser area of the electromagnetic field. This would also force the idea of a single universal vibration, a single field. The electromagnetic field has, and is able to produce all those properties that we recognize the electron, or more generally to all matter. It has in appropriate conditions energy, momentum, mass, velocity, charge. A cluster of electromagnetic field could therefore be a good candidate to describe the electron. When an electron falls apart battling a positron, and what comes out is pure electromagnetic field, is not outrageous to think that the two were made of the electromagnetic field.
There is also another advantage.

Quantum mechanics associates to the electron a wave.
An electromagnetic field can easily produce a wave, in fact, is by its nature, unless the so-called static fields, a vibration, a wave. The wave characteristics of the electron could thus be explained by the following fact: it is an electromagnetic wave.
However along this and other similar directions were made several attempts.
Not possible, or at least we have no exact theory to support it.
We do not have the equations that are able to interpret such things.
Or worse, the equations that we have show us that it is impossible that things go well.
But ... there are indications that instead of inviting us to work persistently in this direction?

Chapter 2
The Radar

2.1 Backgrounds

The attempt, if only based on fantasy, of electromagnetic constitution for the electron and then everything takes to make us a picture of how the whole thing might work.
What does a electromagnetic constitution of all things?
How are they made? How they interact?
Will be sufficient to pose the question, and get a picture of the whole, relatively only to the world of elementary particles.
Once we were convinced of their electromagnetic constitution, we might be satisfied. All the rest, atoms, molecules and so on, would be made reasonably explained.
So we can rephrase the question to only the elementary particles.
How are? How they interact?
We need things, the particles which will rest up autonomously.
In a description in words we could say: "Well, they are lumps, agglomerates, areas of dense electromagnetic field". But not enough. Electromagnetic phenomenology we know enough to pretend to give some satisfactory explanation. For example: we can imagine a single particle as a circuit that accumulates electrical energy? We do not know in their hearts because the particles are too small for looking inside, if there is one inside, but we know several circuits that store energy because they are big and we can look inside. We know the mechanisms of operation. So we can get the similarities. We can say: "this small particle is as if done by a circuit that works so-so".
All this concerns the questions that we can do about a single particle.
Turning to the interactions between the particles. The term interactions refer to the fact that more particles, if only two particles, interact with each other in certain ways. Attract or repel each other, or banging against each other giving other particles or stick, and so on. Why? How to obtain a picture of this?
Physics has a clear picture of the world of elementary particles, both as they are made, both on how they interact. This framework is based on decades of experimental data, and related theories.
There are four fundamental forces or fundamental interactions in nature, electromagnetic, weak, strong and gravitational, this explains how the particles are made and interact.
But if you want groped to figure out everything as electromagnetic field, then the objects, the particles must be made of the electromagnetic field. Interactions between objects should be too purely electromagnetic. And this is all that we must at least imagine, with our fantasy, that is reasonable. We can try to do this precisely with the similarities, with the big things, visible, allowing us to imagine things tiny, too small for looking inside.

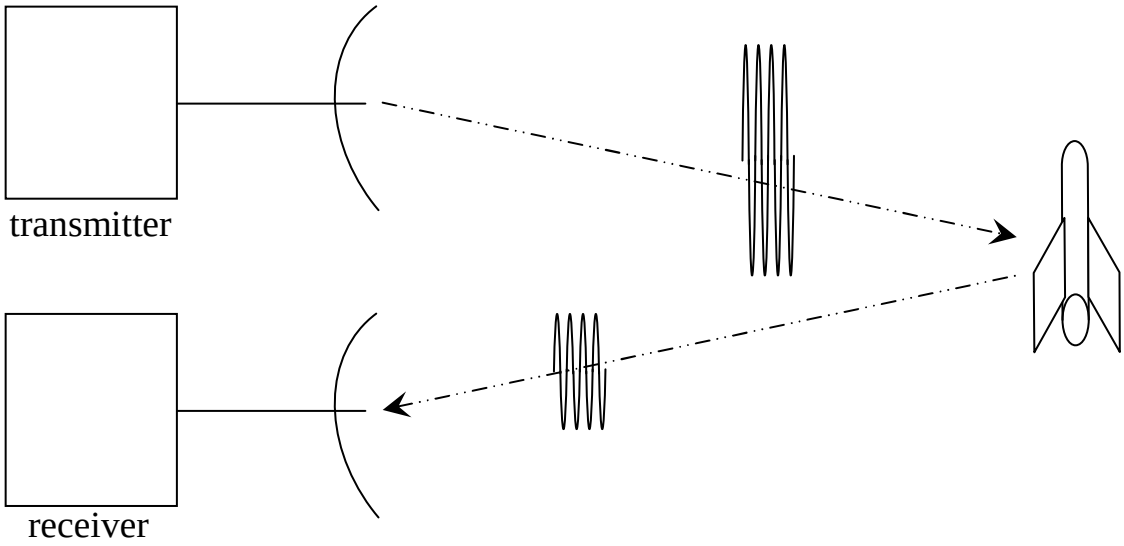
Here you have to open a small parenthesis, but appropriate to mention at least two basic facts. On the one hand we could say that is satisfactory and it works to make us a similarity between a big thing and a little elementary particle, such as the electron. At least that is how a few.
On the other hand we could say that you can not get an idea of the inside of a little elementary particle, such as the electron. At least that is how others.
Let's illustrate, albeit brutal, the two statements.
For those fascinated by the first point of view, that the analogy of the structure, various elements may be in support. Nature often seems to propose forms and behaviours in scale. The model of the planets orbit around the sun and the electrons around the nucleus is an example. There are many. But one particularly striking is offered precisely by electromagnetism. Electromagnetic waves are "scaled", the most gigantic to the ultramicroscopic are the same type of wave. This is to a certain extent under the eyes of all. It is a common experience. Everyone knows that radio waves, radar, microwaves, infrared, light, ultraviolet, X-rays, gamma rays are the same, to scale. Without going into details that become dangerous let's stop here.
Supporters of the second point of view say to begin with that is illusory to always at all costs give us a picture of the physical world. It is an attitude of the past century, it’s naive. This is then demonstrated with precise theoretical arguments. The final substance, for example regarding the shape and internal structure of the electron is not so much that it is difficult to give answers: it’s wrong asking the question.
Are required here to express a personal opinion.
In cases like these I will always remember the past, I remember the Egyptian priests, the Inquisition, a general attitude of a certain culture. The answers to difficult problems are always given precise. The answer is this, full stop. Sometimes the matter is more complicated and so, by who is deemed to have the answers, there is not the phrase "in this case we are unable to respond".
There might not be this phrase.
It then explains that the question is wrong.
Asking the question is naive.
If someone insists on asking the question, then the attitude becomes more precise.
Asking the question is prohibited.
Who continued to ask the question is an idiot, according to age. In other eras, is burned.
But we close this parenthesis and resume the thread of reasoning.
In a fantasy we have no need to have these problems. The fantasy is in fact authorized to go beyond. As a friend of mine once said he wanted to expose myself a little convincing theory: "if you do not want to hear, can I at least tell you a story?".

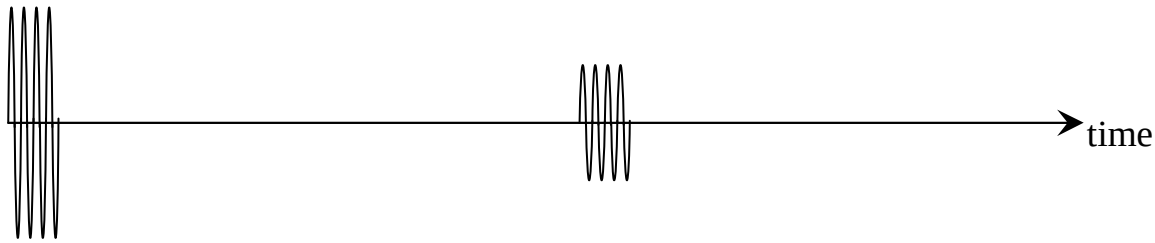
We intend to make us a purely electromagnetic image of elementary particles.
There is an invention that is the radar in which it operates almost any electromagnetic phenomenon which you might think. In operation of the radar are added a series of physical phenomena that lend themselves well to these arguments.

There are in fact electromagnetic fields that are in place, travelling within a waveguide, which interact changing face, changing into a different form. May be useful? Let’s go on.

2.2 What is a Radar?

"Radio Detection And Ranging", so as many U.S. words radar seems a name, actually began as an acronym, like "laser" and so on. See objects through radio waves and determine how far they are, this means.
For our purposes at this time that's enough to describe the radar like this: the directional transmission of an electromagnetic pulse, measuring the time of receipt, the determination of the distance to the object that has reflected back [14] [15] [16] [17]. Something like this was the U.S. radar of Hawaii during the war with Japan.





The impulse is transmitted with an antenna, it receives a reflection from a possible target, it measures the return time.
Time means distance because the pulse velocity is known, is the speed of light in vacuum.
The radar impulse is a short train of electromagnetic waves, we can define various synonyms: electromagnetic wave train, radar signal, radar pulse, electromagnetic wave packet etc. It is an electromagnetic field that travels with its own internal

oscillation frequency and its total duration, usually very short. It is made in the transmitter with a characteristic frequency and / or characteristic wavelength dependent on the use and need.
The impulse produced in the transmitter is sent into space by an antenna. Transmitter and antenna are connected by a cable or, more precisely from a waveguide, which is a kind of hollow tube within which the pulse travels. The same happens with the receiving antenna, which connects to the receiver via a waveguide. If and when the radar pulse arrives at a target, is reflected from the target. They form a kind of echo that is sent in space and in particular back to the radar receiver.
When we say "the radar pulse is reflected" we give a simplistic description of a complex interaction of radar pulse with the target. The result is that an output signal is produced. Note incidentally that the target does not change because the target is rigid, rigid hard material, while the pulse is a "malleable" electromagnetic wave. This observation will be useful later, when we consider the target and the radar signal both having the same degree of hardness or malleability.
That said, how we can help the radar to build analogy? In brief we can say:

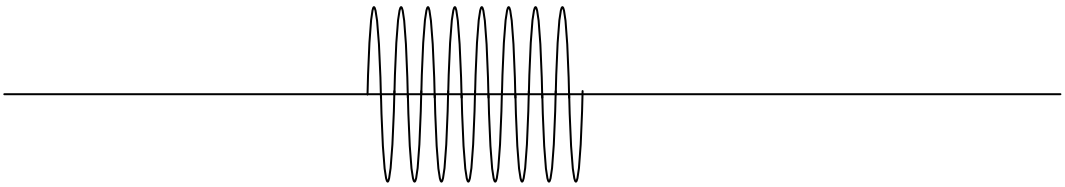
waveguides teach us the existence of the particles;

the interaction with the target teaches particle interactions.

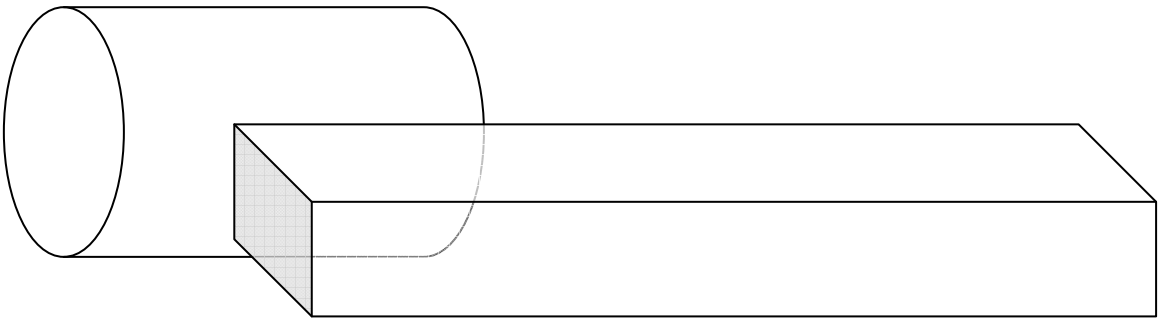
2.3 The electromagnetic field in waveguide

In the radar technique is send electromagnetic wave packets to the target to be detected. During their journey back from the target they travel at the speed of light. Instead, for connection to the antennas they are made to travel within a waveguide. Here, depending on frequency, however, travelling at speeds less than that of light. The waveguide requires them to travel at speeds less than that of light. We'll see why. Wishing into a waveguide pulses can also go very slow. Travel slow if the frequency is slightly higher than the "cutoff frequency" of the waveguide or, which is a synonym, if the waveguide is narrow. If the frequency is equal to the cutoff frequency, are still.

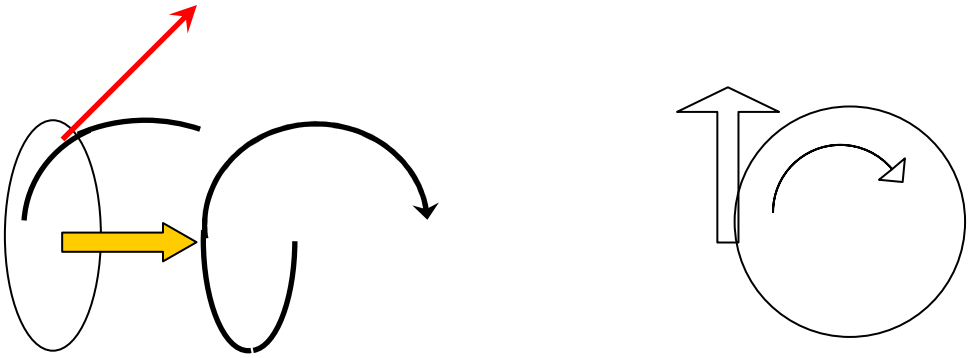
When a packet travels in a waveguide is inside the waveguide. It is so big as the waveguide, a little smaller to get in and can run. A typical packet has a dimension of the magnitude of the wavelength, since this is the waveguide, which is built based on the packets that must lead. A typical packet is rather long various wavelengths, according to project needs. Say for example one hundred wavelengths.
What is the wavelength?
In the technique they are used a lot. Especially in the radar wavelengths usual may be in the decimeter of centimeters of a millimeter, depending on the application. In other applications, the wavelength can be meters, hundreds of meters, km ... ...
But the light that travels inside an optical fiber, which is .... a waveguide for the light, the wavelength is dramatically smaller.
We'll talk about radar pulses that travel in a waveguide. Our aim is to compare them with a particle
This is an radar pulse:



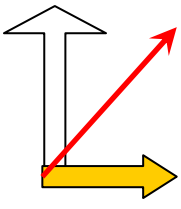
and these are waveguides, in particular a circular waveguide and a rectangular waveguide:



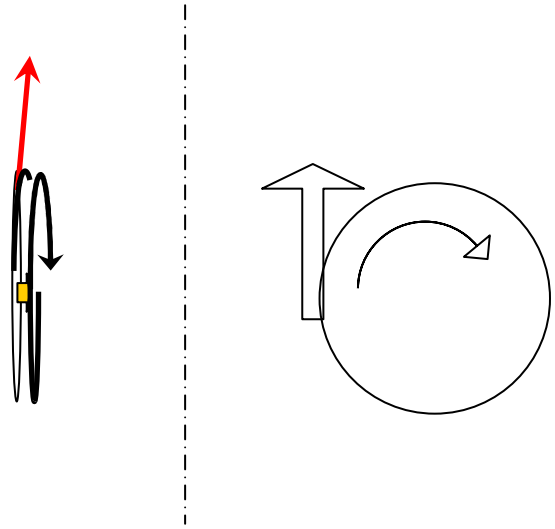
A waveguide is a kind of hollow tube, a circular waveguide is a kind of hollow tube as a gas pipeline, even if it costs more than a gas pipeline.
You say: why not consider a radar pulse in vacuum? Why in a waveguide?
The reason is that the particles can be still or moving at some speed at our option. A radar pulse in vacuum can not be stationary or moving at some speed at our option. Inevitably travels at the speed of light. In a waveguide can travel freely or sit still, so our comparison is fine.
We will show that the radar pulse can stand or move as a particle, can exhibit all the properties of a particle. Or almost all properties of a particle.
For our purpose it is good reason speak about a circular waveguide.
Consider a short radar pulse, in circular polarization (note: for “polarization” see next paragraph), travelling into a circular waveguide. It is held by the waveguide and travels forward and turning. In the extreme case of "cutoff" field does not advance in the waveguide but there remains in place.
But the electromagnetic field is still "light" and then travels at the speed of light. How they will agree the two? Simply this: the field travels along a helix always at the speed of light (red arrow in the figures).



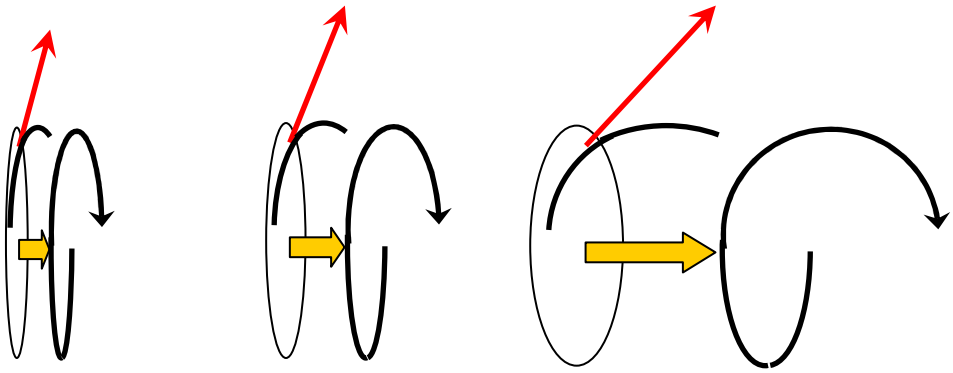
The actual speed of motion along the waveguide axis is the yellow arrow. The speed of rotation is the white arrow.
Overall, the three speeds at all times be composed as follows:



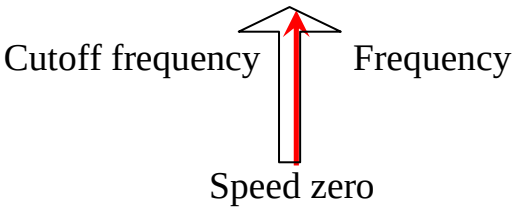
What type of helix describes the field? What causes the helix is more or less elongated, meaning that the field is moving faster or slower? Everything depends on its frequency.
There is a waveguide, set no matter the size, a "cutoff", which means in effect to have an obligation for energy to stay there. Until the frequency reaches a proper value, the cutoff frequency precisely , the waveguide does not propagate anything, not even *enter* anything. . Reached the cutoff frequency the circularly polarized electromagnetic field can enter the waveguide but is exausted. He has just enough energy to stay there, still. Come in, do not travel, is limited to rotate, there on the spot.

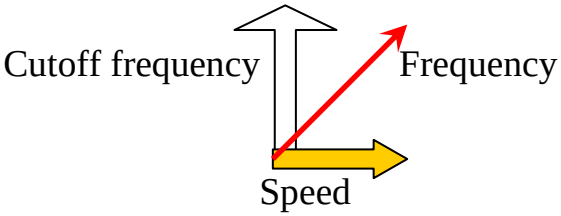


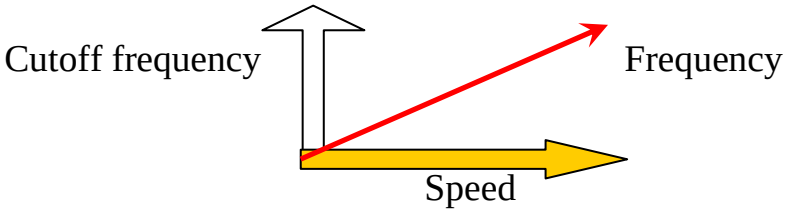
As we do grow the frequency the electromagnetic field can begin to move. Show it with the figures.
With an appropriate change of scale we can represent, by arrows, the frequency increases. The yellow arrow is no longer just the speed but it is proportional to it.



To speed up the field we can therefore increase the frequency. The frequency increases the speed increases with this law:





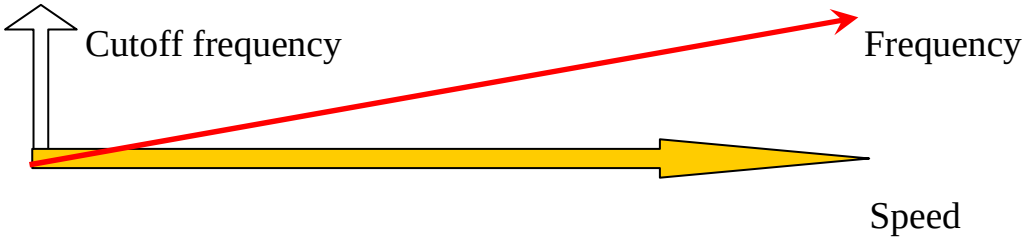


.

Continuing to increase the frequency, field picks up speed, but with difficulty. It must drag this ballast, the cutoff frequency, the white arrow, which was so to say that the fee had to pay to enter the waveguide. To reach the speed of light frequency should become infinite, and that is what happens in the waveguides. The speed of light is reached, it would reach, to infinite frequency. Thus we see what has been prevented from waveguide:

an electromagnetic field, which by its nature would travel safely at the speed of light, into a waveguide can to approximate it what you want but never reach.

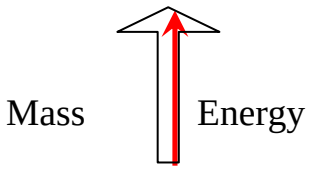
The reason is that the vertical white arrow that is in the figures.



At this point there is the need for a bit 'of imagination
Consider synonyms the **frequency** and **energy** because the particles have, associated to energy, a frequency, the two being tied together by the Plank constant.
To put it simply think of the field as a particle and substitute anywhere in the figures the word frequency with the word energy.

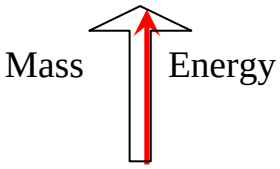
The field that we just finished examining be .... a particle. The frequency of the field becomes the energy of the particle. The cutoff frequency becomes the energy of the particle at rest, the mass of the particle.

The figure when the field is stationary becomes this:

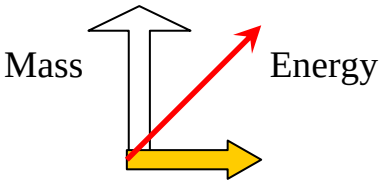


There's only rotating energy. The mass is justified by this energy. Among other things, the movement also justifies the angular momentum, “spin ", possessed by the particle.

When the field is in motion, it behaves like a particle in motion, and drawings, with the words "energy" instead of "frequency", these become:

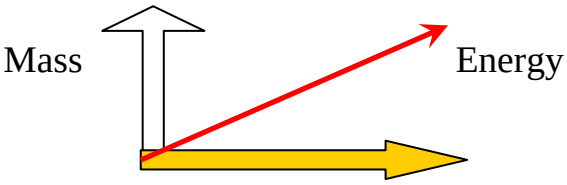


Speed zero



Speed

.



Speed

There is an obligation as we see: the mass (the "rest mass") does not change. This is always the mass, in the drawings the white arrow.

Now it just so happens that these are not just drawings.
They also express, exactly, the mathematical relationships of the relativity theory involving a material particle.

The particle mass is represented by the white arrow.
The total energy is the red arrow.
The speed or better the momentum is the yellow arrow.
The mass we have said is the white arrow. In the waveguide was the cutoff frequency. We can repeat everything we said to the waveguide, now repeating with the language of the particles. What happens to a particle?
Continuing to grow the energy the particle gains speed, but with difficulty. We must drag behind the ballast, the mass. To reach the speed of light energy should be infinite, and that is what happens in the particles. The speed of light is reached, it would be possible, for infinite energy.
We think of a particle as a trapped light:

a particle, due to its nature of trapped light, condemned to approximate what you want the speed of light, but never reach.

If we follow the example of waveguide, now the mass is a fee paid ... for what?
We should say that is an amount of trapped energy, the minimum energy needed to make that the particle exists.

In summary:
graphic relations that exist between the quantities involved in these drawings meet the exact formulas between cutoff frequency / frequency of waveguides and mass / energy of the particle.
What does all this then? Means that a material particle resembles very much, indeed is identical with that electromagnetic field.
Our material particle at this point is no longer a material particle, is no longer made of matter, is exactly that electromagnetic wave.
All this results in formulas and equations but not to bore the reader refer to Notes [n2].

So everything is solved?
The examination of a waveguide there is already proving that an elementary particle is pure electromagnetic field?
Not really. Meanwhile there is a main problem: here is a waveguide which takes the electromagnetic field packaged and determines the cutoff frequency. Who keeps a packed particle in empty space? The electromagnetic field between what dribbles?
Then there is a second great difficulty: we must justify the electric charge. A field in waveguide has all the ingredients, but no electric charge. It is electrically neutral.
For more experienced readers might glimmer a third difficulty, but a careful reflection shows a positive sign.
Quantum mechanics predict the "dispersion of the wave packet”. In other words, a short wave packet of quantum mechanics, even if it exists, in that he is at any given time the particle, with the passage of time is spread out. It is as if the propagation media, the space, was dispersive. Sometimes reads books that this was one reason, or

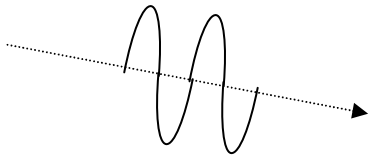
principal, which prevented identification of the particle with its wave packet. He said, "even though I see the particle, after a short time my knowledge vanishes".
Later on this mathematical fact are grafted philosophical speculations of various kinds. This has given rise philosophical considerations about our limits of knowability of the real world. Einstein on these things has always disagreed.
Now a waveguide, effectively, is dispersive. What does this mean that waveguide is dispersive? Means just a short electromagnetic wave packet sent within the waveguide propagates, but after a short time, after much time, is lost. Spreads out.
However, radar engineers do not see our philosophical limits of knowability of the real world. They simply say that waveguide is dispersive.
This in radar practice gives no trouble.

But not even give any conceptual discomfort. A short wave packet which is an electromagnetic radar pulse is not lost for nothing in a vacuum. Disperses in the waveguide, but this is a problem of the waveguide. It makes no conceptual limits to knowability of the position of an radar pulse.
A closer examination of the situation is clarifying how this dispersion mechanism enters into quantum mechanics. Some equations are formally similar to those of waveguides. But never mind.
Without going into too many details of equations and so the conclusion is this: a short electromagnetic packet that was identified with an elementary particle is not lost.

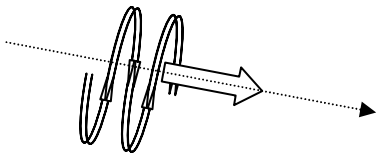
With this the waveguides have finished what they could teach us. Do not solve our problem. But take note that we provide strong evidence in favor of our hypothesis, despite the difficulties to be solved.
The two paragraphs that now follow are not strictly necessary to proceed. We will need later. So if the reader may want to skip directly to the chapter on the Moebius strip.

2.4 The polarization

Let's talk about polarization. What is polarization?
A vibration, an electromagnetic field is said polarized and linearly polarized if the electric field propagates vibrating on a plane. The same will the magnetic field, orthogonal to it. The plane of vibration of the electric field is called the polarization plane.

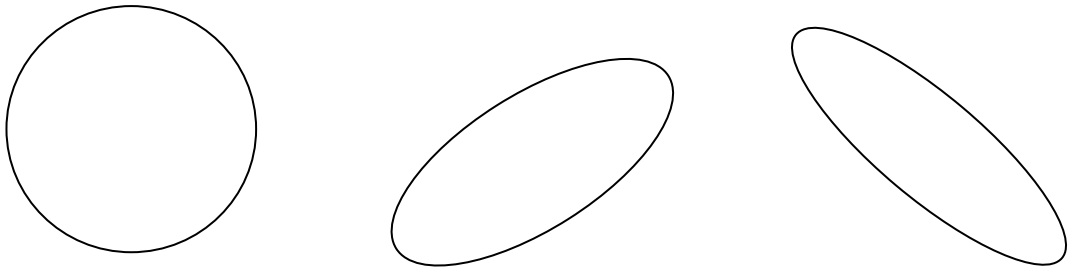


The electromagnetic field is said instead circularly polarized if the electric field is propagated forward and also turning in circle, which ultimately describing a helix.



Since in circular polarization the field rotates in a circle, it follows that has two ways to rotate, one right and one left. Consequently, the helix is described is called, and is, a left helix or a right helix.

What is the right polarization and left polarization depends on which way you look, towards the source or towards the receiver, and is defined by conventions. Obviously, physicists and electrical engineers, just to complicate matters, they chose opposite conventions. I do not will venture to follow one or other agreement or seek to clarify. Undoubtedly, if a thing I call turn left here, we consider that the right will turn there, and this is enough.
(What's not so funny because a large and expensive experiment in England years ago failed because misunderstandings about polarization. Receivers did not receive anything for the confusion that was made on the interpretation of the direction of rotation).
The sum of two circular polarizations travelling in tandem, one right and one left, gives a linear polarization. This, at least, if they are equal in amplitude.
If they are unequal, we obtain all the possible forms of ellipse, more or less inclined, flat, right-handed, left-handed and so on.

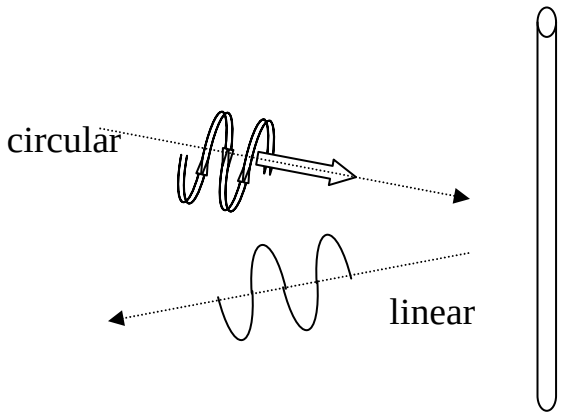


The most general definition of polarization implies the definition of an ellipse of polarization, which provides all possible cases, in particular the extreme cases of linear vertical, linear horizontal, right circular and left circular.

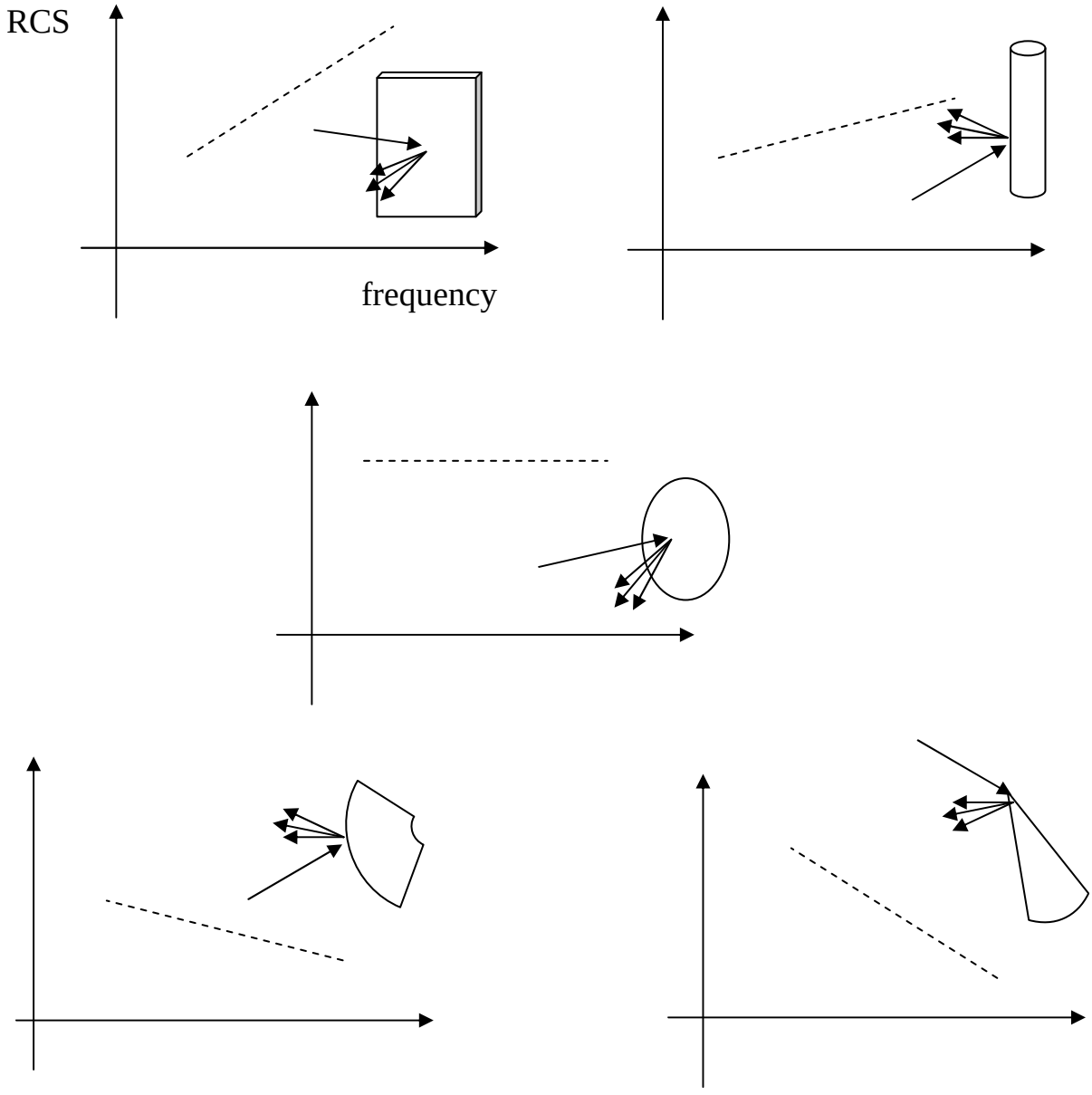
We can now examine what happens when a radar pulse hits the target and generates a reflected signal, because this helps us to see the interaction between two particles.

2.5 The interaction with the target

With a radar sends a packet of electromagnetic waves on a target. We use the terms packet, signal, "wave train", "radar pulse" etc. so as synonyms.
The packet is reflected from the target, intensity and shape depend on how early was made and how the target is made.
The reflected signal "resembles" what has arrived, but has some differences with respect to it. Meanwhile, smaller. We can imagine as if only a portion of what comes back.
In addition to this variation of intensity, the reflected signal undergoes changes in frequency, if the target or target pieces are moving, and polarization.
The change of polarization is expressed by saying that there is a change of polarization ellipse. For example, a incident linear polarization may be reflected in the form, in whole or in part, of circular polarization and so on.
In the radar technique is called a parameter, RCS, “radar cross section” or in its more complete definition “scattering matrix”, which completely determine intensity and type of signal reflected from a target.
We can say that all these variations depend on the forms. What forms?
Meanwhile shapes of the target: This is not only obvious but it is also perfectly calculated in radar technique. You can tell exactly how they affect the shapes of the target.
But we can also bind to the coming signal the concept of form. For example, some incoming circular polarization we can associate to form a helix. If you have a right helix action will different by the polarization that is opposite, the left helix. Opposite polarizations can lead to dramatically different results. And indeed this is what happens.
Another example is that of a linear polarization. If this is vertical and the target has elongated vertical shape, this part of the target will give a strong signal reflection. The opposite happens if one form is horizontal and the other is vertical.
Another example: a circular polarization that would affect a long vertical target completely loses its characteristic of circular polarization. Will be reflected as linear vertical polarization. This case is here represented in the figure.



Now add to this series, the dependence of the reflected signal from frequency. The intensity of the reflected signal depends on the frequency of the incident signal. How? The reflected signal may decrease with increasing frequency. But in other cases the intensity of the reflected signal may also increase, or remain constant. Depends on the shape of the target.
Typical cases are as follows [17].
For a flat plate, the RCS increases greatly with the frequency; for a cylinder, the RCS grows but grows less, for a sphere or egg shape, the RCS remains constant with frequency, for a thin curved edge the RCS decreases, and finally for a tip RCS decreases a lot. The various cases are summarized in Figs. The graphs show the intensity of interaction as a function of frequency.



So far the situation concerning the radar.

Now let's see what happens in the field of elementary particles.
Here we conduct experiments in which they collide particles and study the particles produced. By varying the energy, intensity of interaction increases or remains constant or decreases depending on the type of interacting particles and the "forces" in play. For example, the weak force is ... weak, but the intensity of interaction increases with energy.
Between the particles in play, aptly the available energy is distributed and you can have exchanges of rotation (spin) between the particles involved.
What is the conclusion?
Imagine these particles as radar signals, an incident signal and a reflected signal. The incident particle is the signal that arrives. His energy is the frequency of the signal that arrives. The radar target plays the function of the particle hit. The reflected signal is then emitted a particle. The changes that the particles are subjected correspond to the action of equivalent forces.
At the same time between the incident, reflected particles and target are valid conservation laws, energy, momentum, angular momentum, and so on. All these conservation laws are axioms and general properties of physics that dominate any phenomenon. Energy conservation, for example, says it reaches a certain energy and distributes a bit here and a bit there, but the budget is such that it appears no more or no less than what's available. The conservation of the momentum is said that when a particle strikes the target particle recoils, and once again there will be an equal balance between what is pushed forward and what is being pushed back. The conservation of angular momentum says that there is a balance between the "intensity of rotation". If, for example, what is to come has its own intensity of rotation and a complete loss of rotation takes place the particle hitting the target, then the target particle will forfeit the entire rotation intensity was there before.
We can thus form an image of the interaction between particles. The energy (frequency) of the incident particle, together with shape determines the intensity of interaction and the result of the interaction (what is given out), all under the umbrella of conservation laws.
This way radar signals and radar targets may become visible macroscopic objects to be put in analogy with particles and interactions. The basic idea is that particles and forces are all of electromagnetic nature, light, and appear different due to the size and shape of interacting objects.
We just have to make one last flight of fantasy.
That means we must associate the concept of signal or circuit ..... also to the target. The radar is not so, because the target is immutable. Before the arrival of the radar signal the target has a certain form. After the departure of the reflected signal, the target is always to first. This fact is due to the huge difference in the energy situation that exists between the target and the incident and reflected signals. The incident signal is not able to deform the target. But in the case of the particles we think of the incident signal and target as objects of the same degree of deformability. Are on an

equal footing. Not even know which of them should have the right to be called the target. It follows that the interaction incident particle, particle-target and reflected particle can lead to changes in all three.
So summarizing the interaction with the target allows us to imagine all the possible mechanisms of interaction of elementary particles.
The only thing we have to admit is the existence in the particle shapes.
We can think of spatial objects or electrical circuits of a certain form. If we admit the possibility, for each particle of being a well-defined spatial signal or space circuit, then we can represent the interactions. Of course, all interactions will thus be of electromagnetic nature. We will have electromagnetic interactions between electromagnetic circuits or signals. But these appear, or better will be more or less intense. Could mimic the action of various types of forces that we are different. An electromagnetic force, a strong force, a weak force.
Of course it is not easy to formulate an exact theory of all interactions as electromagnetic interactions. Nor is it said that it is possible. But we just imagine this possibility.
Admit the presence of spatial signals.
But where does the electric charge?
We must justify the presence of electric charge.

Chapter 3
The Moebius strip

In this chapter we will try to make us a model of the electron.

3.1 Electron as a current

Several considerations lead me to believe that as regards the nature we are able not to explain but to modestly tell the world we see, trying to be consistent.
The elements of a story are in observation, and then in the language in which it is said that we have seen.
The language in this case is mathematics. And if the story is done well, the consequences are interesting, sometimes unexpected.
The electric charge is quantized. This means that it has only one elementary charge "e" and jumps of value "e", the electron charge. This is a fact. I certainly do not entertain then groped demonstrate the quantization of charge but only trying to tell something coherent about it.
"I add that the case of electric charge is probably the simplest case, more complete, more accurate, of quantification. There are different masses of atoms and particles, but there is only one electric charge, which is exactly the same in all cases. And this is the only case actually, it is not explained by quantum theory".
The phrase in quotes is not mine, is Schroedinger [4].
Therefore confine ourselves to a finding. There are electricity quanta.
The electron is an elementary quantum of mass or energy "E".
Energy is associated with a frequency through the enigmatic expression *"is equal to h nu"*. The letter "h" is Planck's constant. The Greek letter "nu" is the frequency.
This too must be noted and taken as fact.
So that the electron is an elementary quantum of charge and energy is a fact.
May we tell these two things saying that the electron is a small current?
Let's say a small current that gives a value of charge "e" and energy "E".
If this serves to tell in one fell swoop that there is an elementary charge as well as a elementary energy, would be economic. "Essentia non sunt moltiplicanda praeter necessitatem" said one guy.
It 's relatively absurd to think that there is in nature a small current which is so to speak a current quantum, an elementary current. What is an elementary current? But since there is an elementary charge, and we can not explain, and there is an elementary energy, and we can not explain, I might as well imagine a elementary current explaining both things put together, and in one fell swoop.
A current can justify charge and energy. A moving charge is a current and a current brings power. But you have to verify with numbers. If we put numbers are they plausible? Brutal calculations can be done, just with electronics. It's time for us even though a rough idea of numbers involved.

Under certain extreme simplification [n3] I mean calculation of power dissipated in the resistance of an iron, the result is:

this current should flow in a resistance of about twenty thousand or thirty thousand ohms or so.

This result is already comforting. A priori calculations of this kind could lead to the need for resistance 0.0000000000000001 ohms or 50000000000000000000 ohms which would be awkward to interpret.
20,000 ohms instead is a more reasonable number.
But we see in more detail why we consider it reasonable.
Not so much the number itself, neither great nor small, but because it is relevant to the issue.
If one makes a rough calculation to try to estimate parameters such as DNA, we can reasonably think that the numbers that appear in this calculation have to do with the problem, say, parameters relating to a living cell, the diameter of a molecule but not the length of a Chevrolet or the diameter of a CD of Michael Jackson.
In the case what resistance can be associated with this current?
We are thinking about the possibility that the foundation of Everything there is the electromagnetic field in a vacuum, we imagine that the fundamental particle of matter, electron, electromagnetic field, is a small current, this current should somehow exist in space. A current in a vacuum.
Electromagnetism knows calculate, so to speak, the resistance of vacuum.
It is about 377 ohms. It is Z, "characteristic impedance of the vacuum", one of the fundamental constants of physics.
Certainly, though in a brutal calculation, would be fascinating if we got the numbers the following result:

resistance should be 377 ohms.

Instead the number that is is about twenty or thirty thousand. Patience. The result is not bad, we say that in a sense it is encouraging and lead us not to abandon our hypothesis.
But why thirty thousand?
To be more exact calculations [n3] suggest a formula that gives a resistance of 25,812 ohms.
Z appears in this formula, the characteristic impedance of the vacuum.
Appears then some alpha, which is the "fine structure constant”, a significant number everywhere in the world of atoms. With the necessary calculation, resistance becomes 25,812 ohms.
The appearance of this alpha is not shocking.
But the problem remains.
To continue, we should invent a theory that justifies the presence of this alpha.
The road becomes too contrived to continue.

There needs to realize what is the problem. If a small current to represent the electron that is the most fundamental thing in physics, then it should only appear in this current fundamental constants of physics.
Certainly it is comforting to appear Z.
From this point of view is also comforting to appear alpha.
Alpha is a fundamental constant of physics, rather it is so important that someone believes that the most fundamental of all.
But why should combine these two fundamental constants in order to give rise to this other value of resistance no more 377 ohms but 25,812 ohms?
To make us comfortable?
If these 25,812 ohms were in turn a fundamental constant, should also intervene elsewhere in physics. Should be made in some other physical problem.
Not only.
Should be settled *even more important* than Z and alpha, because they appear directly in the electron.
But among the constants of physics resistance of this value is not there.
The table of physical constants the only resistance that appears is of 377 ohms, the characteristic impedance of the vacuum.
There are no other fundamental resistances.

Or at least *that was the situation before 1980*.

Well then for short we say that a fact occurred in 1980, that at this point is amazing, or at least suggestive.
Indeed, I must be honest and say that there was something that seemed astonishing to me at that time, or at least suggestive.
This resistance to 25,812 ohms was there, but there were not realized. There had never happened under the nose.
Since 1980 a new constant became part of the fundamental physical constants.
A sudden and unexpected discovery has revealed this new fundamental constant. It is precisely this resistance and its value, measured with great precision, was equal to 25,812 ohms, with more and more decimal digits are gradually better known by the refinement of methods measurement.
The discovery happened by chance.
It was measuring the "Hall resistance" [18] on semiconductor materials. The measure involves (.... needless to say) electrons, which give rise to a current moving in a circle under the action of a magnetic field.
The materials were semiconductors, like those of transistors, of various types, from multiple vendors.
Yet it was realized with amazement that changing within certain limits, both the semiconductor material is the magnetic field is the orbit of the electron, measurement gave a value of resistance nailed.
There was faced with a new constant of physics.
In what sense?

Suppose one measures the speed with which comes a radar pulse
First measures when the radar is stationary. Then measures the speed, when the radar is mounted on an aircraft approaching at 500 miles per hour. Then measures the speed when changing radar. Then speeds up the aircraft at 2,000 miles per hour. Then sends a radar pulse to the moon and measures the return time. Then do the same with a laser pulse. The measure gives a nailed value of speed. That is a universal constant of physics, “c”, speed of light.
For our resistance the best current measure provides 25812.807572 ohms, and this is the "von Klitzing constant”, this is the name that has become part of the universal constants of physics. Klaus von Klitzing was the Nobel prize in 1985.

I must reiterate that at the time I was very impressed because when I began to take their first thoughts on a current associated with the electron, the discovery, namely that there was such resistance, had not yet occurred. Here's one that until then had seemed a problem turned into a clue, the clue that the approach was a reasonable approach or at least worthy of attention.

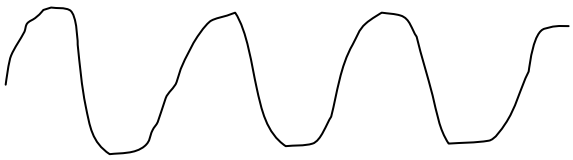
We repeat what we said in brief.
We have expressed a desire to actually think about the possibility that the electron is electromagnetic field.
There are several ways to approach the problem, and we choose a simple approach to electrical engineering.
That the electron energy has and charge and a wavelength associated with is a fact.
The same are also owned by, or attributable to, a current. This is also a fact.
Maxwell invented the displacement current, due to the electric field in vacuum (which in turn was accompanied to a magnetic field), so we can use interchangeably electromagnetic field and current at level of discourse.
Let us consider a simple reasoning for the electron:
let us consider it, *therefore*, as a small current.
This, to represent the electron, should be associated with the movement or transit of a charge, just like the electric charge "e" of the electron, and should justify its passage, as well as the charge, even the mass or energy "E" of the electron.
Electronics teaches us how to calculate energy associated with a current.
By some calculations, to justify the values of the charge and energy, is necessary to invoke an odd value of resistance, in which the current flows.
Calculation shows that 25,812 ohms is needed.
In 1980 he discovered that this fundamental resistance it exists in nature, there is no need to invent a force to support an untenable theory.
It 's the "von Klitzing constant," 25812.807572 ohms, and with this name becomes part of the universal constants of physics.
This is evidence for or at least comforting.
There are other clues?

3.2 An eternal oscillation

If the electron is a small current, this current should circulate forever and be able to exist in empty space.
We should think of a current or a space signal, or you want a space circuit in which this current flows.
Of course it is complex to justify a self-sustaining space circuit in vacuum, but the easiest way to do this is to admit, as a working hypothesis, that is the case, except that we do not know yet write the equations.

Let's see if we can say more about the shape of this current.
How is done this spatial current?
Meanwhile we have a premise, otherwise there is confusion.
We talked about the electromagnetic field in vacuum. Then we talked about current, always in empty space. Then we used the term "spatial signal". Then we talked about space circuit. We used them as synonyms. But actually we can use them interchangeably. For the moment we take note of this, it will resume later in the paragraph 9.1 on "Waves and particles.
Returning to the issue, as is done this spatial current?

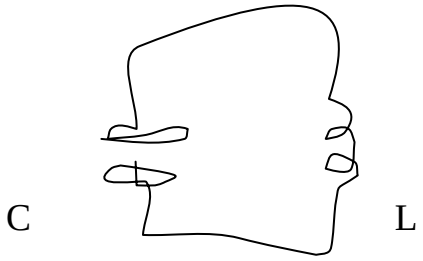
Here we are involved and help the wave characteristics that, in fact, the electron exhibits in the experiments. There may be opinions, interpretations, certainty or debates about what this wave, but the fact is that the electron also shows these characteristics of waves. Consistent with the attempts of others including Hestenes assume that this wave is an electromagnetic wave.
In addition, we assume that the electron *is* this wave.
So the electron oscillates, vibrates, is an electromagnetic wave and its frequency and wavelength are the frequency and wavelength are measured in experiments.



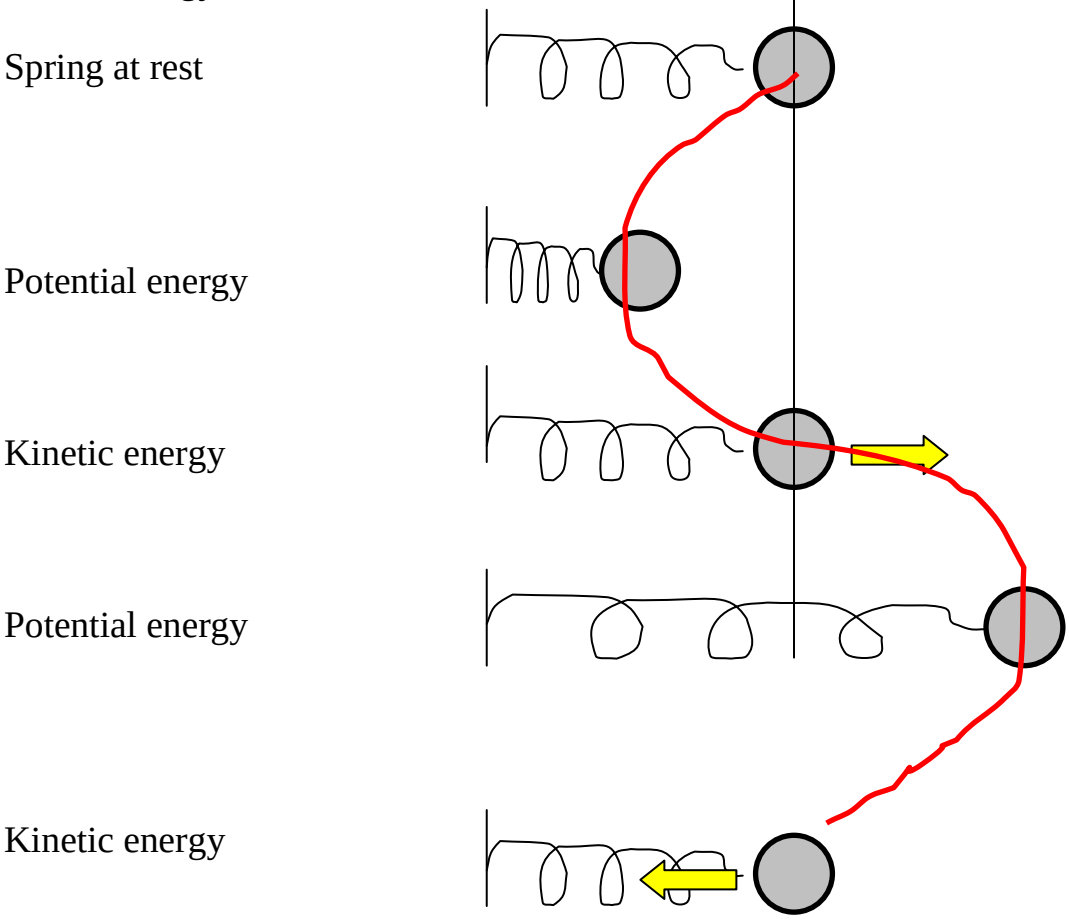
The small current that, in our hypothesis, is the electron, is not only a current, but an *oscillating* current.

With the specific wavelength and the specific frequency.
So to the question "how is made this space current?" to begin with saying that it should be an oscillating current. Moreover since the electron is eternal this current is eternal. Then, since the electron has a mass (energy) that keeps forever, this current should maintain this energy forever.

This helps us a lot because a circuit where a current flows eternally oscillating with a precise frequency, and in which a precise and constant amount of energy is stored is an easy circuit.
It 's an oscillatory circuit L C.
For those who do not even know about what is an oscillatory circuit L C it would be write an interesting book, dedicated only to this. Let's just say two words.
A "L C oscillator" is made with a capacitor C and a coil L. It 's a circuit that requires the presence of pure energy who sits there, forever oscillating between "potential" energy in the capacitor C and "kinetic" energy in the coil L.
The circuit is this:

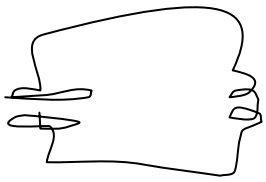


Its mechanical analogue is for example a spring with a mass Or a guitar string that vibrates. The L C circuit can "represent" this spring with the oscillating mass, or if you are pleased the spring with oscillating mass can represent the L C circuit. In the case of the spring, or a guitar string, the energy dribbles between potential energy and kinetic energy as follows:

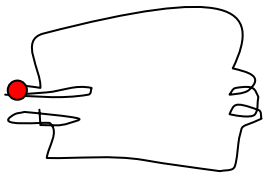


The spring is standing. Compress the spring: his energy is "potential”. It is stored in the spring, full of energy. Release the spring and it snaps and releases its energy. The moment has maximum speed, passing in the same situation when it was at rest, it is neither stretched nor compressed. He still has energy, but its energy is only related to motion, is "kinetic”. Reached its greatest elongation spring stops. Now is tense at best, is ready to snap. Its energy is again "potential”. Etcetera.
Without friction, dissipation, etc., the phenomenon continues indefinitely.
In a L C circuit consider a current in the circuit due to the passage of an electric charge. The energy still dribbles between potential energy, when the capacitor C is charged and ready to discharge, and kinetic energy when the charge runs its maximum speed in the coil L and the capacitor is discharged.

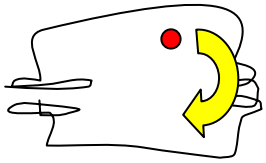
Capacitor discharged



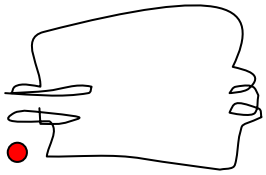
Potential energy



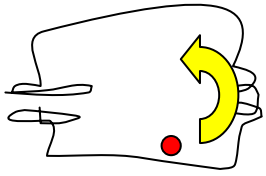
Kinetic energy



Potential energy



Kinetic energy



Without friction, dissipation, etc., the phenomenon continues indefinitely.

All physical quantities involved in these phenomena (current in the circuit, the spring rate, etc.) share the same shape over time. Are oscillations of the form "sinusoidal oscillations". Oscillations theoretically continue indefinitely.
They have been associated with an energy and a very precise frequency. Frequency and energy depend on the parameter values in the circuit.

Summarize.
Electrical engineering or circuit theory teach us to represent and study the so-called equivalent circuits, mathematical models of real circuits. In this case assume an equivalent circuit for the spatial current that should be the electron is easy. This is a simple L C oscillator. It's a circuit that requires the presence of pure energy who sits there, forever oscillating between "potential" energy in the capacitor C and "kinetic" energy in the coil L. The total amount of energy is constant, it simply changes shape constantly. The L C values determine all the parameters of the circuit, oscillation frequency, circuit effective resistance, energy and so on. Note that even here there is a parameter, the "circuit effective resistance" [n4], which has physical dimensions of a resistance, it's measured in ohms. But while it is measured in ohms it do not dissipates the energy. The energy is maintained.

Thus, an oscillatory circuit L C is a good candidate to represent the electron. We do not know the extent to which the L C circuit represents the "physical reality" of the real circuit, but it is certainly a good candidate to perform the function of the equivalent circuit.
It should be clear that the concept of equivalent circuit.
Electrical engineers and systems engineers are accustomed to the concept of "model", "equivalent model" or especially "equivalent circuit".
The physical system of which we build an equivalent circuit, acts relating to his certain parameters like the equivalent circuit.
This speech, deliberately simplistic, however, summarizes key features or limitations of a model:
1-wants to be a representation of the physical system under study only with respect to the parameters examined;
2-does not necessarily fit the geometry or shape or material with it.
Consider, for example, a series of resonant circuits that make the equivalent circuit by the vibration of a bell or a guitar string or the oscillations of a spring.
We are in this situation. We can not be sure of this physical picture of current – electron as a *true* L C circuit. In this sense we have created in effect an equivalent circuit. But the exact reproduction of a flowing current, a current oscillation with a very specific frequency, a stored energy that do not dissipates and remains eternally, all things are well feasible by the equivalent circuit.
In our case the stored energy must be equal to the electron energy E and the frequency of oscillation of the current must be equal to the frequency ν of the electron. To justify this suitable values of parameters L and C are necessary.

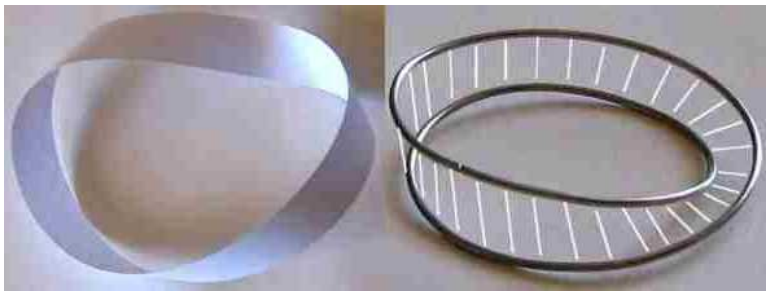
What happens if we put the numbers? You can make calculations with the theory of oscillating circuits. Do some simple assumptions, but, note, are much more advanced than those rough made in the previous paragraph. There is talk roughly of a power dissipated in a resistor. Now the circuit justifies an energy that remains. This is reflected in the fact that the " circuit effective resistance " or characteristic impedance of the circuit is measured in ohms, but it is a resistance that do not dissipates.
For those who want me back in the calculations see Endnotes [n4]. Account here only the result.

a characteristic impedance of 25,812 ohms justify almost exactly the electron energy and frequency.

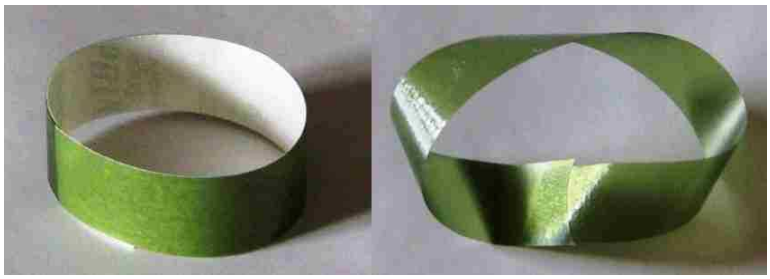
Again, the calculations refer insistently the resistance value *25,812 ohms* already found before.
We hold this as a second clue.
(*almost exactly* means it would take the values of L / C a bit different from those that give us the calculations. This now does not matter, but we take note of this numerical uncertainty, because we shall see later that even with more precise assumptions this will be deleted).
But if this is the equivalent circuit, as can be done but the true circuit?
As we shall see, it suggests a current wound onto itself on a Moebius strip.

3.3 The odd strip

Stubbornly continue to think about the possibility that the electron is electromagnetic field.
At every step, as we shall see, appear helices and a Moebius strip.
Who is he? is a closed strip rewinds on himself after he made a twist of 180 degrees.
This leads to interesting mathematical properties that have made him an object of study several times, and curiosities.
We can easily build at house with a strip of paper or a wire that represents the edge.



We, in the house, realizing that some curious properties.
For example, a normal strip has two surfaces, one inside and one outside.
We stained two different colors. We do the same with a Moebius strip. Color a surface, we realize after a while that .... everything is colored. There is no "inside" and "outside": there is only one surface.



Likewise a Moebius strip has not two edges but a single edge. We can do the test: following the edge with a finger will return to the same point from where we started.

Yet.
We build first a normal closed strip, using paper and glue and then we cut it longitudinally into two parts. Will we get, obviously, two separate closed strips.

This seems obvious enough, and we expect the same thing by repeating the operation with a Moebius strip. But if we do, we get instead ... one strip. Seeing is believing.

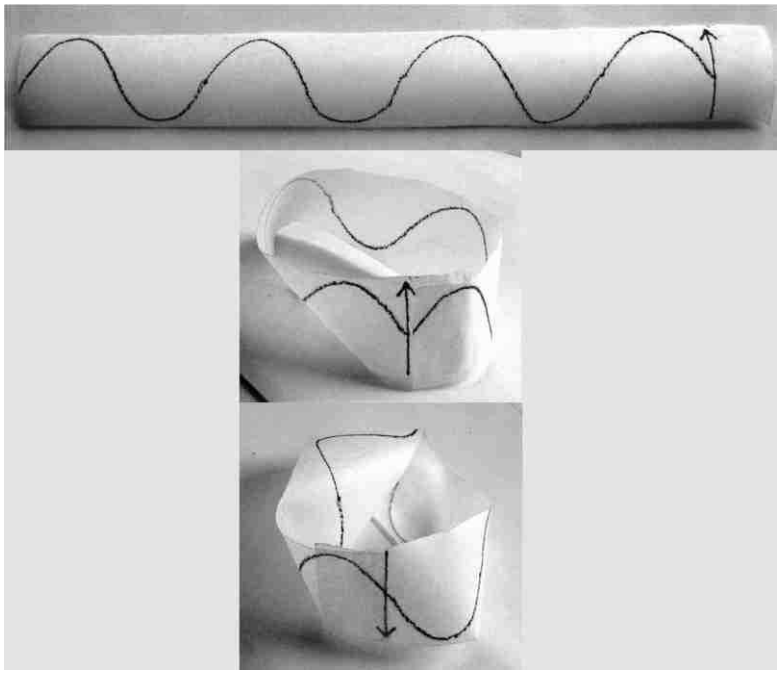
These are just examples of curious properties.
But why it appears here a Moebius strip and what other properties?
We have previously considered a simple argument like this:
"consider a small current".
This, to represent the electron, should be associated with the movement or transit of a charge "e" precisely equal to the charge "e" of the electron, and should possess the energy “E” corresponding to the mass of the electron.
We should think, we said, a current or a spatial signal, or you want a spatial circuit in which this current circulates.
Of course we observed that it’s complex justify a spatial circuit self-sustaining in a vacuum; they may admit, as a working hypothesis, it exists, except that we do not know yet write the equations.
But now we ask: how could it be done?
To introduce stepwise reasoning, we begin to say how an electromagnetic field could justify the passage of an electric charge.
Pulses or "wave trains" or packets of electromagnetic field are usual in radar or telecommunications or waveguides. However, when it passes one is passed no charge. The reason is that the electric field or the current associated with that we can think through the concept of so-called "displacement current" has a zero mean value.

This means that are so many positive cycles as so many negative cycles. If desired, we can also imagine that they are past, throbbing, many positive and negative charges alternate, but the overall picture of what is past tells us that is past a zero charge. Nothing.
Conversely in the case of an electron must justify the passage of a charge.
Then we can, we must think like a small electron current, but with a half-wave "spare" or odd, indicating the passage of a charge. All other offset, but not her.

And then how would the current-electron or electromagnetic field to stay in place, justifying the electron when it is stopped? How does this current to pass but also to stay?
The most obvious is that the electromagnetic field turns on itself.
But if we tie him to the presence of a "odd" half wave , must be on a Moebius strip:

It’s here that can close a wave in wave with any n integer cycles (including zero) *plus half-cycle*. We can convince ourselves of this at home, having fun with various drawings.
With paper and scissors cut a strip and draw a current on the strip that has, for example, seven half-waves (3 whole cycles plus a half-wave). Better if the paper is transparent.
This current could, if desired, run between the two edges of the strip, if these were the two long wires of uninterrupted transmission line, a two-wire line.
(Of course if that were the line is ... electrically charged).
Now collapse the strip on itself as in the figure, the arrow at the top.

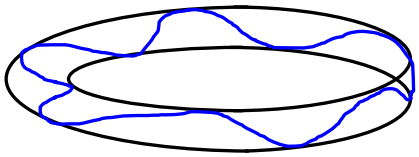
The current wave does not close with continuity between the two wires. Not working. It is no longer a wave.
Now just turn over 180 degrees either end of the strip as shown in the figure, down arrow. Now it works. Wave closes properly on itself and can run indefinitely between the two edges of the strip (.... that are now a single edge, the edge of a Moebius strip).



Now the current wave travels thinking of travelling in a transmission line.

This transmission line never ends.

We have therefore a way in which a current with a odd half-wave can, turning on itself, generate an electrical charge that is in place.
Thus we can provisionally conclude with a model with a current closed in on itself on a Moebius strip.
Made as a current? How many half-waves?
As we know, or rather as we imagined, there must be *an odd number* of half waves.
There are other indications confirm this?



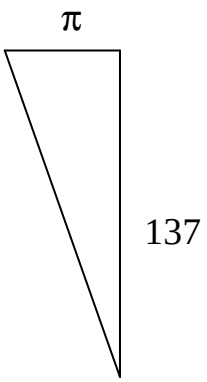
3.4 The fine structure constant

Reasoning of physical nature has so far led to imagine a Moebius strip.
These are just guesses and we will see that even at the end of the book will remain conjecture.
However we will see now that there is another argument altogether, reasoning on the numeric value of the fine structure constant, which leads to the same assumptions of a Moebius strip.
There is a mysterious number in physics which is the fine structure constant.
I have an obligation here to say that when you say such sentences are inevitably a number of people who say that *for them* everything is clear and there is no mystery.
I will leave the reader with the burden and entertainment, consulting papers, books, Internet etc.., to decide what is the truth.
However, the fine structure constant is just a pure number, like pi, ratio of circumference to diameter of a circle, or the number "square root of 2", ratio between the hypotenuse and side of a right triangle with sides of equal length.
But the fine structure constant is a ratio built with quantities which are apparently as potatoes and chocolates, belong to different branches of physics. It 's the ratio between the square of e, the electron electric charge (electricity) and the product of the Planck constant h (quantum mechanics) and the speed of light c (relativity theory). Making the ratio is ... a pure number.
Among other circumstances in which it appears, it (or rather its inverse 137.036) is the ratio between two electron characteristic quantities.
One is "lambda c", the so-called Compton wavelength. This lambda c is the wavelength of the photons they see when they interact with the electron.
The other is "lambda e" calculated by analogy, by equating the electrostatic potential energy of a sphere of charge e with the rest energy of the electron
Note however that "lambda e" is not really a quantity that has ever measured, it is simply defined by the lambda c and the fine-structure constant. So the actual definition of the fine structure constant is that called first.
Speculation on the fine structure constant are wasted: they go from physics to mathematics to esoteric numerology. What is that number? What determines it? What's behind it?
It’s an embarrassing situation. We can not say it is just that number, and not for example the number 429.012 or 13.00061. But this is not so much that embarrasses, or at least not only that. It’s even more embarrassing by the fact that electricity and quantum mechanics with the speed of light which means theory of relativity, appear linked to that number. Clearly, the fine structure constant is sending a message that we have not yet understood.
Richard Feynman said:

:"……. is it related to pi or perhaps to the base of natural logarithms? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man. You might say the "hand of God" wrote that number....."

Einstein was to put first emphasis on this entity, which shows that inexplicable link between quantum mechanics, electromagnetism [n5] and relativity.
The fact is that the fine structure constant is equal to 1 divided by 137.036 ... with more decimal digits that define the value while physics gradually refines its measuring instruments, and nobody knows why.
We come to the point.
I must now confess that I sometimes devoted to the unfortunate discipline that takes the contemptible name, and rightly so, of "numerology", which is to interpret numbers at random with criteria nonsense.
So you can discover, so to speak, that the age of Noah in years divided by pi and then divided by the square root of 2 gives in meters the side of the Cheope pyramid, but similar and comparable results are not make any.
The fine structure constant has long been sacked for catching this sort of cabalistic numbers.
A bit different is the case I was presented. An easy calculation, expressed here in graphical form, provides the following result

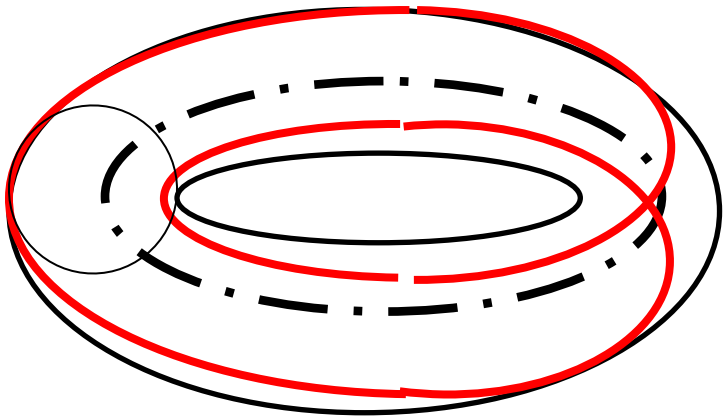
the inverse of the fine structure constant is related to pi and a integer number, 137, and is the hypotenuse of this triangle

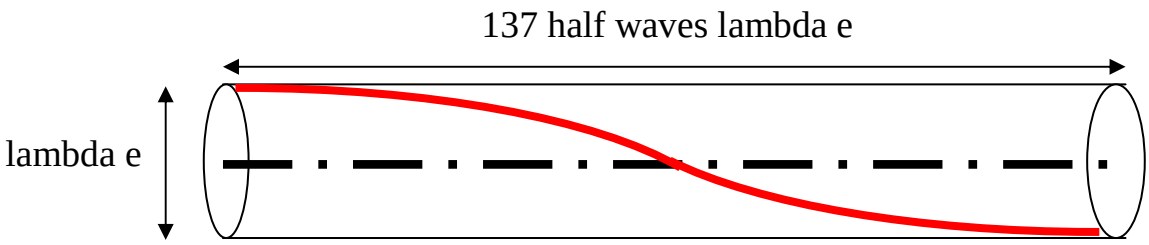


The longest side of the triangle is an integer, exactly 137, while the smaller side ... is pi.
The hypotenuse is then equal to the fine structure constant (its inverse), coinciding with the experimental results with impressive accuracy as discussed later. The calculation is easy. It is with the Pythagorean theorem and a pocket calculator, so the result is 137.0360157.

But how can you justify this integer 137 and pi?
Now in general dimensionless numbers, in mathematical physics, assume a meaning physically or geometrically interpretable. In this case an integer, no matter who is 137 or more, may be somewhat understandable, may be "137 things".
The quantization conditions with integer numbers are usual in physics. When a guitar string vibrates, there are necessarily a integer number of half waves. . For some quantization condition may be needed 137 things, a integer number, and this is plausible.

But why do I see the pi?
The pi was already a clear geometric origin, a ratio of circumference to its diameter. Do not see why it should intervene here. Until we find a geometrical ratio, we consider this "pi" as introduced here ad hoc forced to return things, as if the years of Noah or the pyramid of Cheops. However there is an interpretation, and do not invokes the pyramid of Cheops, but only the electron and even (yes!) a Moebius strip.
A wire lambda c long on a donut with diameter lambda e solve things, but if it is wrapped to give the edge of a Moebius strip.
The donut, "torus" in mathematics, has a diameter lamba e characteristic of the "size" of the electron.
The overall length of the wire is equal to lambda c, the Compton wavelength of the electron.
In two turns is wrapped in helix an entire wavelength. In a turn wraps half wavelength.
Finally on the circle, hatched in the figure is contained exactly a integer number 137 of half-waves lambda e.





It’s quite interesting.
In other words under these conditions are called into question all characteristics quantities of the electron, ie there is no forced introduction of alien quantities.
At the same time it is invoked again the form of the Moebius strip.
All this .....interprets the mysterious relationship that justifies the value of the fine structure constant.
The inverse of the fine structure constant, as shown in a simple geometric calculations, is given by the hypotenuse of that triangle.
The 137.0360157 .... etc. etc. not to be born and then at random but based on a specific geometric model.
Now we say that the fine structure constant is the subject of continuous measures.
A measure of the Germans very accurate [19] gave the value in the 90s 137.0360108 with a percentage difference forty billionths compared to 137.0360157. These values seemed too close because I could think of a simple coincidence. Also, the reference of the Moebius strip seemed impressive. All this seemed to be a strong argument in favor of my hypothesis about the structure of the electron. That in 1998, knowing that worked on the electron structure, communicated via e-mail these calculations to David Hestenes, with the help of my friend and colleague Alberto Bicci. Here attached is the mail:

As you can see I had the following response:

“Thanks for your interesting numerics on the fine structure constant. Of course, no one will give it much credence until it can be derived from equations of motion for the electron and its interaction. I still think that it is possible.
Cheers…D. Hestenes”

Ie: "interesting, but so will not believe no one if you can not write equations to justify all the properties of the electron”.
And because I did not succeed that I decided to write a story.

Bettini
(de Primi)

Bicci Alberto

Da: David Hestenes
Inviato: domenica 15 febbraio 1998 2.51
A: Linea Signature
Oggetto: Re: Consideration on the fine structure constant

Thanks for your interesting numerics on the fine structure constant. Of course, no one will give it much credence until it can be derived from equations of motion for the electron and its interactions. I still think that it is possible.

Cheers.....D. Hestenes

Linea Signature wrote:

> My own activity is radar engineering, but I am interested in physics
> from years.
> I submit some personal considerations concerning the relation between
> the fine-structure-constant alpha and the number:
>
> (1/alpha)=sqrt(n**2 + pi**2)=137.0360157
>
> where n is an odd integer, for example n=137.
> That is derived from the following "admittely primitive" model. In a
> ring torus [1], let the radius from the center of the hole to the
> center of the torus tube be equal to (about) r_c/2 (where lambda_c is
> the Compton wavelength), so that the corresponding circle be exactly
> lambda_e*n/2=lambda_e*137/2, and the tube diameter be lamda_e.
> Let a line on the torus tube have one-half twist in one turn, so that
> it is closed after two complete turns (and one twist). The total
> length of the line is
>
> sqrt((137*lambda_e)**2+(pi*lambda_e)**2)=137.0360157*lambda_e
>
> Let lambda_c be exactly equal to the length of this line (the edge of
> a Mobius strip? [2]).
> The value 137.0360157 is quite close to the experimental value
> 137.0360108 [3] and the model has some similarities and some
> differences (or mistakes) with [4].
> I would be pleased to receive views on these ideas. Any comment would
> be appreciated.
>
> [1] "Torus" http://www.astro.virginia.edu/~eww6n/math/torus.html
> [2] "The Mobius strip and the annulus"
> http://www.geom.umn.edu/~strauss/k/mobius.html
> [3] "New determination of fine-structure-constant using neutrons - PTB
> news 96.2
> [4] "Quantum Mechanics from self interaction" Found. of Physics N. 1,
> 1985
>
> Best regards
>
> Giuliano Bettini
> E-mail: idspisa.signature@tin.it

--
Prof. David Hestenes
Department of Physics and Astronomy
Arizona State University, Box 871504

We can summarize.
In the previous section we had a *physical* reasoning, on a current. Now we made a *numerical* reasoning, quite separate from the previous one, on the fine structure constant. Both lead to the same result. Next we will do a *electrical* reasoning which will still lead to the same result. These clues concomitant become significant.
For readers who were physicists should not ignore the fact follows. Reasoning was introduced in a small wavelength lambda e. It was then brought up an integer number of half wavelengths lambda e. But why should they be in electron?
At short wavelength lambda e joins a large frequency 137.036 times the characteristic frequency of the electron. According to quantum mechanics this leads in parallel to consider a energy or energy at rest or mass equal to 137.036 times the mass of the electron.
Who is she?
In fact this kind of mass in elementary particles exist. There are "blocks of mass" equal to multiples of 137.036 divided by 2 electronic masses, though. ... completely unexplained. The Japanese physicist Nambu had even proposed a formula of the masses of particles that would take account of these blocks [20].
We can therefore conclude that a frequency associated with this short wavelength lambda is not so strange, though undoubtedly it is curious that it already makes its appearance in the geometrical structure of the electron, which these blocks of mass has not.
Blocks of mass so they have the older cousin of the electron, the muon, these he also the pi meson, and this might indicate something.
But go on.

3.5 The wave impedance

Retrace the journey made. We thought the electron as a current produced by an electromagnetic field, but with a odd half-wave passage that justifies the charge. And how does the electron to stay in place? The most obvious is that the electromagnetic field turns on itself, and this must be done on a Moebius strip. A wave drawn on a Moebius strip has indeed necessarily n integers periods plus a “odd” half period. . So we have a way in which a pure electromagnetic field can rotate on itself, justify a charge.
We then saw that if the strip width is lambda e, and is made of an integer number of half-waves 137 lambda, a length of wire that is the strip edge is equal to a Compton wavelength lambda c. This allows you to "get", so to speak, the fine structure constant.
Moreover, considering that lambda c is the wavelength at which the photons "see" the electron, all we have seen is satisfactory.
In at least one book of fiction.
In simple terms what happens? This happens, the model, besides being beautiful, suggests once again the physical parameters of the electron and "calculate" the fine structure constant.
That's all we've seen.

But why the strip should be lambda e wide, which is precisely that number?
To make us comfortable that we match calculations? To enable us to say that we have explained the mystery of the fine structure constant?

Why lambda e? Only to match calculations?

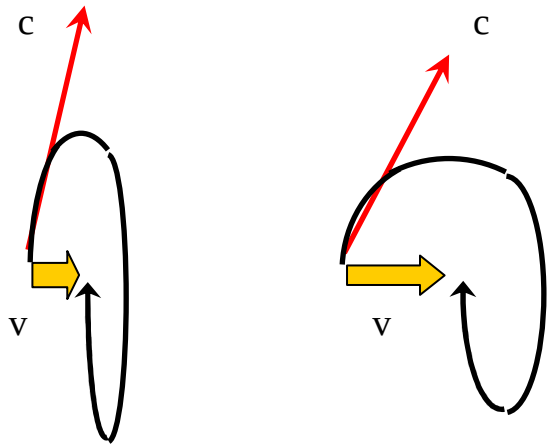
But there is another curious coincidence that justify it.
Summarize and then illustrate.
Electrical calculations we have previously shown the need to intervene to 25,812 ohms resistance. We later discovered that this resistance exists. It has repeatedly intervened in the calculations.
It’s maybe linked to some aspect of the geometry of the strip? What geometric meaning has this value?
Or rather has a geometric meaning?

From what has generated this value to 25,812 ohms?

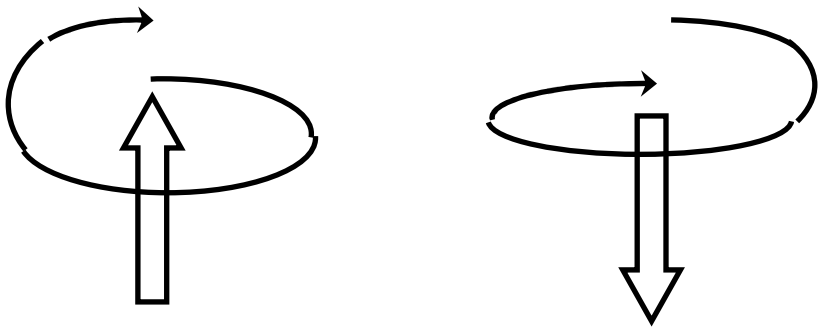
Well, there is evidence that appears to link these two mysteries so that, at least, one explains the other, and are reduced to a mystery just.

The geometry is such that simultaneously needs 25,812 ohms and width lambda e.

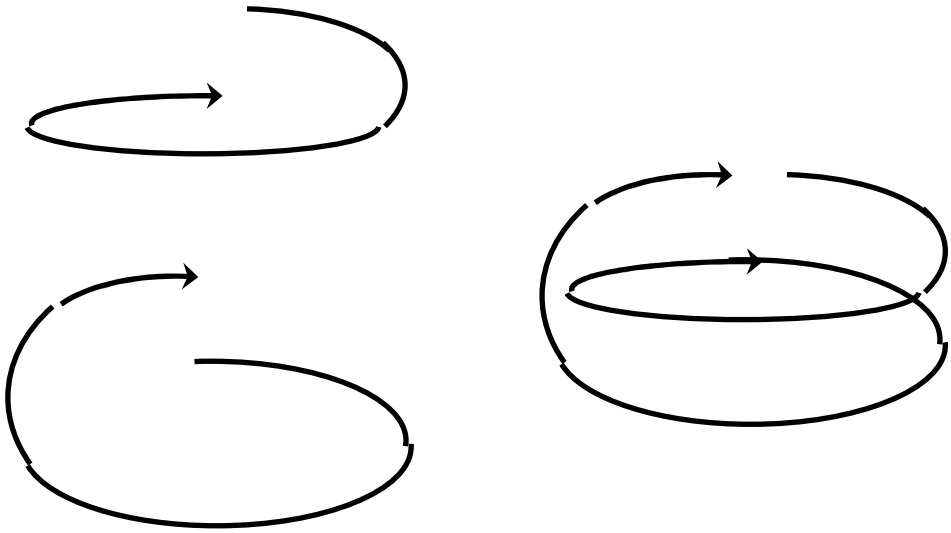
That is not necessary to make two hypotheses to explain things. Given of one, the other necessarily follows.
The clue comes from so-called microwave frequencies technique and it is provided by the waveguide.
Simplifies a little things to make them visible.
Consider the motion of a circularly polarized electromagnetic field in a waveguide.
The theory of waveguides can handle exactly this phenomenon.
We have already described:
the field travels at speed c, but propagates at speed v along the waveguide. It propagates along a helix and, depending on the speed "v" in which advances in the waveguide, the helix is otherwise inclined.



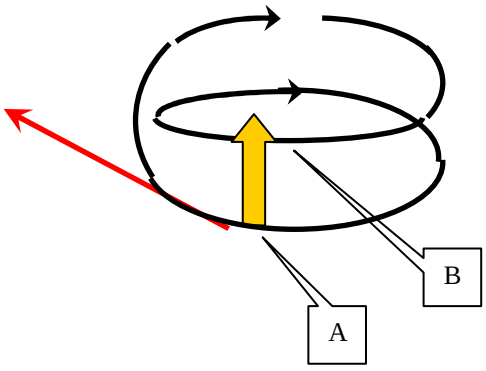
For every angle of the helix waveguide theory binds the value of resistance, the “wave impedance”, impedance seen that the electromagnetic field in its axial movement. Its value can easily be calculated with the theory of waveguides. The value depends on the inclination or the helix, which is the same, the axial velocity v
Let's look at the edge of Moebius strip. If we look carefully in the axial direction, we realize that he's done ... two steps helix, except in this case a helix pitch goes on, and then another step ... goes back.



Perhaps we can persuade better if we manufacture two steps of the helix wire, and then join them to form the edge of the strip. Build it exaggerated, out of scale to better understand and see what it is.



As the travelling electromagnetic field on the strip? We argued, we remember, an electromagnetic field that he is to be equivalent to a current flowing in space, rotates on a circuit in empty space. The field, of course, turn in circles. Then if we look in the axial direction, going back and forth. Pulsating back and forth.
How fast travel?
Consider a, so to speak, part of the field that travels from A to B and then back to A.



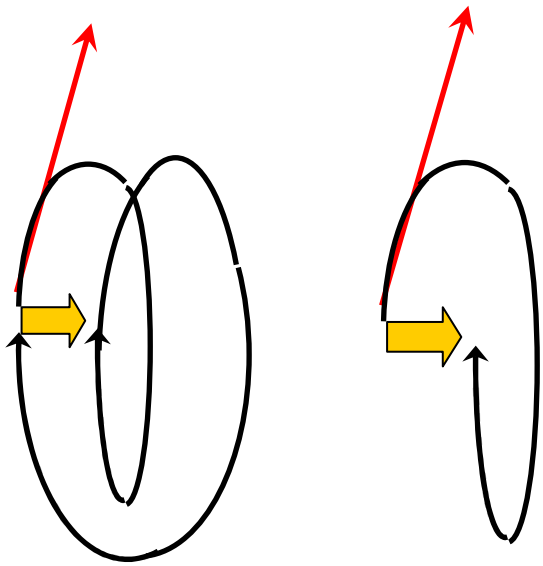
The size of the strip, which we calculated, we are told that the field covered a circle with a total length lambda c the speed of light. At the same time interval, did back and forth for a total journey twice lambda e. The speed in a circle and the speed of

axial displacement are then together in the same ratio c / v is between lambda c and twice lambda lambda e.
We know this ratio, is 137.036 divided by two, equal to 68.518.
Ultimately, the axial velocity v is known. It is 68.518 times smaller than the speed of light.
And then the impedance seen the field?

The theory of waveguides helps us [16]. We saw that in the waveguide is able to calculate the impedance of the electromagnetic field for each value of v.
Here v is known and the answer is:

a velocity v 68.518 times smaller than the speed of light corresponds to 25812 ohms impedance.

This means that the data 25812 ohms is implicit in sizes we calculated for the strip.

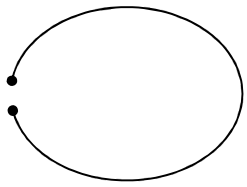


You can think of purely random numerical circumstances, but it is not. This coincidence of the pitch of helix does not show a numerical coincidence, but coincidence of physical behavior.
Everything leads us to think about the propagation of electromagnetic field on the Moebius strip as a wave propagation on a helix which corresponds to an impedance of 25812.8 ohms; the field stepped forward, then come back and gradually batted back and forth. As a L C circuit. Simultaneously the characteristic size of the strip must be in the ratio lambda c / lambda e.
It’s appropriate a consideration. This issue of the Moebius strip is not so interesting for numerical explanations, which may appear the result of a search found in a more or less artificial way, but for providing interpretations of facts and circumstances, that no he's thought to ask. The model provides unintended consequences.
Some we have already found.

It will find others.
Take for example the famous "half spin" of electron, which will be discussed later. It is given a spontaneous interpretation [n9]. Another case that impresses is the electric charge. You can interpret the electrical charge as an internal polarization.
We will see later.
Then the Moebius strip, treated as a distributed parameter circuit, justifies a resonance current with all parameters, *this time exact*, of electron.
This we see now.

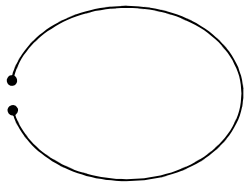
3.6 An eternal movement

Vortices as they imagined? Heisenberg reported that after a conference a spectator had moved closer, thank him because, he said: "You made me realize that the foundation of everything we are small vortexes". Heisenberg had absolutely talked about this, but the spectator was also happy because he had strengthened his conviction.
Trying to imagine a purely electromagnetic constitution for the electron we have been forced or led us images, and that of an electrical spatial circuit has enabled us to support the theory of oscillating circuits, waveguides ..... Now that we have reached a more precise idea of this hypothetical circuit we say more?
We imagined an oscillating circuit or as we say also "resonant". What we had imagined it to be precise a parallel resonant circuit, a circuit that keeps eternally oscillating voltage across it, while inside a circulating current.
It's also what is called a "lumped element circuit", all the electrical characteristics are provided by these values of L and C, which are imagined "concentrated" in the coil and the capacitor. The wire that connects them doesn't matter.
But for very high frequencies involved the question changes: indeed becomes the wire that is important, or ... just the wire makes coil and capacitor.
We can imagine very well if we reconsider the game of dribble of energy that we saw. Without going into too much details to see the most drastic is to repeat the play of energy dribble for a piece of wire.
Consider a piece of wire that is done, for example, like this:

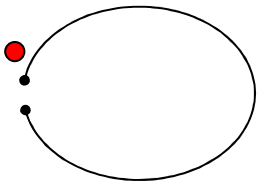


On it we see the same energy dribbling we had seen in oscillatory L C circuit.

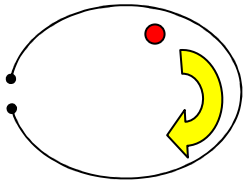
Capacitor discharged



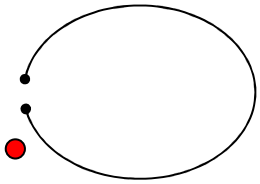
Potential energy



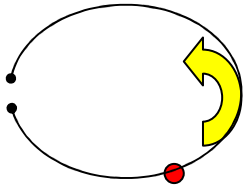
Kinetic energy



Potential energy



Kinetic energy



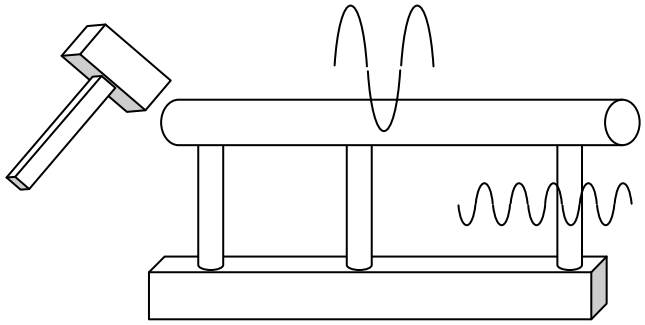
This time the values of L and C are no longer concentrated in the physical elements, coil and capacitor, but are distributed throughout the wire and their value depends on the geometry. This is an example of distributed parameter circuit.
But that means "distributed"? Distributed as? how do we do calculations?
Look at the example we have done. We see ..... a wire. What L and C we have made in the calculations?
In this and other questions, there's an answer. There are various ways of working. One of these is, from a distributed parameter circuit, to create a "lumped element equivalent circuit" [21]. After this we can treat it with the old techniques.
Probably not the case bore the reader with too many details, some exact calculation is in Endnotes [n6]. I can mention the method.

You can build a lumped element equivalent circuit with the method of impulse response. What is it? Explains with an example. Imagine a circuit, or any physical object with distributed parameters that you want the equivalent circuit.

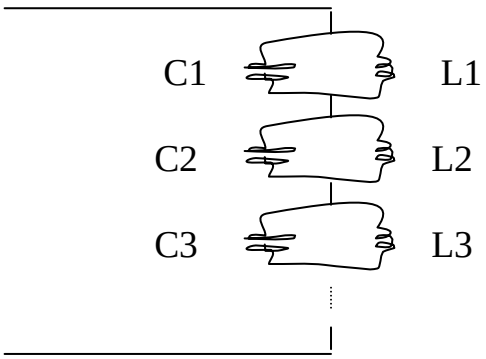
The equivalent circuit, if the object in question does not dissipate but merely vibrate without dissipating energy, will be composed of elements that do not dissipate energy, in practice coils L and capacitors C, but without resistors R which dissipate energy (this assumption is not necessary but serves to clarify the example).
Who can be covered in this study does not dissipate energy but merely react vibrating? We think the metal railing of a balcony with metal wires hang out the laundry, a steel bridge, a guitar with six strings taut and the like. These objects resonate in a first approximation without dissipating. If they vibrate at certain

frequencies or "notes", in the lumped element equivalent circuit more L C oscillators reasonably appear. Each of these will take account of each note.

So how do you find the equivalent circuit of this item?
Conceptually, you give them a big hammer.
The system will vibrate at its characteristic frequency, with characteristic intensity for each frequency. This will identify the equivalent circuit of the L C oscillators.
In practice, the hammer is a mathematic hammer, is the excitation system with a pulse, the "Dirac delta function" (still him, but this has nothing to do with the equation.) The method of reconstruction of the characteristic frequencies is still math.

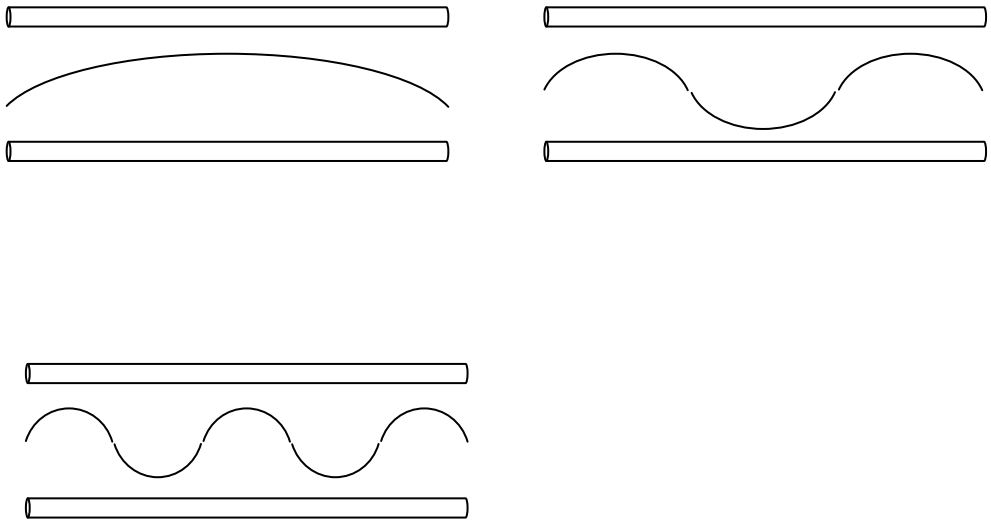


Doing this with the Moebius strip, the result is the following.
The Moebius strip is not equivalent to a simple L C oscillator as we simplistically assumed, but a theoretically infinite number of oscillators; the former has values C1 and L1, L2 and C2 the second and so on.



The first of these is able to resonate at a wavelength lambda c, Compton wavelength of the electron.
The second at a frequency triple, the third at a frequency fivefold and so on.
The result, if we think, it is not strange: it only confirms what we see from the geometry of the Moebius strip and its size, we now know. On it sits a half-wave

lambda c, but also three half-waves, frequency triple, five, quintuple frequency and so forth.



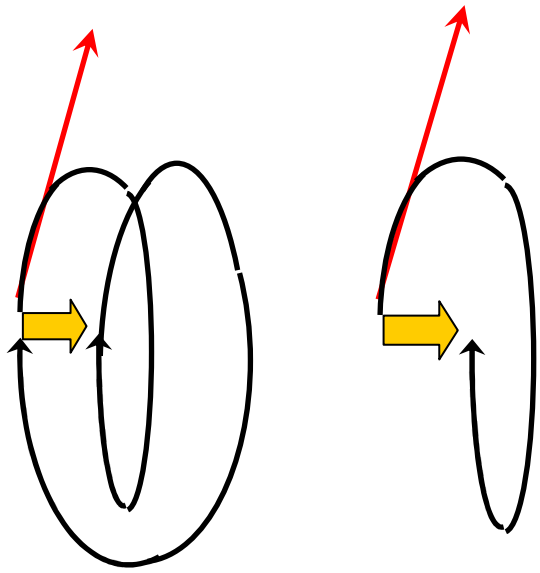
The values of L1 and C1 are now slightly different from those we found, in particular the ratio is different L1/C1. Recall that we said that things were matched *almost exactly*. Now with this more realistic interpretation of the strip, a distributed parameter circuit, the numbers match exactly [n7].

A characteristic impedance of 25,812 ohms justify <u>exactly</u> the electron energy and frequency.

Let us draw a conclusion.
We can claim to have achieved a complete model of the electron? Certainly not.
It's true that the model has a number of attractive properties.
A current travelling in a circle is associated with an energy which corresponds to the electron mass [n8]. The energy in rotation justifies the precise value of the electron spin [n9]. The charge in rotation provides the exact value of the electron magnetic moment [n10]. When everything is in motion are exactly satisfied formulas that provide the mechanical behavior of an elementary particle [n11]. The system, still or in motion, performs exactly the values of wavelength [n12] which provides the "psi" wave of quantum mechanics.
All starting basically from a single hypothesis: there is a current rotation, a rotating electromagnetic field. Apparently it was possible to construct a complete model.
Everything is in place?

Almost. Too bad that none of the calculations made show something.

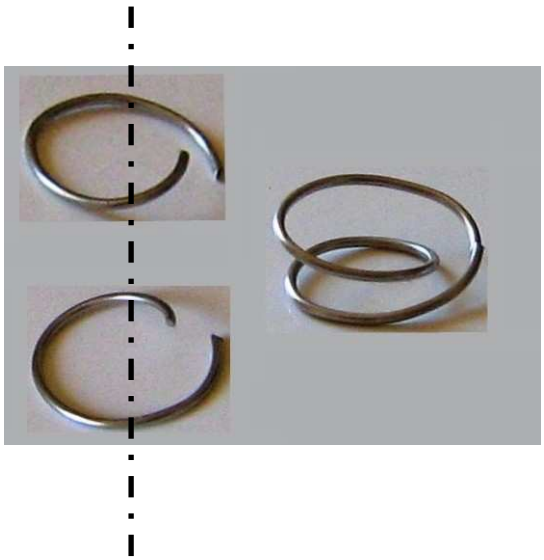
To begin with Maxwell's equations do not provide any electromagnetic field can rotate so. Maxwell's equations do not admit any electromagnetic field that can stay bundled, in a vacuum. We were forced to keep him there, imagining a hypothetical circuit that acted as a constraint.
Also known as the calculations that we have mentioned are together at the very least questionable. It can not be used from time to time electronics, the theory of waveguides, the theory of transmission lines or distributed parameters circuits or quantum mechanics, in a disjointed and without a consistent pattern as a whole. This when there was possible.
Finally, even when taken one at a time known as the calculations are debatable. Are not able to really prove something. We can only say that with certain simplifying assumptions, which in turn are made, the similarities appear, it seems that the numbers match.
Clues.
Clues that suggest the structure of the electron.
We could say we have not stringent equations. Patience. But we have the electron that it is there to suggest that may be made so.
This is legitimate in a fantasy story.



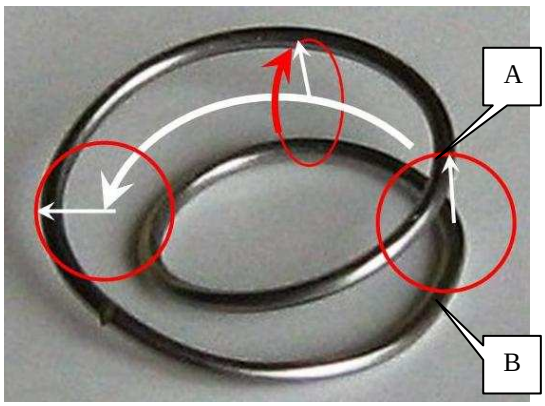
Chapter 4
The Hestenes model

4.1 Go-go helices

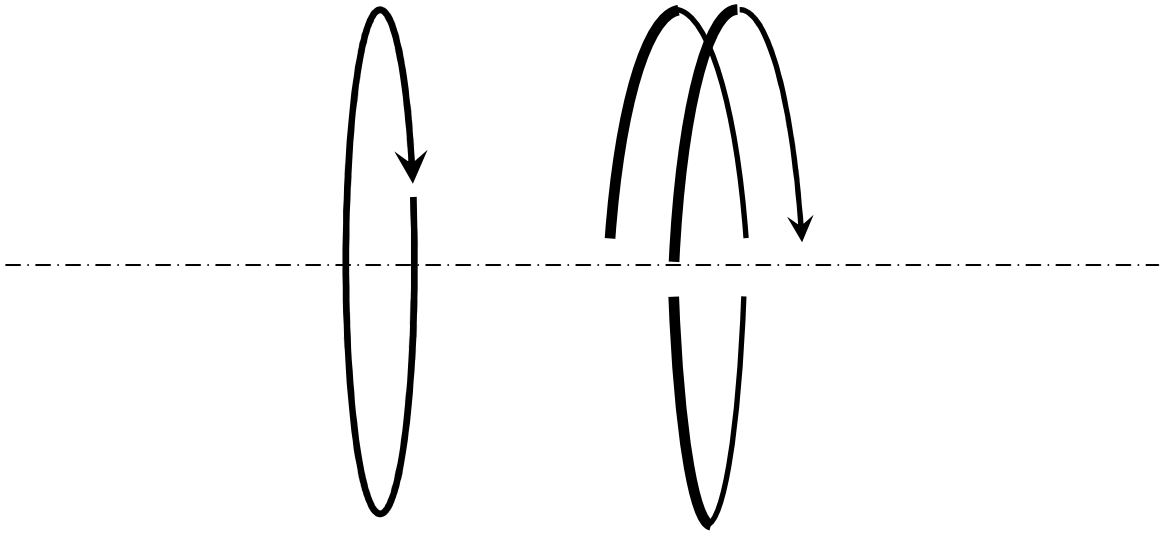
Exhibit now the electron model of Hestenes but first, to avoid confusion, we specify the context in which on several occasions used the word "helix".
We have already spoken of helices, and still happen to him. We start from the last case seen. We said that watching the strip in the axial direction, the direction of the dashed line, one sees that is made of two steps helix. This is undoubtedly a helix. A large helix. It 's already happened to use the word "helix" to refer to this helix.



It’s lawful but read a second helix screw. Suppose you run the wire from A to B and then back to A (see figure). You will find that we are running, internally, along an helix. This is a small diameter helix, an helix inside. In this case also we use the word "helix”.



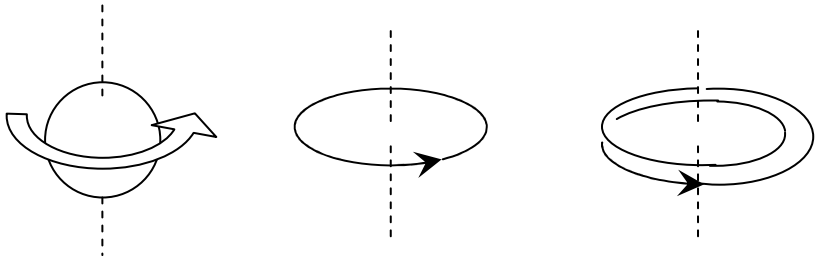
There is a third case, is the case of something that is standing rotated in circles. We see a circular motion. If this something goes in motion, instead of a circle we will see a helix.
It's the situation we encountered talking about the electromagnetic field in a circular waveguide.



It’s important to understand in any case what kind of helix is talking about.
The helices are mentioned Hestenes of the latter type.
With these clarifications, we turn to expose the Hestenes model proposed for the electron.

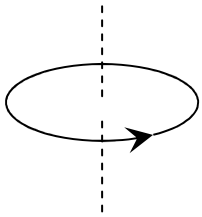
4.2-"Still running!"

We have accumulated many clues. It is sometimes said "three clues as a proof", but in engineering and physics three, or four, or many clues do not constitute evidence. Remaining clues.
We fantasized about the possibility that the electron has that structure. By reasoning entirely different David Hestenes assumes and proposes a model in some ways resembling, both in structure and in numbers.
To put it roughly and in a nutshell, the model assumes that the electron is made of electromagnetic field that rotates in a circle.
You say: "Again!" ...
In fact, reflections of humanity sometimes have a curious thing. It is noted that often, just before a discovery, many of us were arguing over.
Hestenes speaks [11] "multiple discoveries".
He refers to another topic, but the concept is general. A discovery is when the time is ripe to occur. In a sense it is noted that when a discovery is, well, at that time the environment has made it almost inevitable. Many people are thinking over there. Many people, in different places and different times, are persistently making the same arguments.
Probably, says Hestenes, this is an extreme point of view, but it is the extreme opposite of the equally exaggerated, which gives a discovery to the single stroke of genius of an isolated individual.
In this case instead of multiple discoveries we could talk about persistent ideas.
There was in fact no discovery that so far has been able to, as Einstein said, make us really understand the electron. But there are persistent ideas. A persistent idea is that something that runs in circles.

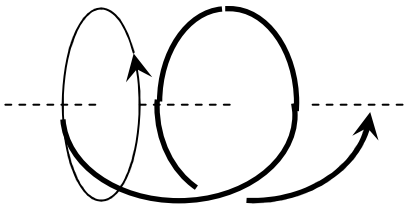


Many physicists tell us that it is naive, or wrong, think of the electron as a something that runs in circles. But the electron shows the properties of something that rotates. Almost all popular treaties of quantum mechanics tell us much the same thing: electron for some of his property is like a top, but do not imagine it is really a top.
The reasons for this inability are many. One, not the last, is as follows. Something that runs in circles has an "angular momentum". The angular momentum is a quantity, to put it approximate, to measure the intensity rotation.
The electron shows an angular momentum, the spin of the electron.

But if it is considered a top, a ball that turns round, and make calculations of the spin, does not add up. The electron has spin half of what it should, if it were a top.
Conclusion: for this and many other reasons is naive and wrong to think the electron as something that turns round like a top. Persico [22] writes, back in '39: "This model was soon forced to leave ..".
But some physicists have stubbornly continued to think of something that turns round. In recent decades this idea has become insistent.
Many in different times and places, have proposed a physical picture of the electron as something that turns round. One such is David Hestenes.
The work of Hestenes touch various topics, carried out with the new math, which he invented, or rediscovered, as he says sometimes, that reworks the Clifford algebra [23]. For nearly forty years the innovative work of Hestenes has been little consideration except by a crowd of enthusiastic supporters in Cambridge [24].
However in 2000 he finally obtained an important recognition from the academic world, the Oersted Medal for teaching physics. This is a premium less known to the public than the Nobel, but that in the past has honored celebrities including for example, Oppenheimer, Richard Feynman, Arnold Sommerfeld among many.
David Hestenes as we have said has worked hard on an interpretative model of the electron.
Probably the paper that best expresses his ideas is "Quantum Mechanics from Self - Interaction [5], although later, he said [25] “despite its shortcomings”. In [26] is given a definitive interpretation mathematically "well - grounded" of the Dirac theory on the basis of these ideas.
He begins by quantum mechanics.
In [5] he says:
“We note that a literal interpretation of the zbw (zitterbewegun, a concept introduced by Schrödinger to explain certain high frequency oscillations that arise in Dirac's electron theory) *implies that the electron is the seat of an oscillating bound electromagnetic field similar to de Broglie's pilot wave”*.
Later he says that the zbw is a circular motion whose circumference is lambda c, the Compton wavelength of electron. and whose center we can call zbw center.



Then he says that the trajectory of the electron in motion is a helix that wraps around the zbw center motion.



In [27] there is a further exposure of ideas, summarizing in my own words:

The Dirac theory suggests something that rotates. Physicists want to understand if indeed the electron can be interpreted as something that rotates. Some physicists have tried to interpret the electron as a small rotating ball. But this introduces a number of theoretical complications and does not help much. Together with Asim Barut (note: another physicist*) and others I think it is much more promising the following idea. The electron is thought of as a massless point particle and electric charge q = e, executing a very minute helical motion, called zbw, which is the origin of the spin. The static electric field of the electron is the average value of an oscillating electromagnetic field generated by this zbw motion. The frequency of this electromagnetic field is equal to the electron de Broglie frequency. We face therefore a new version of wave – particle duality, where the electron is a spinning, electrically charged particle to which this high frequency electromagnetic field is permanently attached.*

Then we find in [5]:

"Thus, we surmise that the electron mass and spin can be identified with the energy and angular momentum of electromagnetic self-interaction. (....) To solve the self-interaction problem and explain the zbw, it will presumably be necessary to begin with a suitable electron equation of motion coupled to electromagnetic field equations".

Summing.
Hestenes examine the possibility that the Dirac equation, wich in quantum mechanics describes the electron, say something about the physical structure of the electron.
The electron according to him:
when it is stationary, rotates in a circle on a circle whose circumference is lambda c;
when he travels, describes a helix;
its "pilot wave" is identified with the electromagnetic field.
With this following Hestenes, material particles and between them the electron first should be described by a theory that admits:

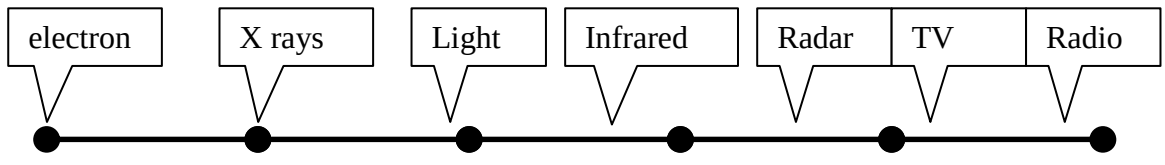
"… bound (or standing) electromagnetic waves, the pilot waves attached to every particle".

with equations that says Hestenes [5], at this time not even try to write ("*No attempt to divine such equations will be made here*")

4.3 The evolution of the model

There is no need to enter details on the mathematical model of Hestenes, but we try to tell it in terms that might not be strict, but serve to illustrate the idea.
The model assumes that the electron is made up of oscillating electromagnetic field, plus a massless point particle with electric charge. The electromagnetic field which is discussed here is a standard field as usual. We can think of an electromagnetic field such as television, radar, or light waves. Its frequency is dramatically higher than that of television, radar, or light waves. This electromagnetic field, therefore, as it were "neutral," not in itself justify the electric charge.

Where is the electric charge? He says Hestenes in the massless point particle moving on a circle. As it was not otherwise justified the electric charge, we are forced to buckle "e" electric charge of the electron, to the rotating point, as the number written on the shirt of a cyclist.
These two entities, the rotating point that warrants only the electric charge and the electromagnetic field, coexist. How do they coexist? It would, says Hestenes, the appropriate equations that we have not, but the mechanism is clear. Let's say they are self sustaining with one another. The rotating electric charge generates the field. The field holds the rotating electric charge, without running away.
The electromagnetic interaction between the two, charge and field, generates the mass and spin. They mass and spin, then have electromagnetic origin.
The oscillation frequency of the field is equal to the rotation frequency in the circulation of electric charge. As we said this frequency is very high. While the circle on which the rotation is a very small circle.
Let's see a figure. In the figure the frequency varies with each ball a thousand times, and so does the wavelength.



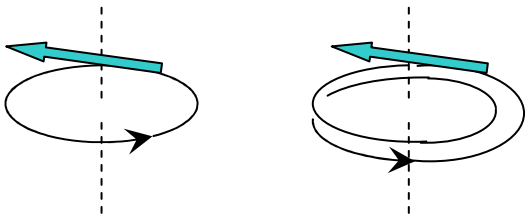
0,01 Angstrom 10 Angstrom 1micron 1 mm 1 meter 1 kmeter
3 Giga Hz 3 Mega Hz

The size of the circle, has undergone some changes among the first ideas of Hestenes [5] and subsequent works. Even here there is no need to get into details, but we display the results.

Hestenes at first assumed that the circumference of the circle was equal to the wavelength lambda c.
He later revised his ideas.
The circumference of the circle equals half a wavelength lambda c.
You say: exciting!
Indeed, the fact that the size is changed by a wavelength lambda c to half a wavelength lambda c is not in itself very exciting.
It's always a tiny circle.
But note this:

on the circle sits a half-wave lambda c, as in the model with the Moebius strip.

Turning, finally, is the speed of light.
We can make a final confrontation between the two models. Both have the same size. Both involve a movement at the speed of light.
Who runs?
In the Hestenes model circulates a massless point leading written "I am the electric charge q = e". In the model with the Moebius strip runs a half-wave of current, which equals the flow of electric charge q = e.



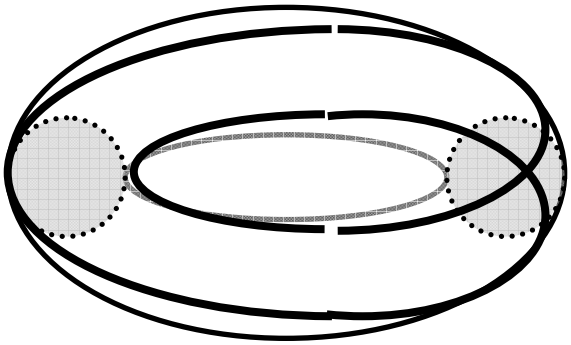
Overall, the final result of the two models become similar. But there is one important consequence. The model with the Moebius strip has an internal structure. Brings more complex geometrical information. This information is to be interpreted.

4.4-Other models

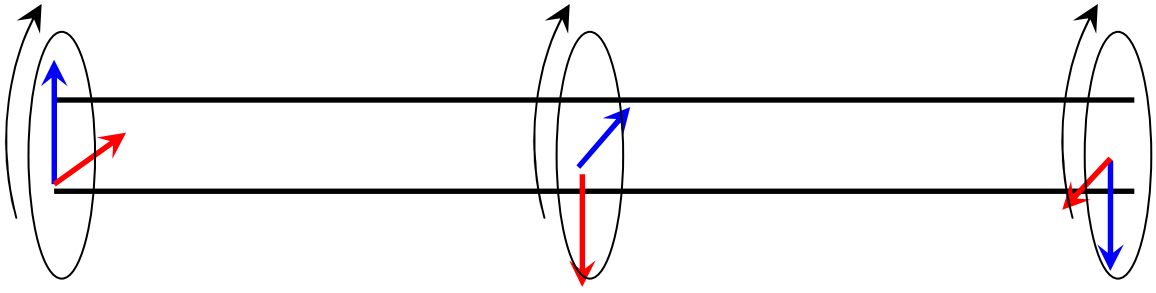
"…the same scientific discovery is frequently made by two or more people working independently. (….) Moreover, the more important the discovery, the more likely it is to be multiple".D. Hestenes [11].

From one point of view is almost unbelievable that a lot of people (speaking of scientists and physicists) whisk head, a bit 'of years now, the same ideas.
What we talked about? If I wanted easy I would say helices, waveguide analogies and trapped light.
The electron is trapped light. The helical movement, we have presented the example of waveguides, to justify the properties of the particle. These and similar ideas are recurrent. The light wraps around itself and stays there, and forms matter. The shape of the helix on which the motion of light is constant, explain the situation using formulas.
All this is disruptive. The electron is so. Everything else follows on the wheel and it is so. We are light. For a pure technological fact, not of principle, we are not able to modulate the electromagnetic field to achieve things. . But someone might be able. Or someone has already done. No scientific revolution has never been this size. These extreme consequences are not talking. I think you have fear of ridicule, is afraid of exposing themselves, you have fear of drawing conclusions. And yet ..... the electron is trapped light. Already say this, regardless of philosophical considerations about the extreme consequences, is a form of heresy. Therefore it is said with caution. Form of hypotheses. However the idea is insistent. Some people exposed to publish it.
The shape of the helix is also proposed with insistence. Nature has chosen the helix structure for DNA, and several other structures in biology. But the helix has its own natural inclination to explain, using formulas, properties observed in the particles. What strikes, needless to say, against a number of theoretical difficulties and drawbacks. But even this is an idea that, despite the difficulties, many ventured to exhibit.

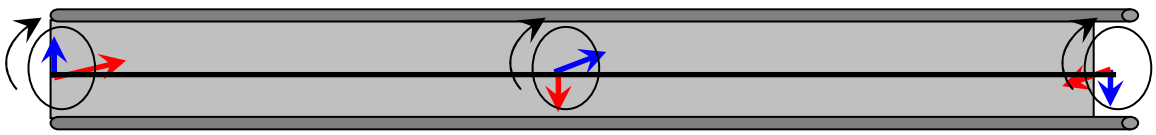
I will make only two examples [28], plus a third [29] that was recently put to my attention by my friend and colleague Riccardo Rauber .
The first is the trapped light.
Williamson and van der Mark, the first of the University of Glasgow and the second of Philips Research Laboratories in Einhdoven make explicit the assumptions of the trapped light. The reference paper is "Is the electron a photon with toroidal topology?" [28], published in the Annales de la Fondation Louis de Broglie.
It is assumed that the electron is an electromagnetic field, a photon, which turns on itself. The model resembles closely to that presented here. In particular, it's assumed the electromagnetic field trajectories that wrap up a donut (torus). It is never quoted a Moebius strip, but so are these lines, just like in the following picture:



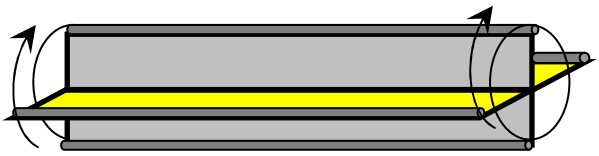
All of the "justifications" brought in support of the model are debatable, but basically the idea is very clear.
A electromagnetic field, a single photon as the authors say, is wrapped around itself and justify the mass, spin, magnetic moment and electric charge.
The authors also present an imaginative and interesting visual idea of how magnetic moment and electric charge could arise. This sums up how I understand.
I make a provisional statement: “imagine a strip and a circular polarization, a circularly polarized photon, which propagates along it”.



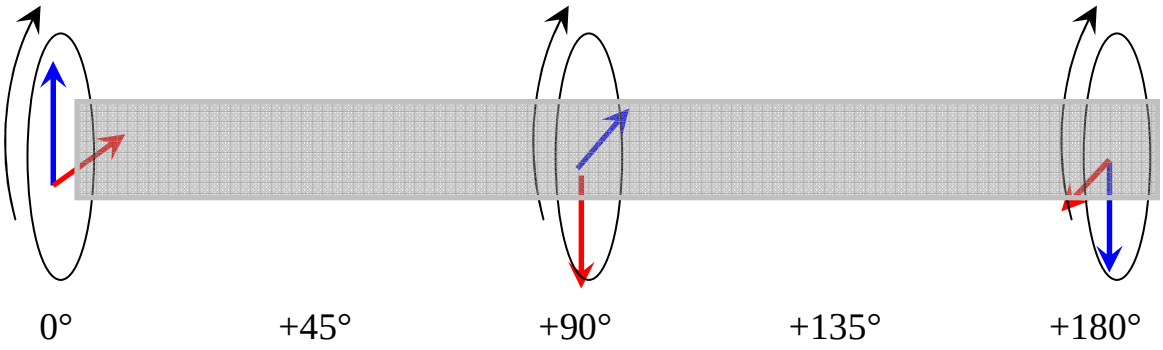
To be more precise we can not speak of "strip" but two-wire line (which wire are the edges of the strip).



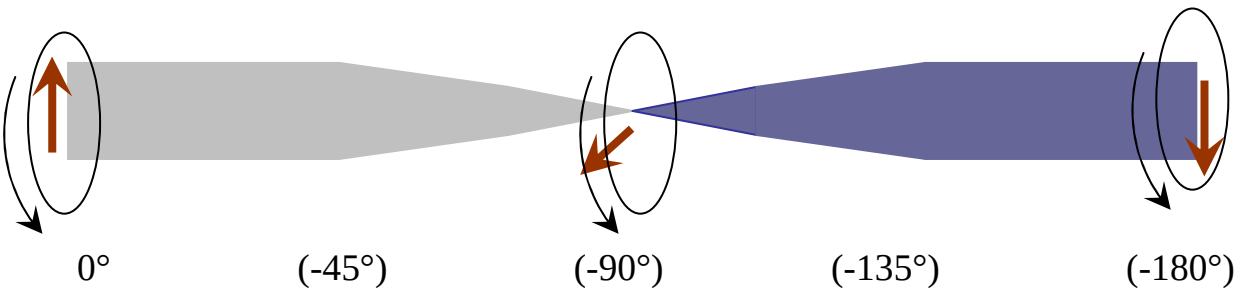
For the experts add that yet so it is not yet satisfactory, because a two-wire line would support a vertical linear polarization and not circular. So to support a circular imagine to have and to build a four-wire line, on which can now truly propagate a circular polarization by means of its components H and V.



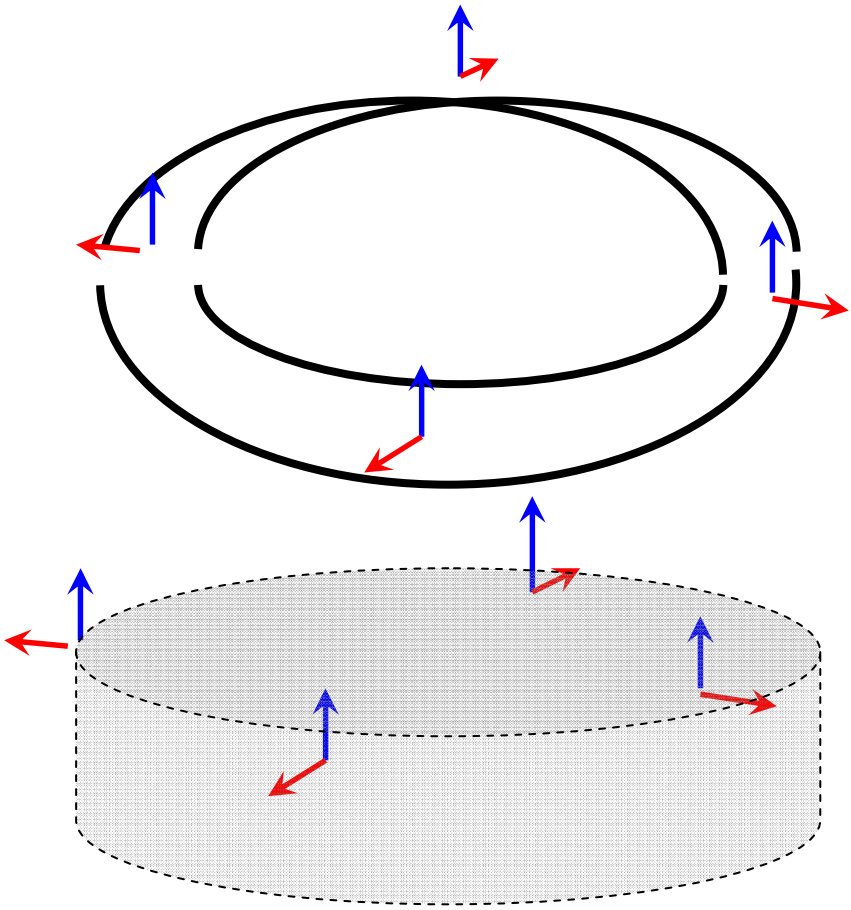
Clarified the situation, for practical exposure will continue to speak of "strip", and always for convenience will continue to draw a strip.
Consider then a strip and on it an electromagnetic wave in circular polarization. For example in the figure the electric field is red and blue magnetic field, the wave propagates from left to right and advancing spins counterclockwise.



I for a more considered piece of strip or a portion of the wave equal to half wavelength. The fields rotate counterclockwise as depicted in the figure, 0° and 90° and then 180°.
Close the strip in a circle. The only way in which we can think to close the strip respecting the boundary conditions is to close it in a circle after torsion of 180°. In this way, however, are not only satisfied the boundary conditions, but it happens more. Perform a twist of the tape (before closing) that are clockwise, contrary to the rotation of the field, ie 0° and then (-90°) and (-180°). In the drawing, the brown arrow represents the twist of the strip.



Let us now consider the vicissitudes of the fields along the circumference so closed (which measures half a wavelength).
Consider for example the magnetic field (blue) starting from the vertical position. After a quarter wavelength the magnetic field in circular polarization rotated +90 degrees counterclockwise. But the structure that supports it has been twisted in the opposite sense (-90°). Therefore, the magnetic field ..... is always vertical.
The same happens in any other point on the circumference, and therefore the structure performs as a whole, a DC component of vertical magnetic field.
By the same reasoning is that the electric field, if the start was directed outward, is directed outward.

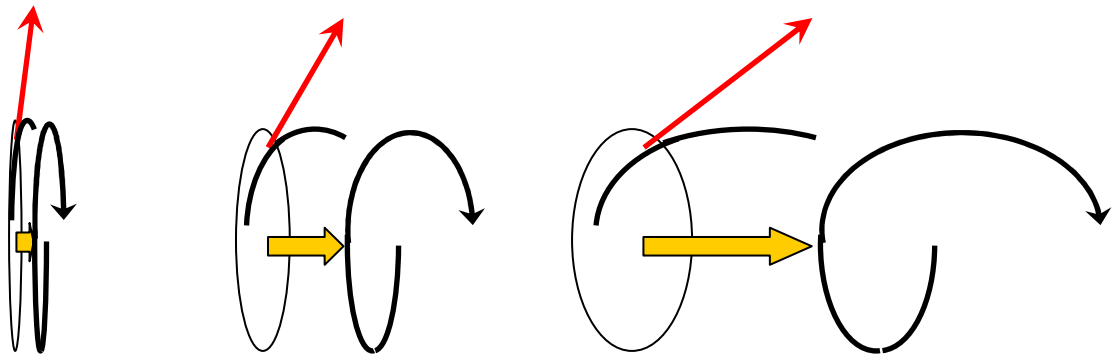


Also for the experts the final situation respond visually and with a little imagination even to the question:

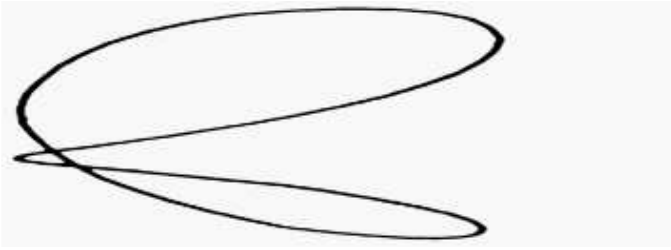
"Based on Maxwell equations the charge should result from a nonzero flow of electric field incoming (or outgoing) from a closed volume. How is that?".

We obtained a magnetic field that remains vertical, and an electric field that keeps outgoing outwards.
Thus a single photon, in itself not electrically charged, it exhibits precisely the properties expected for an electron (here, a positive electron, a positron).

We come to the second example, the shape of the helix.
The shape of the helix is supported by TS Natarajan (Department of Physics, Indian Institute of Technology). In his paper "Do Quantum Particles Have a structure?" [28], Natarajan presents ideas virtually identical to those we have exposed here.
Again, the "justifications" are given a debatable, but basically the idea is very clear. The idea is that I've exposed here with the analogy of the electromagnetic field in the waveguide. Are thus justified the properties displayed by the particle in obedience to the theory of relativity and quantum mechanics. Of course not given any explanation for the electrical charge, nor could, as we have seen.



Here I must add a third significant example, Qiu-Hong Hu, "The nature of the electron", [29]. This work has been put to my attention by my friend and colleague Riccardo Rauber, during the English translation of my book. I was impressed, and I quote briefly. It cited a particular helix, *a closed two-turns helix, a so called Hubius Helix*, but rapidly recognized as the edge of a Moebius strip *("the edge of a Mobius strip is a Hubius Helix ")*. Here's a drawing.



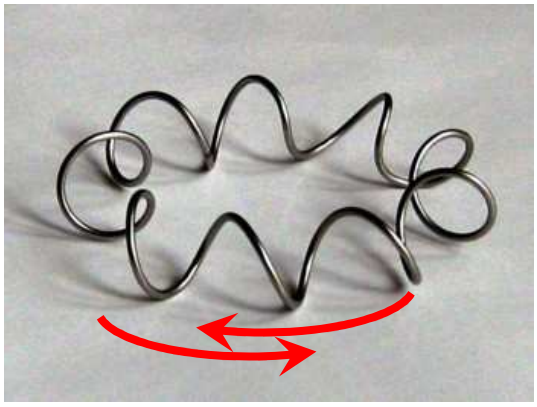
The properties of electron are generated by the *circulatory motion of a mass-less particle at a speed of light on helix*. Many other data, including numeric, coincide with the model proposed to me. Perhaps the main difference lies in the mass-less particle running at a speed of light on helix. This work struck me, I was very impressed, because the model of Qiu Hong Hu is basically identical to mine, also in numbers. Also, something I was very impressed, neither was aware of the work of the other.
This recalls the earlier remark about "multiple discoveries" or "persistent ideas".

4.5 Comparisons

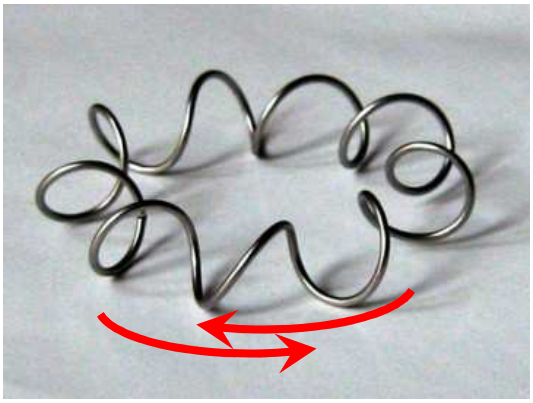
Confine ourselves to a final confrontation with the Hestenes model.
What Hestenes says is much more complicated and I apologize to him for doing so brutal, but in summary, as we have seen, mentions in geometry and in the spirit the model to which we arrived here but according to considerations undoubtedly primitive.
Remembers almost anything.
Except in the Moebius strip.
If we consider a purely geometric, the Moebius strip is .... a more complicated than a simple circle.
Here is one more twist that the electromagnetic field undergoes as it rotates in a circle.
The twist of the Moebius strip implies that any wave drawn on it inevitably also rotates internally. But geometrically it means?

There is more an internal helix to be interpreted.

Moreover, if you wrap a helix on a donut, there are four situations.
In fact, two types of helix , a right helix and a left helix, each of which can be travelled in both directions for a total of four different situations.
In a figure drawn on a sheet is difficult to do with reason, but it is obvious that for any way to spin inside, there are two possible directions.



right helix



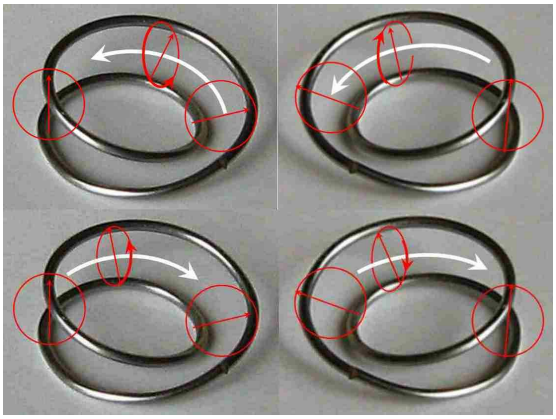
left helix

We can also notice an interesting property, which we summarize as follows:
the left helix (or right) is an intrinsically left object (or right), which is that is going through it one way or another.
You can clearly see from the figures. We observe for example the right helix.
If I walk in a circle following the arrow that rotates clockwise, I walk a right helix. If I walk in a circle following the other arrow, rotating counterclockwise,..... I walk always a right helix. How do you justify these four types of situation? For the moment's just say that there is internal rotation to be interpreted.

But perhaps we can say more.
The most obvious that come to mind is that can be linked to the electric charge.
May we think that a change of internal rotation changes the charge?
Use interchangeably the terms "internal polarization", "internal helix" or "internal rotation". A careful examination of the things we show a connection between the charge and the internal rotation is reasonable. Indeed, a closer examination shows that this connection is required from what we said. It is not only possible but necessary based on what we said. Simply had not noticed.
We are saying that the connection charge = internal polarization is not absolutely mandatory, but is mandatory if one accepts the model. Ie if one accepts the model there is no need for any further assumptions about the connection between charge and internal rotation: This connection is already there.
The connection is established from the odd half-wave.
Indeed retrace more carefully what we said.
We have associated the electron with a small current, then we saw that the charge to represent this current may not have even number of half-waves, we need a half-wave odd. So the presence of charge implies a half wave odd.
But any waveform with a half-wave odd to wrap on itself, can not wrap on a standard closed strip, but must wrap on a Moebius strip that *internally must twist*.
So a half wave odd necessarily imply the presence of internal rotation, an internal helix. So summarizing the sequence of reasoning required is:

Charge =odd half wave=Moebius strip=internal helix

Among other things this allows us time to review the four structures we have seen is consistent with a Moebius strip.
Two have internal helix opposite to the other two. In light of the current interpretation, two must be regarded negatively charged and two positively charged. Reasonably this offers us the electron, negative, in two different spin states or external rotation, and his twin brother, the antiparticle positron, positive.



↑↑internal left helix opposite spin ↑↑internal right helix opposite spin

Chapter 5
The weak interactions

5.1 Weak interactions and quantum mechanics

This short paragraph could be useful to peek some mathematical writings that I have published elsewhere. Otherwise a short digression on the weak interactions. Anybody who wants can jump and go directly to paragraph 6 on Quarks.
In Chapter 2 on Radar we said that *the interaction with the target allows us to imagine all the possible mechanisms of interaction of elementary particles*.
We shall now go on to consider for example the weak force. This force is exerted by the particles W and Z°. So, if the interaction with the target allows us to imagine all the possible interactions, particles W and Z° carriers of the "weak force" should find their interpretation in the action of a radar target, or an object in waveguide, or similar.
You can support this point of view?
You can view the action of an object on an electromagnetic signal incident on it saying, “Look, this is the action of the Z° particle "or "This is like the action of the W particle "?
But let’s go on slowly.
The weak interactions are those in which intervenes the "weak force", one of the so-called four fundamental forces of nature, the electromagnetic, weak, strong and gravitational. Since there are about books and popular articles in quantity, I'll put it here to summarize the characteristics and properties. I refer to these various popular works. I will confine myself gradually to capture those properties of weak interactions that are relevant to this work.
Also will take advantage of that, along the way, weak have become *electroweak* interactions, ie those electromagnetic and weak interactions were unified.
This gives us an advantage, because the electromagnetic interactions are more familiar, if only because everyone at least once took the shock, he knows TV and Radio and know roughly what is a radar impulse.
What does this mean that the weak interactions are unified with the electromagnetic? Brutally said, is like saying that .... are electromagnetic. They are just weak. Or rather are weak at low energies, they become as intense as those at high energy (or high frequencies, or small distances).
The electron "feels" both the electromagnetic and weak interactions.
That said, you must say something about quantum mechanics.
The electron in quantum mechanics is described by the Dirac equation.
The Dirac equation describing the electron and its electromagnetic interactions, does not describe its weak interactions. What the hell is the Dirac equation, and it does not describe the weak interactions of the electron? (Since, after all, are *electro*weak .....).
David Hestenes attempted to read into the Dirac equation also weak interactions [30].

Hestenes has done commendable work on the Dirac equation, so much so that now we speak of "Dirac equation in the Hestenes form".
He rewritten in another form, another mathematics.
Summarize the results as follows:

"now the Dirac equation can also understand the electrical engineers.....".

The result should be considered of formidable importance, should consider that before, in the original Dirac formalism, for electrical engineers average was not only impossible to interpret the Dirac equation, but it was impossible to try to reason about it.
Too bad the mathematics used by Hestenes (Clifford algebra, etc., etc.), in some ways elementary, is tricky and in other ways, however unfashionable.
In practice, ignoring everyone except Hestenes and a working group in Cambridge.
However this new mathematics can serve to make us work on the Dirac equation which I'll discuss in a little while.

5.2 An electromagnetic wave packet

We started with the intent to examine a working hypothesis, namely that the electron was somehow a lump electromagnetic field, an electromagnetic wave, a packet of electromagnetic field.
A kind, really, the package of electromagnetic field, all to understand.
But a true package of electromagnetic field is something well known.
I repeat.
The radar is sending packets of electromagnetic field toward the target to detect.
They travel at the speed of light. Can be produced in linear or circular polarization.
Similar packages can be made to travel within a waveguide. Here, according to the frequency, however, travelling at speeds less than that of light, and wishing can also go very slow. Travels slowly if the frequency is slightly higher than the cutoff frequency of waveguide or, which is a synonym, if the guide is narrow.
When a packet travels in a waveguide is inside the waveguide. It' sso big as the waveguide, a little smaller to get in and can run. A typical packet has a dimension of the magnitude of the wavelength, since this is the waveguide, which is built based on the packets that must lead. A typical packet is rather long various wavelengths, according to project needs. Say for example one hundred wavelengths.
What is the wavelength?
In the technique they are used a lot. Especially in the radar wavelengths usual may be in the decimeter of centimeters of a millimeter, depending on the application. In other applications, the wavelength can be meters, hundreds of meters, km ... ...
In a large waveguide could hypothetically come in, or get us into the instruments, and measure point by point the electromagnetic field. On certain special occasions and for some particular reasons why we do it. The field obeys the Maxwell equations. This you know, and the measures it happen. If, therefore, a wave packet passes, can be measured, or think to measure, the characteristics point by point, and find that the field obeys the Maxwell equations.
So in essence a packet electromagnetic knows everything.
However, already for the millimeter wave waveguide is tiny.
Worse still if we considered an optical fiber, "waveguide" for the electromagnetic field (or light). This is a hair.
Now he has a condition that has nothing to do with quantum mechanics or the uncertainty principle or philosophy, but it has to do with technology. If the packet is very small, we can not look inside for the simple that is too small for us to enter the instrumentation tools.
So we can only study it from outside.
We can then do the following reasoning.
Suppose, how we intend to demonstrate, that the electron is a kind of electromagnetic packet. But it is very small. Instead an electromagnetic packet is normally great. But sometimes it can become very small.
How to describe an electromagnetic packet so small if we can not ever look inside?

That is, there may be an equation that, deliberately ignoring the characteristics of the field that is Maxwell's equations, describes an electromagnetic packet treating it as a particle of quantum mechanics?
That is, giving only the overall characteristics, seen from outside?
(wavelength, velocity, energy, mass, polarization, etc.)
Should consider a field in free space, but also in the waveguide, in order to have an electromagnetic packet at all speeds possible, even staying, as a particle.
The algebra developed by Hestenes lends itself well to this investigation.
The result is this:

this equation exists and is the Dirac equation.

I have shown this elsewhere [31].
We must say a few words about this result, to evaluate their significance.
The Dirac equation is the equation of the electron (and neutrino). It describes very well all, or nearly so, the behavior of the electron but does not tell us anything about how it's done inside. Assuming that there is an inside.
David Hestenes has tried to dig into the Dirac equation to figure out if there is any information on the structure of the electron, but that's not what interests us here. What interests us is that the Dirac equation describing the electron from the outside, and informs us on wavelength, energy, speed, spin and so on.
If now we find that even an electromagnetic wave packet is described in the same way, there are two alternatives:

or the electron is an electromagnetic wave packet, or it resembles him a lot.

One might object:
"Okay, so. But it is only because it is an isomorphism , namely, the two problems are the same type of problem".
We can well accept that the two problems are isomorphic, but this just makes the thing interesting. Indeed, the internal constitution of the electron there is invisible, while the other problem we have before our eyes.
It's as if we discovered that the same equations that describe in all respects the behavior of a tiny virus, just or not visible in the electron microscope, also describe in detail a kangaroo.

Kangaroo we have before our eyes and we can reason.
And that is what interests us here.
What interests us here is to try to understand something more on the electroweak interactions.
Perhaps it is now possible: the most remote meaning of the Dirac equation are controlled as in this case refers to a visible problem. There are clear meanings of various parameters.
We have analogies that are "visible".

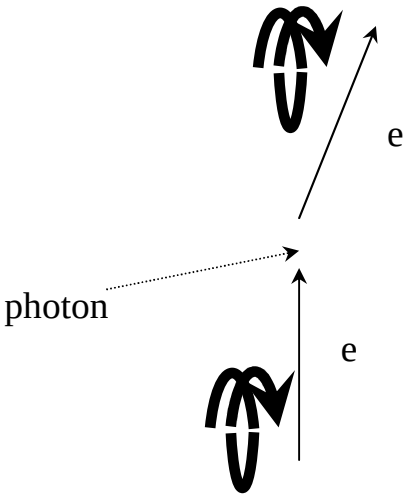
He says Tommaso Dorigo, an experimental particle physicist, in a blog [32]:

Analogies are a powerful way to explain complicated scientific concepts. I use them as much as I can whenever I describe particle physics in this blog or when I give a outreach talk in a school. However, good ones are not always easy to find. One usually needs examples from everyday life, which are simple to describe and which do not possess distracting features.

What are the analogies or similarities of behavior that gives us the Dirac equation [31]?
Firstly, an electromagnetic field wrapped in helix inside a waveguide is analogous to the electron or positron.
Second: an electromagnetic field that travels in a vacuum at the speed of light is similar to the neutrino (the cousin of the electron, without mass and without charge, and always travels at the speed of light).
Continuing the study and used the analogy, you can do more: you can interpret the action of the photon, or the "electromagnetic force", which deflects or changes the speed of the electron.
I tell this interpretation.
I help with a drawing:

electron
electromagnetic field wrapped in helix
inside a waveguide

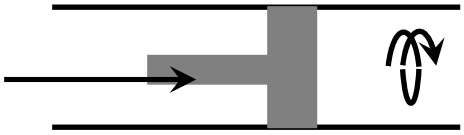
Summarize the action of the photon. It does several things but in particular accelerates or slows down or diverts electrons



In the electroweak theory the action of the particle "photon" is represented by a mathematical operator. We take this mathematical operator and uses it in case "visible" to us comes from the analogy. Take this mathematical operator and we

apply to the electron, to the electromagnetic field wrapped as helix inside a waveguide. The action of the photon becomes the action of a visible object.
And what is this object and what it does on the electromagnetic field in the waveguide?
I have shown elsewhere the result [31].

Him a push.



In the radar-electromagnetic analogy the action of electromagnetic force is that of a "push" that accelerates or slows down the field in waveguide.
This is very interesting and suggestive.
Since "the appetite comes with eating", how it appears instead, and if it appears as one interprets a weak interaction?
Hestenes, as we have seen, tried. to read the weak interaction into the Dirac equation.
In particular, he identifies the parameters that he thinks are characteristic of the weak interaction.
In our case they are interpreted.
And with this statement I should stop. The rest is mathematics.
I have published about that two rather complicated papers.
But maybe something I can explain.
I try.
.

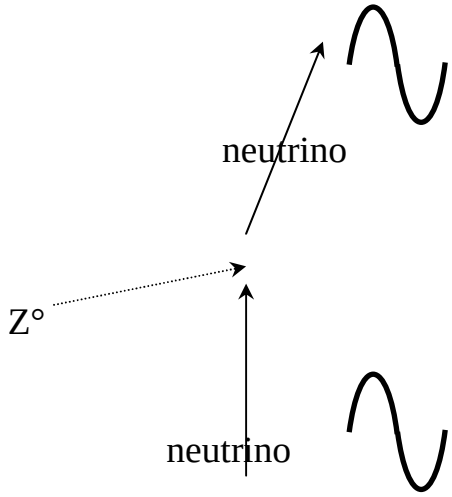
5.3 A packet of electromagnetic waves and the electroweak interactions

I said that the Dirac equation describing the electron.
If now we find that an electromagnetic wave packet is described in the same way, there are two: or the electron is an electromagnetic wave packet, or it resembles him very much.
Also the most remote meaning of the Dirac equation are controlled as in this case refers to a visible problem. There are clear meanings of various parameters.
We have analogies that are "visible".
Because now we want to interpret the action of weak forces, so we start with revise the action of weak forces (the electromagnetic force have already spoken).
Weak forces are exerted by the particles W and Z° carries of the "weak force". What they do and how do they work?
They do actually several things, but to simplify, I fixed on some examples.
Help me with the usual drawings to add the neutrino.
The neutrino has no electric charge, has no mass, always travel at the speed of light, and the study of the Dirac equation we have identified with an electromagnetic field in a vacuum, speed c.

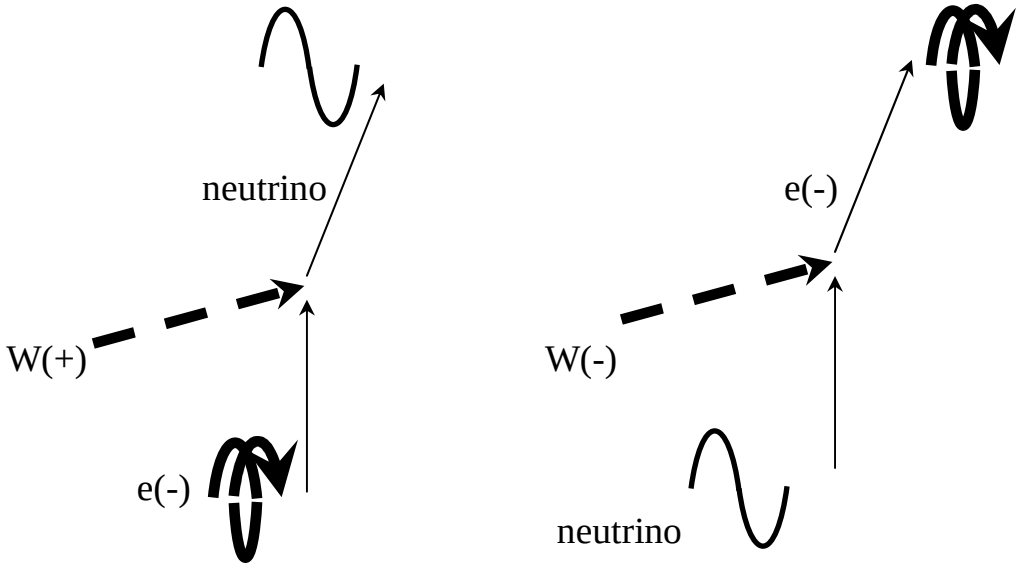
neutrino
electromagnetic field in vacuum
speed c

electron
electromagnetic field wrapped in helix
inside a waveguide

What are the particles W and Z° carriers of the "weak force"?
The Z° does many things but, for example, is able to act on neutrinos.
No photon is able to act (to divert or slow down) a neutrino, which is consistent with the fact that the neutrino has no electric charge, whereas the electromagnetic force (photon then) operates only on electric charges.
Neutrino can act contrary to the Z°, whose action is represent by a diagram (not a Feynmann diagram but a sort of):



The more complex the action of the W particle. It can transform into electron neutrinos or vice versa (and therefore a particle with charge).

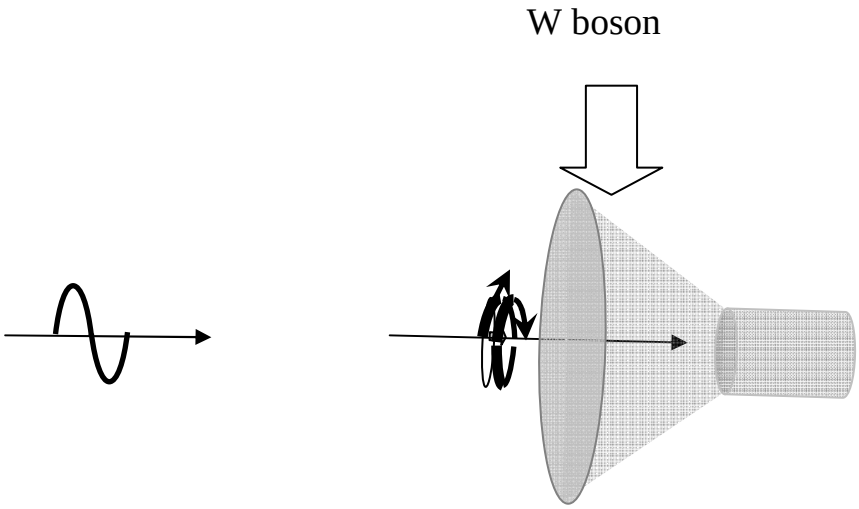


The challenge is to translate the mathematical formalism of the action of Z° and W particles in quantum mechanics in mathematical operators representing the electromagnetic action of the various objects.
At the risk of repeating myself, I summarize the situation. The electron in quantum mechanics is described by the Dirac equation. The Dirac equation describing the electron and its electromagnetic interactions, does not describe its weak interactions. Hestenes tried to read the weak interaction into the Dirac equation. In particular, he identifies the parameters that he thinks are characteristic of the weak interaction. In the Weinberg Salam theory of electroweak interactions is a thing called "$SU(2)\otimes U(1)$ symmetry ", an internal symmetry in an abstract space. Instead, says Hestenes [30] (I translate freely his thoughts) should be possible to give a geometric interpretation of this $SU(2)\otimes U(1)$ symmetry in physical space (the real one).

I have proposed this and something more, or if you want more modestly something less: it must be possible to give a geometric interpretation and also see the effect, given the aforementioned similarities, on the electromagnetic fields. View that the effect of the electroweak forces not only on elementary particles, electron and neutrino, but also on normal electromagnetic fields in free space and in waveguide.
Why can we be confident that achieve it?
The question can be posed in these terms that I brutally simplifies apologizing to the experts: the "$SU(2)\otimes U(1)$ symmetry", internal symmetry in an abstract space, contains the mathematical operators of which one represents the action of the W particle, another particle Z° and another particle "photon", the carrier of the electromagnetic force.
Of these one was interpreted and that is what is the action of the particle "photon", the carrier of the electromagnetic force.
Therefore, it is hoped to be able to interpret the other two.
Well what are the results we provide the mathematics or the Dirac equation? These results are described in mathematical articles that I've published elsewhere [31]. I can summarize them in a concise and simplified.
First, an electromagnetic field that travels in a vacuum at the speed of light slams on a target, is reflected, and this is the action of Z°.
Second, an electromagnetic field that travels in a vacuum at the speed of light is captured by a "horn antenna", is wrapped in helix and becomes a field in a waveguide, and this is the action of W.
(And eventually third, as already seen ...)
Third, an electromagnetic field that travels on a waveguide guide is pushed, or slowed, and this is the action of the photon.
If we wanted to imagine the only with the fantasy the action of W and Z° particles in quantum mechanics, based on everything we have said until now we could think just about these analogies. We imagined what follows.
First, who is Z°? The action of Z°, seen in terms of radar, can be represented by a reflection on target. The field is in fact diverted or delayed (or accelerated). The object can then this is simply a radar target.
Second, who is W? In a radar analogy an object that transforms free space fields into fields in waveguide or vice versa, exists and is ..... a horn antenna at the end of a waveguide. It operates the transition free space – waveguide and then the above said changes.

electron neutrino neutrino electron

So we can be very satisfied with what tell us the math.
Mathematics gives us a "visual" interpretation of the electroweak forces, and in particular the weak interactions, which action, if studied on electromagnetic fields in vacuum and in waveguide corresponds to the action of visible objects.
I repeat for the most attractive, which is the action of W.



It happens that an electromagnetic field in vacuum is wrapped in helix and becomes a field in waveguide, and that the action of an object that is a horn antenna.

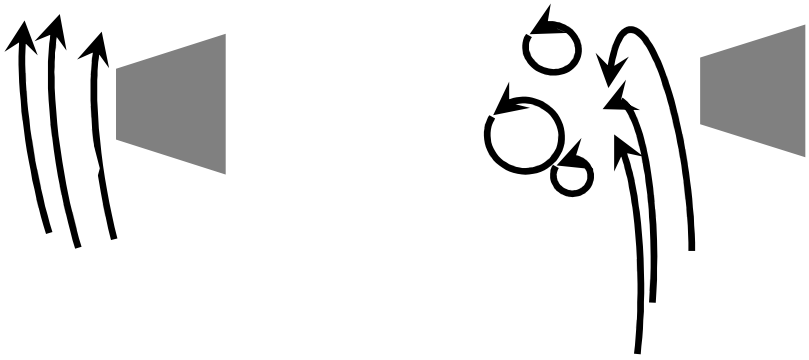
In this action mass it's given to the field.

The concept is important so it's worth insisting.
A circularly polarized electromagnetic field, when it propagates, it travels within the waveguide following an helical path. The extreme conditions are infinitely large frequency, where the helix is very long and the field travelling at the speed of light, and the so-called "cutoff" of the waveguide, when the helix is increasingly shortened, the field ends with turn on itself, and stands there.
Both the frequency and the energy of the field obey the relativistic formula linking mass energy and momentum of a material particle. The mass is precisely ..... the field energy at rest, ie the energy of the trapped field that revolves around itself. Light trapped.
So the electromagnetic field in the waveguide already behaves as expected for a relativistic particle. A trapped electromagnetic field is behaving like a particle.
In particular it has mass.
The object that transforms free space fields into fields in waveguide is a horn antenna at the end of a waveguide. It operates the transition free space – waveguide and then gives mass to the field.
In all this did not include the Higgs particle.
Why quote the Higgs particle?
The Higgs particle appears in the Weinberg Salam theory of electroweak interactions.

This theory describes and "justifies" the leptons, in particular electron and neutrino, and their interactions. The theory, for mathematical reasons that now there is no need to investigate, was born and developed with massless particles. After all the development of mathematical theory is necessary to invent a mechanism capable of providing mass to particles without mass, in particular electron. That was invented ad hoc, the Higgs particle, which has sole responsibility for this, and still is hunted, not yet found.
The Higgs particle is an hypothesised particle which, if it exists, would give the mechanism by which particles acquire mass.
We might instead think of the creation of rest energy, or mass, because the light begins to move in circles, like an electromagnetic field in vacuum which is wrapped in helix and becomes a field in the waveguide?
Some scientists are seriously thinking about this.

5.4 Electroweak interactions and the Higgs particle

We then showed that an object similar to the W boson provides mass to the electromagnetic field. I have carefully limited to speak about electromagnetic fields in free space and in a waveguide. I noticed that an electromagnetic field that travels in a vacuum at the speed of light is captured by a horn antenna, is wrapped in helix and becomes a field in a waveguide, with rest energy, mass.
I also noticed that in all this did not include the Higgs particle.
I did not speak explicitly of electrons and neutrinos, but the similarities are inevitable, all questionable, with electrons and neutrinos.
However Hestenes in one of his many writings (D. Hestenes, "Spacetime calculus"), says more.
Speaking of the helical motion (note: helical motion and zitterbewegung in the Hestenes interpretation of electron are synonyms) Hestenes makes explicit an hypothesis that, given the similarities, it is interesting.
The hypothesis is this:
"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".
Hestenes says in essence that the mechanism of circular motion and / or helix motion may be able to give him the mechanism of the electron mass, it is unnecessary to involve the hypothetical Higgs particle, which some have called imaginatively God particle.
Basically it creates energy at rest, or mass, because the light starts to move like a whirlwind, a vortex.
Faced with possible elimination of the Higgs particle by the electroweak theory useful then I revise my previous ideas.
We saw that in the Weinberg Salam theory of electroweak interactions for mathematical reasons it was invented ad hoc the Higgs particle, among other things necessary to give the electron mass.
However now the Higgs particle is still hunted, and no one has seen.
Also more of a scientist begins to think that creates rest energy, or mass, with some other mechanism. May we therefore think that mass is created because the light gets to travel like a vortex? In analogy we saw that an electromagnetic field in vacuum "impact" against the horn antenna, is wrapped in helix and becomes a field in the waveguide. May be this mechanism that justifies the electron mass?
I digress on the vortices.
Come on, for example, in Pisa.
Crossing the Arno bridge, and looking below, one can observe the flow of waves near the piers of the bridge.
Sometimes vortices appear, which are formed when the wave energy becomes high.
The violent impact against a barrier can produce these entities, which remain, though short, independent life.



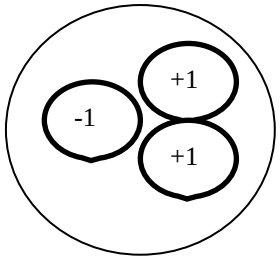
Now it must be said that the mathematical mechanism by which manifests the action of W on the electromagnetic field is a mechanism that resembles a contact action, a shock. The electromagnetic field "bump" and then is wrapped.
(Note that in quantum mechanics the W particle has a large mass, has a short life and acts only at very short range. This proves nothing, but is compatible with the action of impact against an obstacle). If this is the mechanism to give a neutrino mass and make it an electron, 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 electrons.
We can fantasize.
Currently there are many neutrinos around us, but there is not an appreciable amount of W, also because of their short life. But for high energies and close to the speed of light the life of W becomes sufficiently long, says the theory of relativity. Live long enough to see neutrinos. They would in an environment of high energy may have constituted obstacles in large amounts, very massive particles against whom the light, even her great energy, could knock and rewind....
In any case, this mechanism would provide an alternative to the mass of the Higgs particle.
With this digression doubt end up on the weak interactions.
At this point, fantasy for fantasy, we can proceed to broader hypotheses on the formation of all material particles.
What we do in the next chapter.

Chapter 6
Quarks

6.1 Composite particles

So far we have reasoned on the electron.
We now say that the electron is the simplest stable particle with mass, the only stable particle with mass believed to be *elementary*.
All other particles are thought to have composed. In this sense the word "elementary particle" for pi mesons or the proton, neutron, etc. etc. etc., we can consider a relic of the past. The electron has the right to be called an elementary particle. The others are not elementary but composed [33].
Composed of what?
They say: other elementary particles.
But we have just seen that in hunting elementary particles the only has been found to be such is the electron.
So the electrons are all? The only brick base is the electron? Accurate.
Meanwhile, we complete the picture of elementary particles, and stable.
They are the electron and its antiparticle the positron, and neutrino together with its antiparticle, the antineutrino. To put it briefly, the electron and the neutrino, together with their antiparticles. The word *stable* means that these particles have eternal life. Nobody has ever seen an electron disappear, or break down into any smaller pieces or “decay”. The same applies to the neutrino.
There is another particle with these properties. It is the proton. Although the proton is stable. But the proton is not elementary. There are abundant clues, to say the evidence, suggesting that the proton is a composite particle.
The neutrino and electron are in a sense very similar. We can say, simplifying, that the electron has mass and charge, and instead the neutrino has not, and this is their only difference. In particular, the neutrino, having no mass, travelling at the speed of light forever.
(Note that here we examine the assumption that everything is light, electromagnetic field; what would then be a neutrino? Travelling at the speed of light could only be a particle of light. It differs from the photon having spin ½ unlike the photon which is assigned a spin 1. We are not deviating from a very old idea of de Broglie to consider the photon as consisting of two half spin ½ photons).
With this background we return to the problem of the conformation of the composite particles.
Hestenes [5] together with Asim Barut is assumed that all particles are composed of ".... stable bound states of the three particles: electron, proton and neutrino”. So the brick would be electron neutrino and, where appropriate, the proton. The proton then, being composed in turn, would be made of an electron and two positrons. Of course neither Hestenes neither Barut nor anyone else have a theory that can explain how two positrons and an electron could sit together to form a proton, give the correct

mass value, and so remain confined forever. The fact is that as regards the electric charge calculations match: two positive charges of positrons together with a negative charge of the electron give the charge +1 of the proton.



Williamson and van der Mark in the aforementioned article [28] are a different situation:

"*If the electron is indeed constituted by a photon, other elementary particles may also be composed of photon states, but in some other configuration"*.

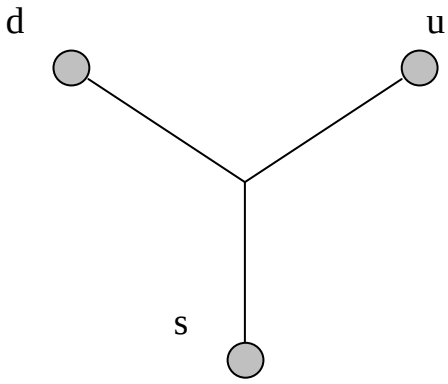
We speculate that the particles (the authors say) may be described by composite confined photon states. This hypothesis is therefore an explicit assumption of "trapped light". How can you connect this idea of trapped light by what you know physics? For physics the most likely hypothesis is that of quarks. Quarks (see below) are strange objects which isolated, alone, do not exist. So, van der Mark and Williamson say, we think of as quarks, so to speak, of pieces of light that alone do not exist.

"If we identify a quark with a confined photon state which is not sufficient in itself to complete a closed loop in space (…), it would then only be possible to build closed three-dimensional loops from these elements with QQQ and $Q\bar{Q}$ *combinations"*.

In other words, since the electron is a photon with a lambda c that closes on itself in two rounds (the authors describe it), we examine the hypothesis that quarks are something similar, but not able to close in on themselves. In so doing quarks would still exist as interior compositional elements of trapped light, but could not exist alone outside.
The physics does not provide all possible combinations of quarks. Only possible combinations of three quarks QQQ and combinations Q(antiQ) of a quark and an antiquark. (Why the physics says this? We could say: "why so things go well").
Well, maybe, they always say Williamson and van der Mark, that these pieces of light, inside loops, can be closed only in combinations of three quarks QQQ and combinations Q(antiQ) of a quark and an antiquark.
We now want to try to translate these assumptions into a visual image of quarks, which safeguards what we have assumed so far for the electron.

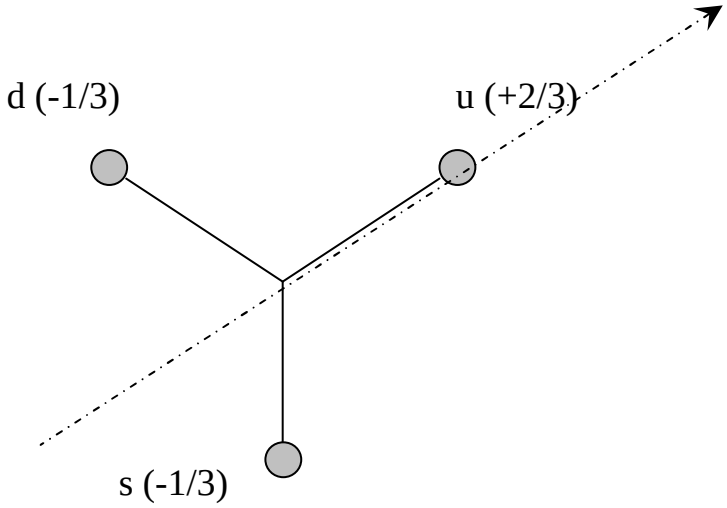
6.2-Quarks and SU(3)

"In any history of philosophy for students, the first claim is that philosophy began with Thales, who said that everything is made of water. This immediately discourages the beginner .... ".
So says Russell, "History of Western Philosophy".
We could apply the phrase with some variations to the physics and quarks.
In any explanation of physics for beginners the first claim is that we now know that matter is made of quarks and that quarks are not free, are not existing alone.
Also this sentence is quite daunting, or at least no exciting. Why?
Perhaps it is because then you do not tell the reader much more.
We do not know to describe the particles in a convincing way.
There is no physical image, visual, of the various particles. It tells the reader that the stable elementary particles are electron and neutrino. The other particles are composed, and are composed precisely of quarks. But how are they made of? And why quarks are not free?
By comparison the reader but knows that atoms are small solar systems. The electrons revolve around a nucleus. The nucleus is made of protons and neutrons. Everything has a precise image. The reader also knows, though he did not know other details, that the physicists they can do with this model all the calculations you need. For example, a nucleus having as constituents two protons and two neutrons weighs at least approximately, as two protons and two neutrons combined. And so on.
In the quark does not happen that way. Everything becomes much more nebulous. The weight, for example, is not the sum of the weights. Even you can not say what the weight of each quark.
If you continue reading, we read that are three quarks: u,d,s are called, "up", "down", "strange", and so called them a physicist Murray Gell-Mann.
They are often pictured to put 120 degrees between them, like this:



Why?
This picture reminds the reader something, a sort of symmetry, or something else would know but they do not understand what it is. In fact, these 120 degrees at least their mathematical reasoning have it. Quarks have electric charge (+2/3) and (-1/3). Quarks, so put at 120 degrees, have electrical charges, measured from the centre and

along an oblique axis, which are just double the other, and how they should be exactly opposite, u (+2/3), d (-1/3) and so on.



But those 120 degrees are something real? Quarks are the objects placed at 120 degrees inside the particles?
Continue.
Together with the quarks are antiquarks, which have opposite charges. As the electron (-1) which has its antiparticle positron (+1), so each has its antiquark to opposite electric charge.
But roughly explanations end there.
For example, no one knows exactly assign a weight to quarks such that a particle made with udd weights as u, d, d combined.
Then top it all no one has ever seen a free quark.
What is strange. If the electron exists, one expects to see every time an electron. This actually happens. When this happens, we say: "Here was an electron".
Nothing like that happens to the quarks. No one has ever isolated a quark, as they say.
However, there are composite particles, made of quarks. This you know. They meet in groups, multiplets, groups of eight particles (octets), ten, and so on. There is a definite classification. For convenience, the composite particles, they are all listed in the Endnotes.
For example, a proton is uud.
Instead it is a neutron udd.
Instead d with "anti-u" is a pi meson.
And so on.
But essentially as is done uud? How did udd? And what are the quarks are balls, and what are these 120 degrees? And as the composite particles are made in?
We now want to see if the assumptions on the charge as internal polarization, which has worked for the electron, is consistent with the quark model.

Quarks have imagined giving the particles an internal symmetry, abstract symmetry, called SU (3). The formalism of SU (3) has allowed to predict the presence of composite particles and these predictions have proved correct.
That said, what is this SU (3)?
In mathematics there are complex numbers and vectors.
SU (3) is "the group of all unitary transformations of a complex vector in three dimensions". This phrase itself is not very illuminating. There is something like talking about SU (2) for the interpretation of which can be referred to a radar signal. Who is SU (2)?). It 's already appeared talking about of electroweak interactions, along with his cousin U (1). There still appears, albeit in a different guise. We are in mathematics: SU (2) is a "group of transformations".
SU (2) is "the group of all unitary transformations of a complex vector in two dimensions".
Also this phrase itself is not very illuminating, but in the theory of radar signals a complex vector in two dimensions is an entity commonly used, describes all the changes of polarization of the received signal [31]. What say all the possible transformations of SU (2) the radar?
They say that the reflected signal can be all possible transformations of the polarization ellipse, and SU (2) represents them. "Unitary" means changing the shape of the ellipse of polarization but not how is big. In other words SU (2) we get all the possible elliptical polarization, but the same energy. If desired, all polarization ellipses can be obtained by combining the basic polarizations. Basic polarizations here are, it only takes two: the right circular and left circular.
In the theory of radar signals with a complex vector in three dimensions is any polarization in space. Then it was on a plane, is now in space. In other words SU (3) we obtain all the possible forms of polarization ellipse in space, all with the same energy.
You can see that now it takes three basic polarizations to represent a generic polarization. We choose these three basic polarizations in a suitable manner and call quarks. In other words we can or we might think of quark as signals component a polarization.
An analogy of this kind is usually not presented in radar theory, radar engineers does not care and there is no need to develop it further here, because continuing down this road we could only imagine, we could not certainly come to understand "how they are made the quarks".
However, this SU (3) involved in the particles, and there must be some reason.
As we have indicated, the quarks have been imagined by giving the particles internal symmetry SU (3). The formalism of SU (3) has allowed to predict the presence of composite particles and these predictions have proved correct. In addition, regardless of the real existence of quarks one can say this [34]:

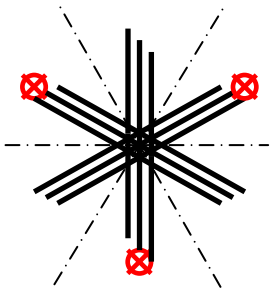
"……even if quarks do not exist, the formalism of SU (3) remains valid and would remain an extremely useful tool for the classification of particles".

Referring to the meaning of SU (3) applied to the radar we see that "quarks" are basic components of a polarization.
We associate a internal polarization to a charge.
So let's keep this clue:

we can think of quarks as basic components of internal polarization that gives the electric charge.

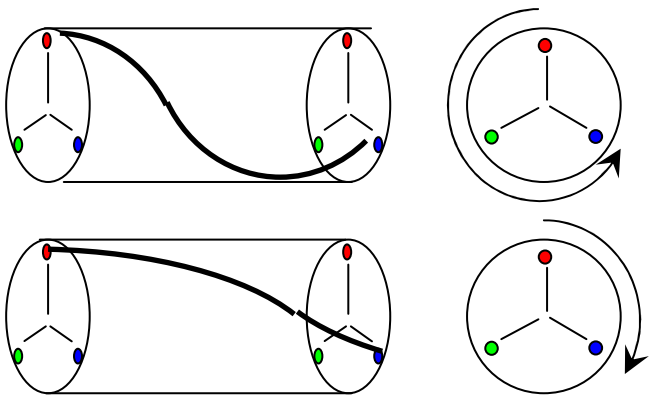
6.3 The structure of quarks

In an exact physical theory could never, at least for now, give us a visual image of quarks, but in a science fiction novel of course yes.
We follow some clues.
It 's important, however, a premise, we must realize that open before us various alternatives.
Each of these could have its validity and its own charm.
In fact, what elements do we have?
One clue is that quarks make up the internal polarization.
But how to make? In the scheme of SU (3) a generic polarization can be formed with three basic signals, but they can be chosen more than one way, and we do not know which choice is better suited to suggest a visual image, a form of quarks.
Another vague suggestion that comes to us insistently properties of quarks, is that somehow intervening 120° symmetry.
120° but what kind? Are 120° in space? Or are 120 degree phase difference? A striking example, for connoisseurs of electronics, we are given by the rotating field that uses electrical machines.
To produce a rotating magnetic field three-phase systems are used where three currents are equal in magnitude and have a 120 degree phase difference. Three similar coils having mutual geometrical angles of 120 degrees will create the rotating magnetic field in this case. All this produces a circular polarization .... The rotating field of electrical machines proposes figures of this type:

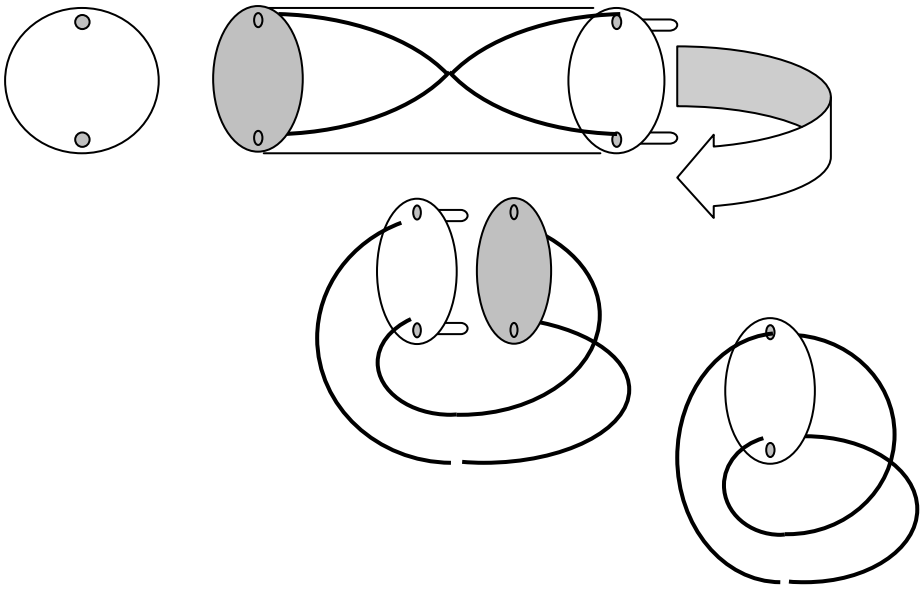


Quarks are related to something? Some calculations seem to recall the fractional charges of quarks. I speak in the Appendix.
A third clue comes from a form: the helix.
The shape of the helix we have repeatedly encountered in electron.
It’s possible that quarks are helices?
And if they were, two quarks may be composed in the double helix to give mesons?
And three quarks in the triple helix to give the baryons? These are forms of biology, nature sometimes repeats its forms.

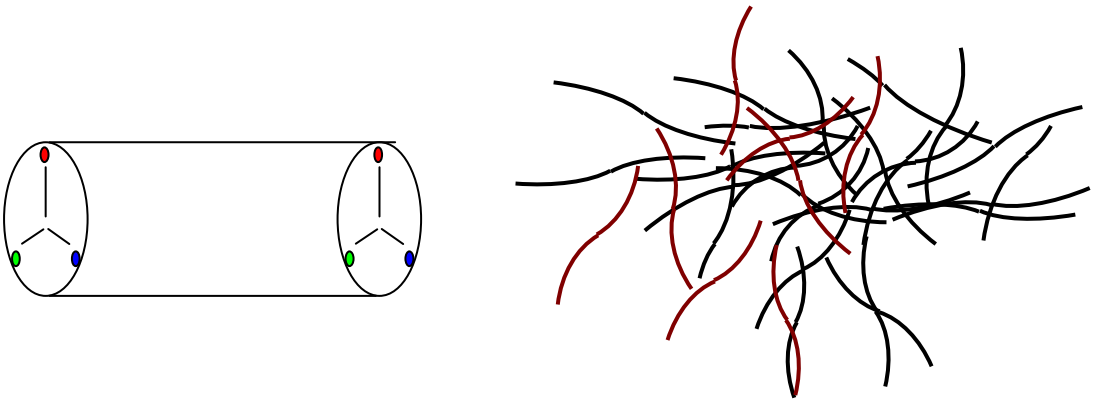
A fourth clue is strange. These quarks should be, but at the same time never being in any way extracted from a particle.
This could well occur if quarks were helices whose properties depend for example on a mutual internal position. Once extracted, the quarks would no longer have any mutual position, and would look for what they are, helices, perhaps helices that alone do not exist. We could identify a quark with a confined helix which is not sufficient in itself to complete a closed loop in space.
All these clues are confusing, hard to put together composing a coherent framework. It’s possible that the development of one or more of these ideas will lead to valid conclusions, but for now we can not determine which way to go.
We follow therefore a convenient way of composing this "puzzle" in a way that helps us at least with the images.
Claim, however, three things.
First, that is not to be denied and even supported the model that we took the particle electron.
Secondly, the model, the image of quarks will comply or explain and possibly will require the quark composition of the known particles.
Finally the third and even more important as we intend to maintain key properties that we have attributed to the electric charge, ie correspond to an internal circular polarization.
To this demand that the quarks, which are assigned charges 1/3 and 2/3, are associated with portions of a circular polarization.
Associated in which way?
Us refer to the electron and how we imagined. Internal helix "produces" the electrical charge. A complete rotation of helix of 360 degrees giving rise to a charge of 1. Consider a piece of helix that has just rotated 120 degrees, 1/3 turn and more or less arbitrarily assign to it charge 1/3. Consider a second piece of helix that rotates 240 degrees, 2/3 turn. Assign to it charge 2/3.
At the direction of rotation, left or right, attach the sign of charge. To fix ideas combined with a right rotation charge (-) and a left rotation charge (+).
We draw such a piece of helix that rotates 240 degrees to the left, and one that rotates 120 degrees to the right:



These pieces of helix are absurd about their possible existence outside, not self sustaining, that does not correspond to closed circulations of light, but can be imagined as compositional elements inside, where they have a right to exist.
More, corresponding to a ternary internal symmetry, or 120°, instead of a binary symmetry, or 180°.
To be an internal symmetry at 180° look at a wall outlet or plug. A standard double plug.
We have seen that the conditions of existence for a current half-wave who justify the charge are those of closing on a Moebius strip. It, or rather the wire, the helix that is the edge, is made of two pieces, the first piece is twisted 180 degrees and the second of 180 degrees.
We manufacture two of these pieces and to connect the pins of a dual plug, male and female, then close in on itself.



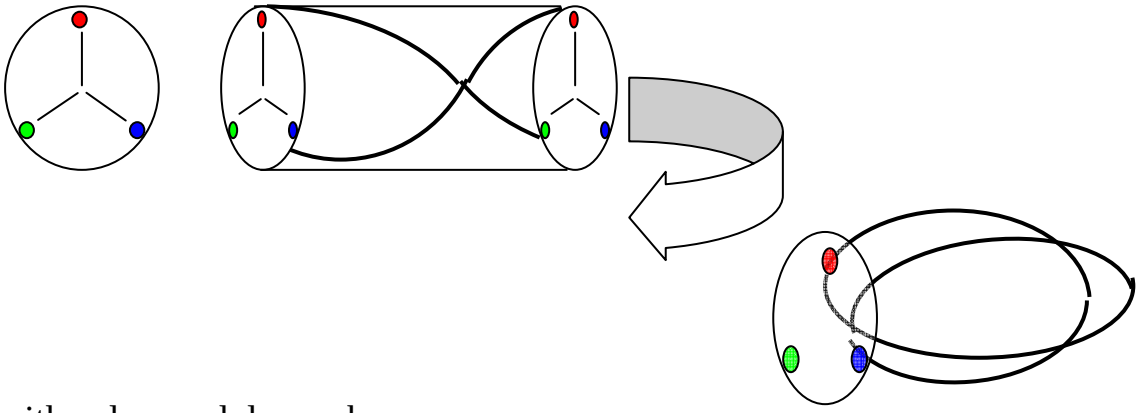
In this way we made a closed thread.
Now consider an internal symmetry of 120°.
For this we use a triple plug.
As you can now compose the helices? To work with a ternary symmetry, build ourselves first as basic elements pieces of helix. Pieces of wire twisted 120° and 240° (+120° and -120°, and then even +240°, -240°).
To be more precise we take as basic elements of many threads **u** (-240°) placed in a box and so many wires **d** to (+120°) always put in the box. Then let's have a third basic element **s,** always a wire (+120°), exactly as above, but which somehow differs from the previous, example, with a different color. This is somewhat a strange thread, write above which is always a wire (+120) degrees, but it is strange. However, even this let's take many equal pieces and put them in the box. Do the same for all rotations of the opposite sign.



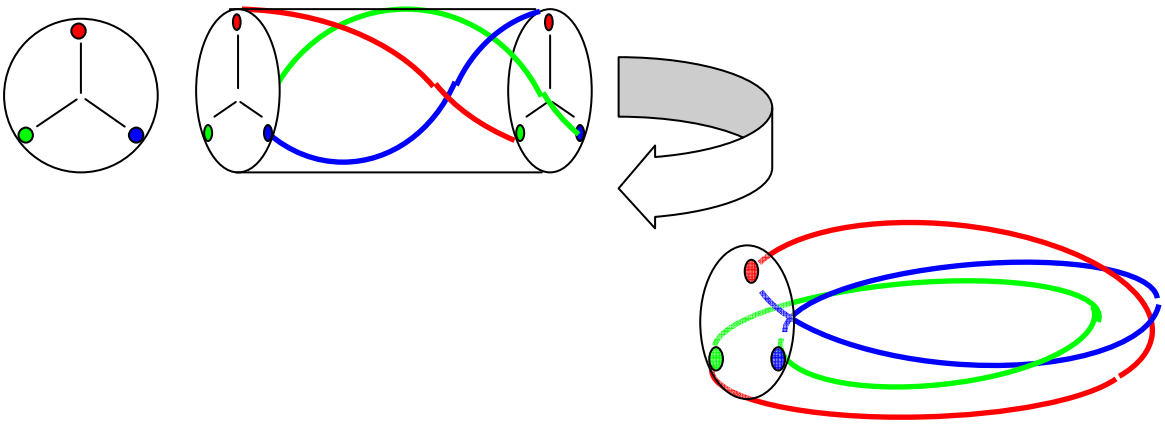
Now taking random wires from the box using the triple plug realize all the possible connections between the pins free. Will, closing the triple plug, *combinations that form closed thread, a thread that closes on itself.*
We can help with the calculation, or the graphics of a computer, or you can build physical models. The end result is pretty amazing:

these closed thread combinations represent elementary particles. All the elementary particles.

Namely, you can find *all* the combinations (and *only those*) who make the quark octet of baryons, the quark decuplet of baryons, the quark octet of mesons and their antiparticles (see [n13]). Here is a meson:



Help me with colors and draw a baryon.
Use the colors only to distinguish the various pieces of helix, without giving any special significance to the color.



How to justify this result?
In truth there is an easy way to verify this.
Sufficient to establish a correspondence between name and charge of quarks and pieces of helix that we used.
We call **u** the wires (-240°) placed in the box and call **d** the wires (+120°) always put in the box. Then we take as the third basic element a wire (+120°), exactly as above, but which somehow differs from the previous, example, more fine, or coloured . It's always a wire at (+120) degrees, but it is strange. We call **s**. However, even this let's take many equal pieces and put them in the box. Do the same for all rotations of opposite sign, called **anti-u**, **anti-d** and **anti-s**. You're done.

Here we are now just the result. What he says about interesting?
First, the fact itself. A trick of joints, as a game for children, reconstructs the known elementary particles. Gives us, as it were a physical image. We can not pretend that this is real, but it is certainly suggestive.
But, in addition, with interpretations.

A first interpretation concerns the elementary particles that exist. Why those? Why just those? Well ... are those that give a thread closed in on itself.
The birth of an elementary particle is connected with a concept mnemonic, or at least picturesque, "comes a closed filament". In addition, this happens with components that are pieces of helix. With those pieces of the helix forming particles are all, all that are known to exist.
But not only are all: they are *only those*, you can not build up further.

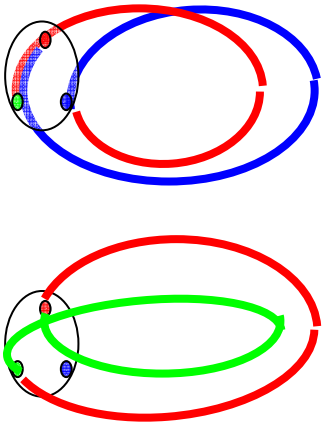
A second interpretation concerns the electric charge. There seems to be confirmation that the electric charge corresponds to an internal rotation, and that quarks have somehow a form that owns part of the rotation.
In fact, the final strand so created has its own internal rotation. It corresponds exactly to the charge he should have that particle. But the pieces have in turn a partial rotation. Their rotation is the one that corresponds to the fractional charge of quarks.

A third explanation concerns the evidence of 120 degrees It was the need for a symmetry of 120 degrees to build a working physical model. These 120 degrees thus seem to have a geometric counterpart.

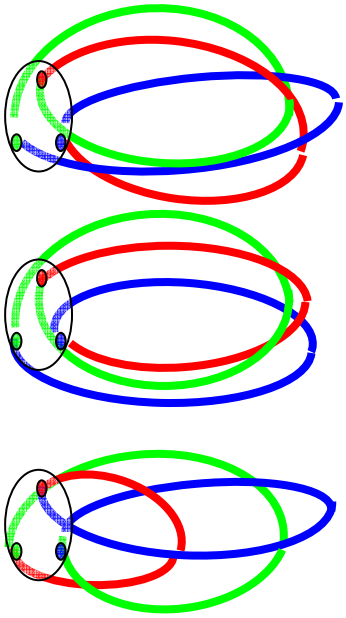
A fourth interpretation concerns the helices. Indeed it seems that we propose forms a helix as in biology. Combinations are precisely two helices that correspond to combinations quark-antiquark of mesons and three-helices combinations that match QQQ combinations of three quarks of baryons.

Here are some drawings of the structures that arise.

Mesons:



and here was some baryons

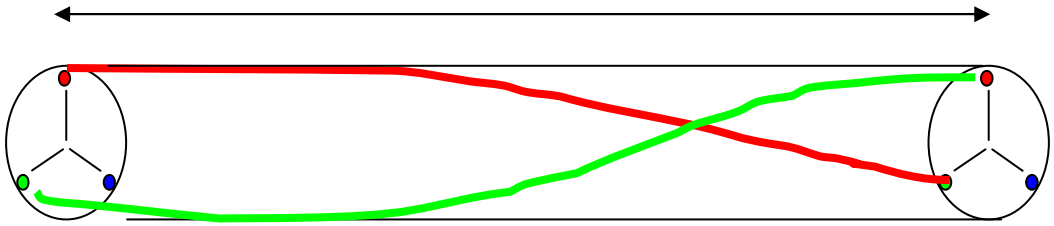


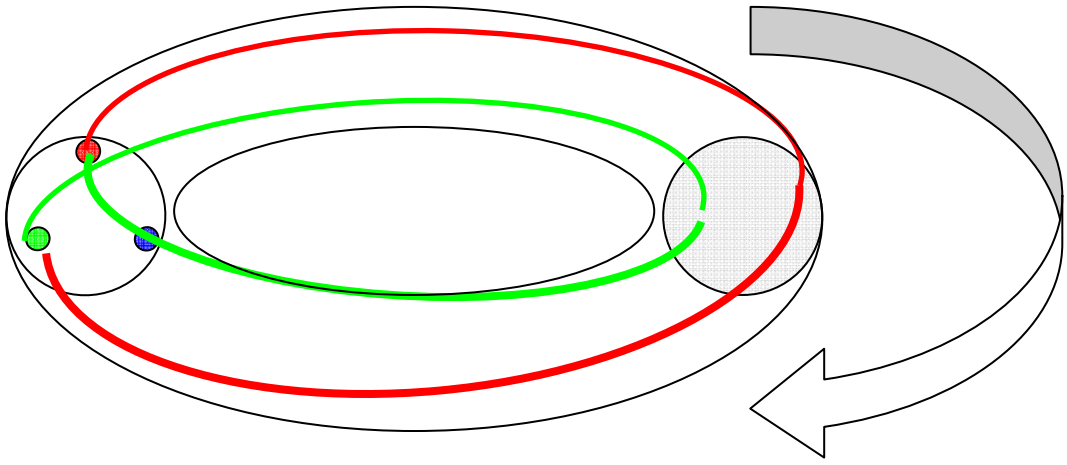
I remember once again that these drawings do not attach any particular significance to the color. Use color only to better distinguish one from the various rings.
It requires a final comment. The model is *isomorphic* with the quark model.
Isomorphic to mean *having the same properties*.
If you find a model isomorphic with the quark model, where the bunnies are attributed to the properties of quarks, it is clear that the model works as the quark model, but this does not mean that elementary particles are made of bunnies.
The model presented here is just isomorphic.
This however is not in itself a defect.
A model *must* be isomorphic, because it must provide all those properties, found in years of trials, which are well reproduced by the quark model.
Eventually it can be assessed if it has a more physical meaning, or a greater "appeal", or less arbitrary assumptions can explain more facts, or for that provides a visual image.

In the present case is interesting that the legitimate combinations that give rise to observable particles have a suggestive interpretation: are those that correspond to the creation of a closed filament.
Already this is interesting. Franzinetti says [34]:
“Multiplets we mentioned above are only observed experimentally but **are not the only predicted** in the SU (3) scheme”.
(The bold is mine).
Namely: in the SU (3) scheme there is no interpretation of why other particles are prohibited. The imposition of closed filament gives instead an interpretation, if not certain, at least interesting as hypothesis.
Note however that we talked about model.
We may speak of "equivalent model" as in electrical engineering is introduced the concept of "equivalent circuit".
Remind some things already said.
The physical system of which we build an equivalent model, acts relating to its certain parameters *as if* it were done in the manner of the model.
A model:
1-wants to be a representation of the physical system under study *only with respect to* the parameters examined;
2-does not necessarily fit geometry or shape or material with it.
Consider, for example, a series of resonant circuits that make a model to the vibrations of a bell or a guitar string. We are in this situation. We can not be sure of this physical picture of quarks as helices. In this sense we have created in effect an equivalent model.
In this case, perhaps we could not even speak of a model. We can call it a puzzle game. But it is suggestive. The allocation of the charge to quarks as parts of helix is at least consistent with the hypothesis of charge as internal rotation. Also interesting is the interpretation of the closed filament.
We will see in the chapter on the biology of particles a variant on this physics of quarks, which is even more satisfying.
To summarize: the assumption of charge as internal rotation seems to apply also to the quarks without contradictions, and also gives us a picture of the composition of the particles.

6.4-Spatial arrangement

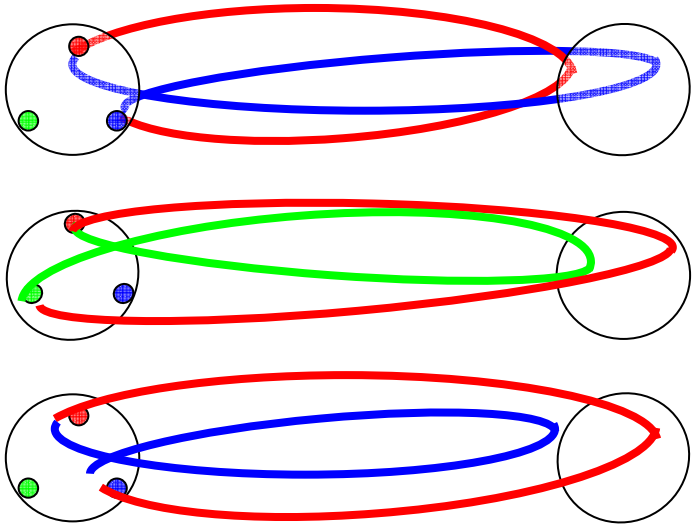
Ask ourselves what spatial arrangement could take the quarks.
We imagined to connect together with pieces of helix, quarks, two triples plugs, which are then closed on each other.
As we have amply illustrated, it forms a single closed thread.
Continue to help me with colors.
Use only the colors to distinguish the various pieces of helix, without giving any special significance to the color.
Wrap pieces of helix, quarks, between two triples plugs at a certain distance between them.
Drawing one of two quarks with the color red, the other with green.
A hose, a rubber tube, will help us for the winding process, then it will close on itself into a ring.
The result is that the pieces of helix are arranged on the surface of a torus.



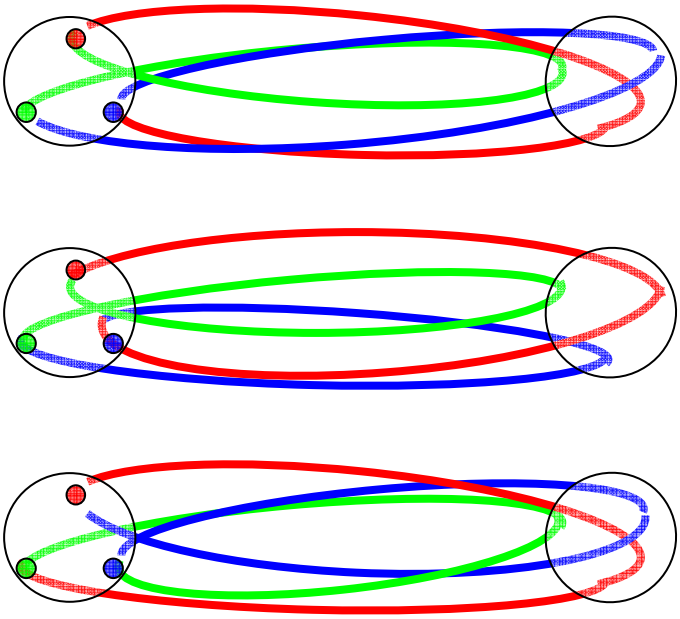


The red quark form a single closed loop in red.
Another ring, green, is the other quark.
(In fact individual rings are not closed, confirming the impossibility of their independent living. Only their combination forms a closed thread).
We saw that all the combinations made with random pieces of helix **u**, **d**, **s** (and anti - **u**, **d**, **s**) and which have a closed thread, representing the elementary particles. All the elementary particles.

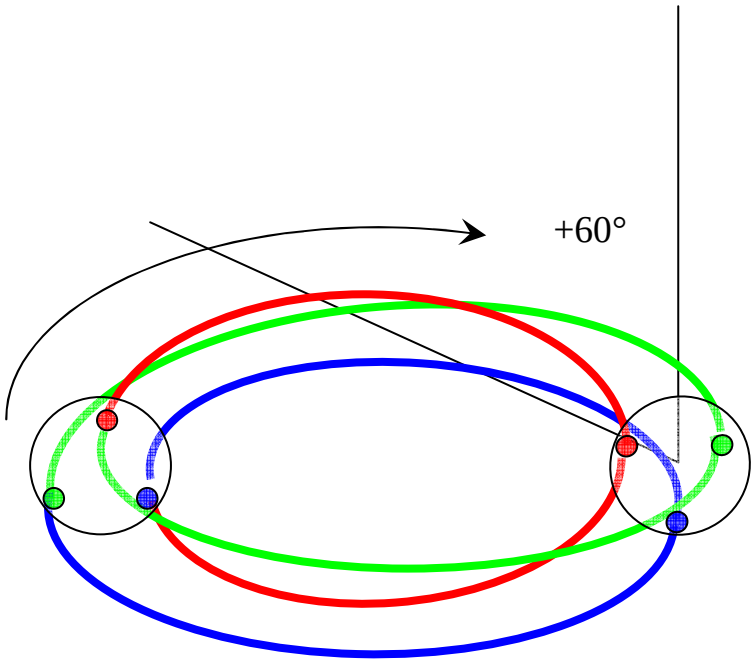
Namely, you can find all the combinations (and only those) who make the quark octet of baryons, the quark decuplet of baryons, the quark octet of mesons and their antiparticles.
So we can safely draw a series of combinations **u**, **d**, **s** (and anti - **u**, **d**, **s**) in a closed thread, being certain that represent mesons or baryons. Their spatial arrangement is always a single wire, wound on a torus.
Here a number of mesons



and here was some baryons

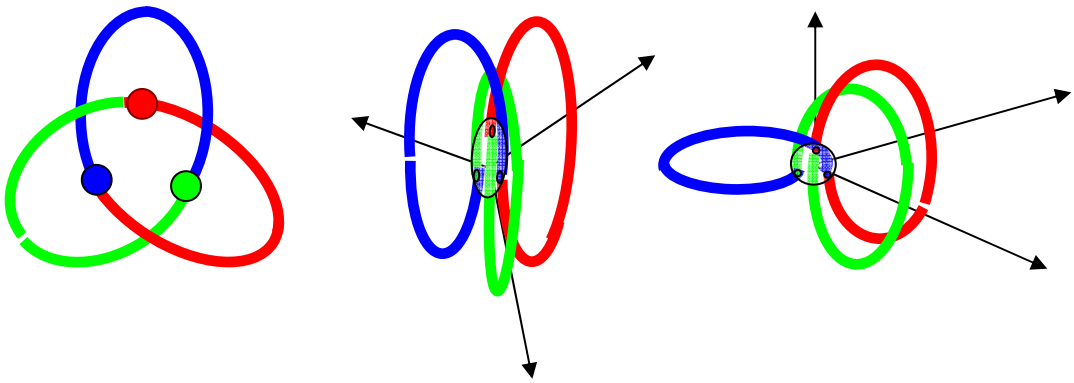


Consider a different hypothetical spatial arrangement.
Each of the individual pieces of helix has a distinct individuality.
In the following example the red quark starts by the red pin and ends on blue, having rotated (+120°) clockwise.
(Note that the piece of red helix could stop at the blue pin with a rotation (-240°) instead, but this is not the case, as shown in the auxiliary reference rotated 60 degrees to the right that I showed. Proceeding in rotation indicated by the arrow, it is rotated +60° clockwise).
Following is a piece of blue helix, which starts from the blue pin and ends on green, having rotated (+120°).
The last piece of the helix starts from the green pin and ends on red, having rotated (+120°).

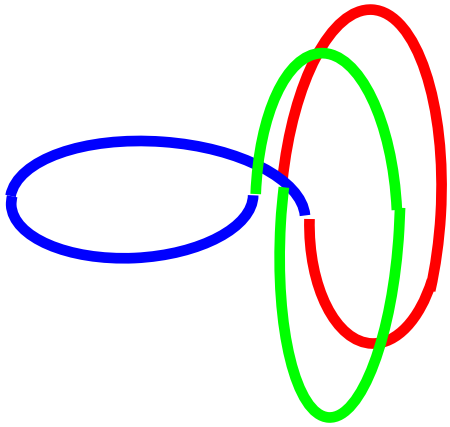


The individuality of each piece of helix is then determined by the degree of torsion, or rotation phase, respectively (+1/3x360°), (-1/3x360°) or (+2/3x360°). We can also consider a rotation frequency which is still in the ratio 1 to 2 or 1/3 compared to 2/3. Incidentally these frequencies in the ratio 1 to 2 or 1/3 to 2/3, could be a useful clue to the development of a mathematical treatment, but here there is no question. We just consider these "electromagnetic rings" as having their own specific individuality. The presence of an electromagnetic interaction between the rings could bring them to arrange themselves in space as
- Trefoil;
- In three spatial axes to 120°;
- On three planes at 90° between them.

I will not make any attempt to imagine what kind forces might be involved or what types of equations can govern the phenomenon.
Drawing these three possibilities following only a concept of graphic symmetry.



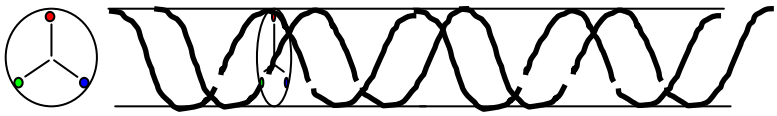
I would emphasize that, despite the appearance of separate rings, these structures are formed from a single-stranded closed ring. We will see that you can imagine even separate rings. However, the single strand seems to be more consistent with the "confinement of quarks”.



Chapter 7
A biology of particles?

7.1- Helices

At this point one might think that we should propose a complete explanation of the structure of the various elementary particles and perhaps of all the phenomena of production and decay of the same. We will venture into anything like this. If until now we have introduced fantastic assumptions, while trying to support them with a little math, from now introduce assumptions even more fantastic, with even less math.
We go into biology.
We found helices. Better to say we assumed helices. These would be quarks.
We also noted that the persistent form of the helix and more the presence of double and triple helix brings to mind similar forms of biology.
There is another clue.
To dial with quarks-helices was need for a symmetry to 120 degrees. The most famous helix that appears in biology is the DNA double helix. It also shows a symmetry to 120 degrees.
The two helices instead of being trivially opposed to 180 degrees, are at 120 degrees.



There are precise reasons for this, but now we are not interested. We note a fact:

there is symmetry to 120 degrees.

We may well speak of nothing more than a clue, but it is curious, it is strange, is suspect.
With a free flight of fancy we can say that this is another element of similarity between the internal composition helices-quarks and molecular biology?
Are certainly similarities rather vague to seriously consider it, apart from its charm.
But insisting on this point of view, there is another fact that could be defined entirely unexpected that supports the idea of quarks helices with a symmetry of 120 degrees.
The fact is the following.
If the quarks are helices, as they are together?

In a sense we could say that we have said, formed a single filament. In order to have this, the partial rotations of 120 degrees or 240 are necessary, as we have examined, and then the symmetry of 120 degrees.
What he says instead physics on how quarks are together?
There are forces between quarks, and there is a theory that explains it, the color of quarks.
This is essentially a mathematical theory, and difficult mathematics, except for those for whom it is not. Physicists have since also made visual explanations for the uninitiated, have tried to describe the theory of colored quarks.
Well, what's the point? The point is that the description of the color of the quark theory seems to tell you ... the model we have imagined here.
Let's see how.

7.2 Colors and quarks

Armed of fantasy let’s now to imagine an interpretation for the theory of colored quarks.
What is the theory of colored quarks?
In particles sometimes there are more equal quarks inside the same particle. For example, into the proton "uud" there are two quark "u".
The thing is strange and following the physics is prohibited.
It’s forbidden by the Pauli exclusion principle, which essentially says that the two quarks being equal can not stand there together in the same place. Must differ in something.
But since two quarks "u" are two quark "u", equal in all respects, Nambu and others said:

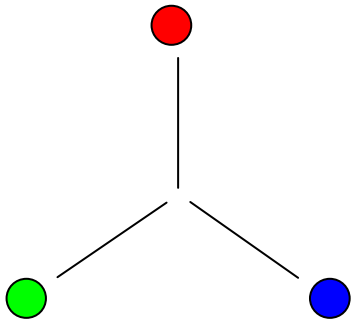
"have different colors”.

At this point even a baryon with three quarks are all equal, such as "ddd", it’s authorized to exist. Just suppose that each quark "d" has a different color.
Assigned to all the quarks a further quantum number, this "color", you can fix things with three colors.
Each antiquark has the anticolor of its quark. Eg "u red" has "u antired" as antiparticle. The three anticolors are the three complementary colors: any color with his anticolor gives white.

Colors quark 

Anticolors (complementary colors) $\overline{R}$ $\overline{G}$ $\overline{B}$

Sometimes we seek complementary colors to represent antiquarks. Other times uses the same colors, with written above the bar that indicates "anticolor”.
Everything is represented with drawings at 120°:

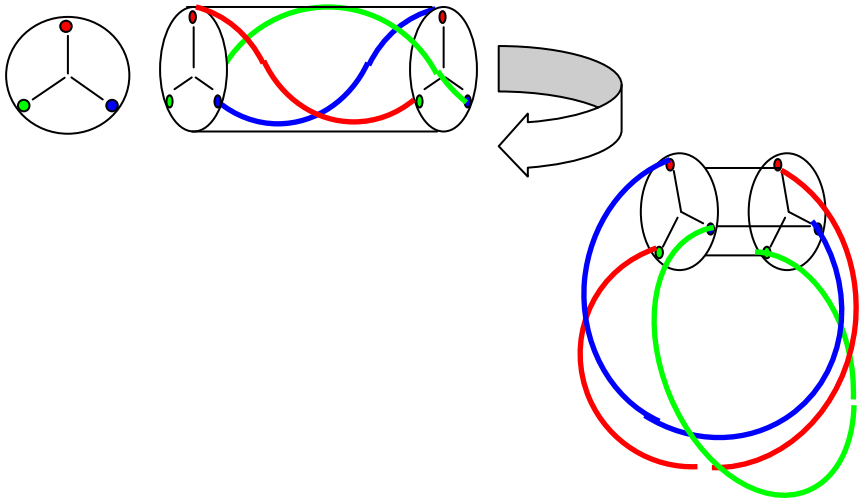


Let it be clear that this is pure mathematics and mathematical physics, then these colors have nothing to do with true colors. So the position of 120 degrees has nothing to do with a real position to 120 degrees.

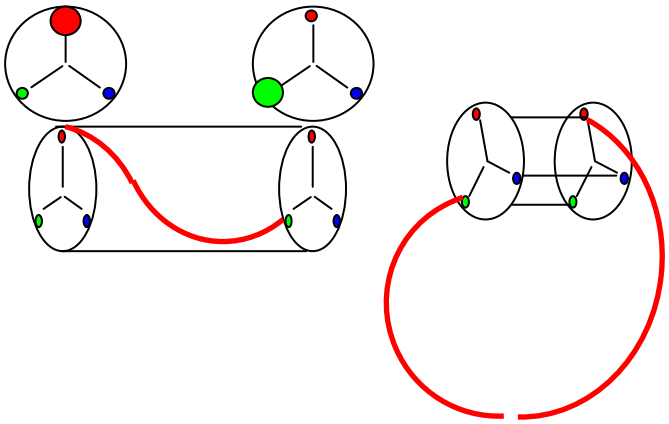
Instead, we assume in a little while they are 120 degrees related to a real position.

Let's go back to what does the theory of colored quarks.
If each quark exists in one of three colors, there is a lot of quarks and so perhaps there should be many new composite particles.
But this is not, just assume that every particle must be "colorless".
Assign the three colors the property, taken together, to give the color white. The requirement for each baryon to be colorless ie "white" limits the number of baryons to the existing ones known.
As for the mesons, all composed of quarks than antiquarks, the color white is that you will achieve with the presence of a color with its anticolor.
Summing each baryon is always formed by mixing RGB red green blue, while each meson is formed from a color from its anticolor.
The theory, created to explain the presence of same quarks inside the same particle was then followed up in QCD, "quantum cromodynamics"
What does the QCD? The colors are held responsible for the forces that hold quarks together.
It’s a continuous exchange of colors that binds quarks together. The exchange of colors is by hypothetical particles "gluons", from "glue".
In this vision quarks of a baryon stay together because they are constantly changing color exchanging gluons, while any time there is always, however, the simultaneous presence of three colors R G B. But over time there must be an equal presence of each of three colors.
As for the mesons in them at all times is a color and its anticolor.
So far the theory.

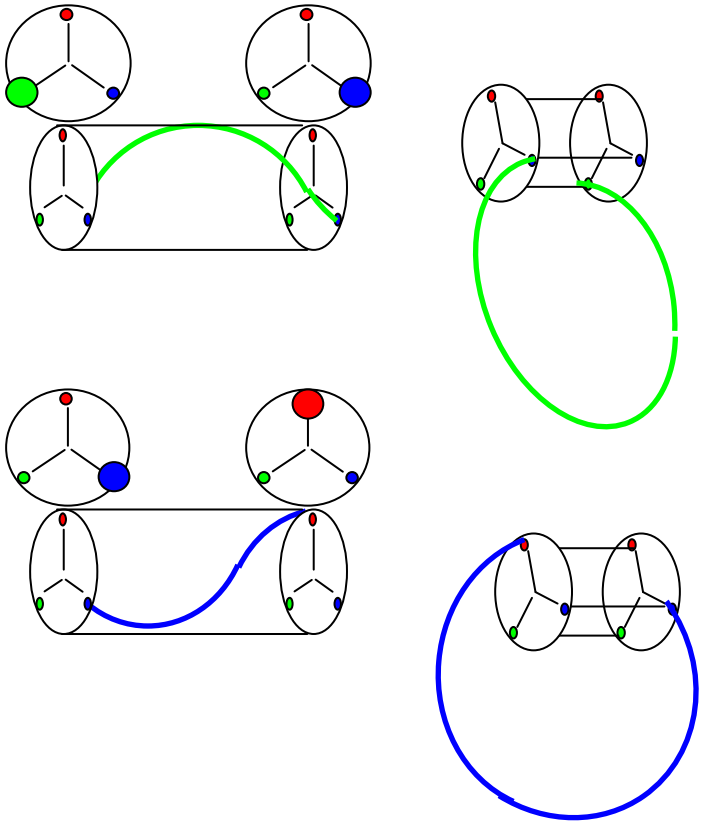
Now let's play.
The game, in short, consists to give to the mathematical concept, abstract, color, a physical concept, the real position. The position of each pin in the triple plug.
We have used colors to distinguish the positions of the pins.
But now we make a drastic change.
At the same colors we used to distinguish the pins give the meaning of a physical theory.
We make a triple combination with two plugs to three wires (quarks), which gives rise to a baryon.
As you can see in this example the red joins with the green, green goes to blue and finally blue to red.



Once made the connections, the triple plug at arrival, the right one, you rotate 360 degrees and will close the connection.
As we had already seen, will come a closed filament, wrapped on a torus. It's just that closed filament we have attributed the stability of the particle.
The elementary particles "allowed to exist" are in fact all and only those that correspond to combinations of these quarks to give a closed filament closed. He is born a baryon.
Right now we speak just "baryon" no matter what it is, no matter what quarks we did use. To fix ideas, we can imagine that the wires are twisted, as shown, to +240° ie all quarks are "**u**".
The game now consists in the color of the quarks.
We said that from the red pin starts a thread that is quark "u". We can say that it's a quark "u red".
As you see the quark "u" starts from the red pin and reach the green.
We can say that the final position has become a quark "u green". He should have anyway to get a pin of another color, not red, because the links "rotate", or 120° or 240°. Then the quark should change color.



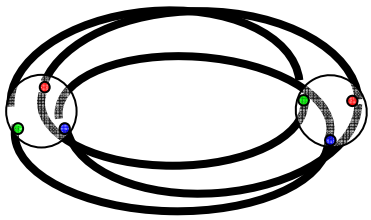
We pass the second quark "u".
This starting position is green, in the final position is blue.
The final "u", changed from blue to red.



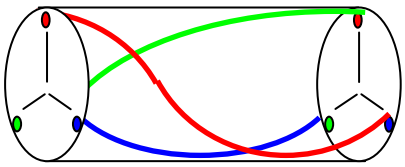
What happened is not a chance. In the model we have taken is a general property of baryons.
In baryons, in fact, all three positions are occupied.
So is each of the three colors.
Therefore, the particle is colorless, R G B.
However, in addition, the positions are occupied but how?
Are occupied working twists of 120 degrees or 240 degrees, never right wires. This condition is necessary for the formation of a closed filament. It means that *each quark is constantly changing position, or change color*.
We can say our game is constantly changing the color of quarks that "holds together" the closed filament structure.
In summary, this is indeed the essence of the phenomenon. Each quark, because the internal rotation, constantly changing position. The obligation of the continuous change of the position of all three quarks becomes synonymous with the fact that quarks are wound to form a triple helix and a closed strand. In what could be that the "forces" which keep quarks stuck in the particle. Approximately the same reasoning, with minor variations, apply to mesons.
We can imagine alternative models?

7.3- Helices and colors

We fantasized about the presence of various helices.
We have seen that a particle like the electron has a simple interpretation with a helix.
We then associate the quarks to pieces of helices.
We have identified the compositions of quarks, helices, which could justify the baryons and mesons.
The baryons are proposing to triple helices, wrapped to form a single filament.
Mesons instead we have associated with double helices.

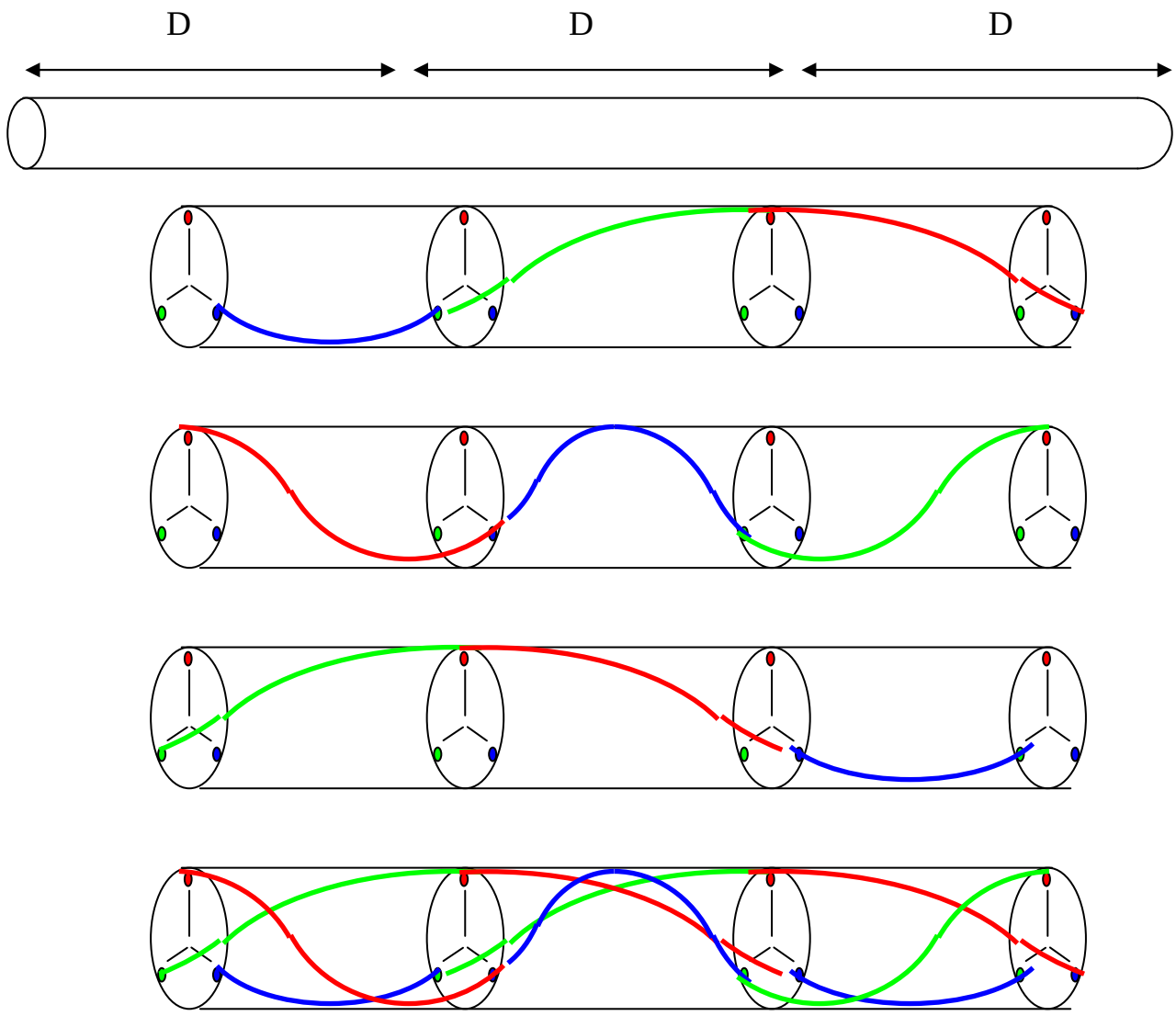


This speech, however, is somewhat ambiguous. Consider a baryon as shown. It's true that there triple helix, in that, in the figure, we see wrapped a triple helix. But this is apparent triple helix. Indeed, as we always repeat, he's made a closed thread.
But then ... we are facing a *single* strand or *three* separate strands, ie three helices real, distinct, juxtaposed with one another?
Making use of the imagination can associate double and triple helices to mesons and baryons in an even more explicit.
Think of an alternative model that we have proposed, or if you want an evolution of it. Consider the following example:

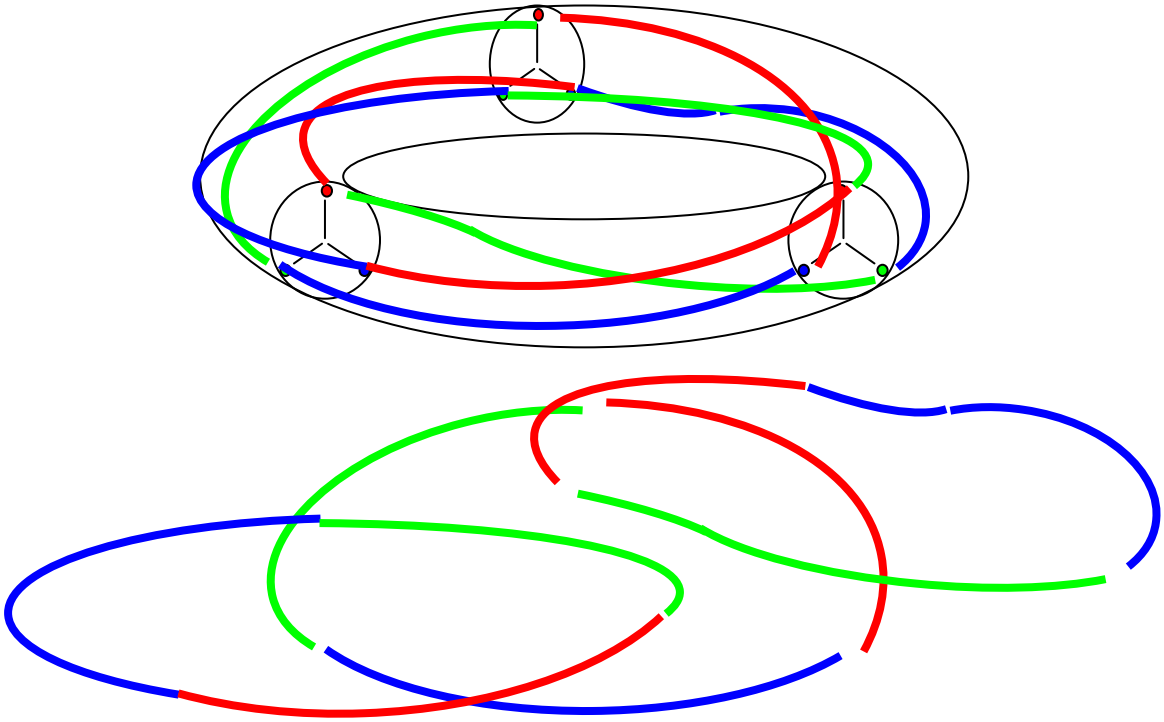


In this example, the twisted wires are respectively 120° and 240°.
It will be recalled that we said to wrap the wires - quarks between two plugs, D away from them. A hose we needed help with the winding process, after which we closed in on itself into a ring. We saw three apparent helices wrapped on a donut: an apparent triple helix, in fact a single strand.

Let us now with the following variant: let the two sockets at a greater distance and more precisely 3 times. We need a rubber tube 3 times longer. Wrapped wires exactly as before for a distance D, continue to wrap.
A wire that was twisted 120 degrees is rotated 120° in the first distance D, another 120° in the second distance D, and then another 120°. After three repeated windings were sold for 360°, a full circle. You return to the starting point.
The wire was twisted to 240° is rotated to 240° in the first distance D, then another 240° and then another 240°. The whole is equal to 720°, two complete revolutions.
So after three repeated windings also this wire back to the starting point.
The same for the third wire.



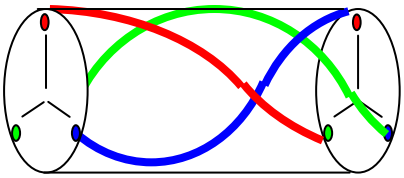
This is the situation. Each wire has resumed its initial position.
We can now close the hose on himself donut-shaped. Each strand folds on itself.
Formed three separate rings, three helices.



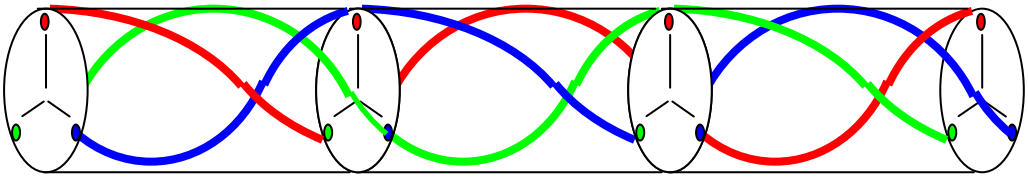
On a donut is wrapped in circle a triple helix.

This time it is a true triple helix.
Three separate rings, but twisted together to form a triple helix.
They say this is just one example.
Not so.
If we adopt this variant of the quark model, all the particles we classified are grouped into separate double or triple helices.
In fact, all quarks and antiquarks we are inevitably associated with rotations (+120°) or (-120°) or (+240°) or (-240°). Therefore, whatever the quark composition of the particle, after repeated every three-winding wire can close in on itself to form a perfect helix.
Who is in these conditions entitled to be called a quark?
Quarks may be the single helices.
The particles that we form with these rules are the same of the previous classification scheme.
We do not know if and imagine what these helices could be prolonged. Indeed we can imagine these pieces in sequence than they want.
We have structure, as shown, with different pitch helices.
It’s possible to think of alternative structures where there are helices, double or triple, with constant pitch, 120 degrees between them.
It can finally think of structures that, after many separate windings, are closed again on themselves to form a single strand.

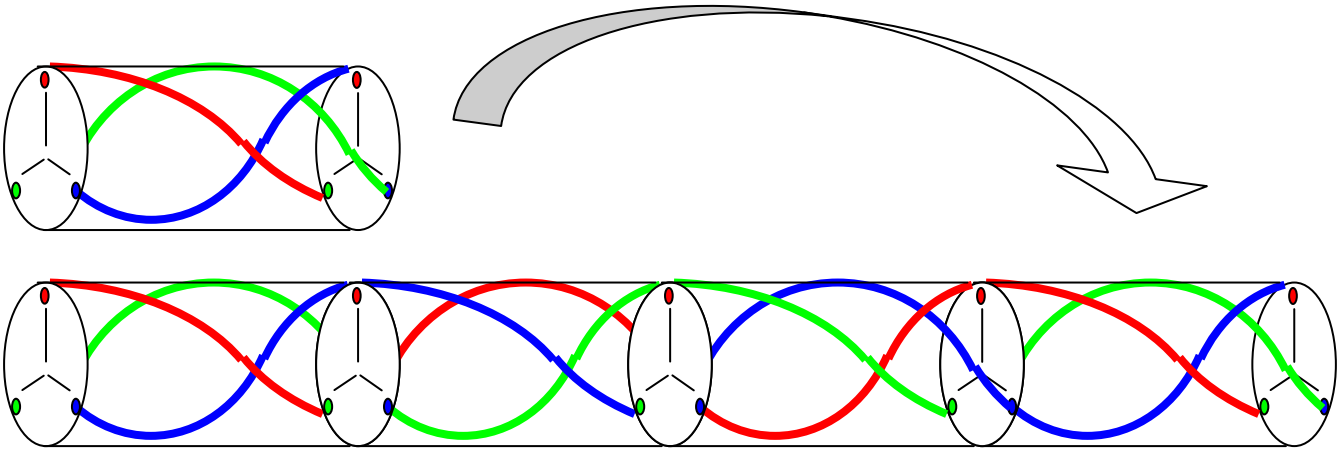
In fact we consider any lawful combination of quarks.



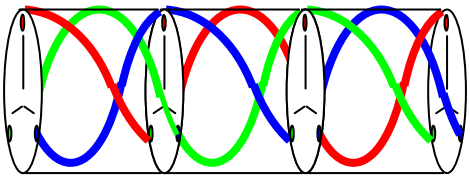
As already noted, if this structure is repeated three times, the situation returns to the starting point.

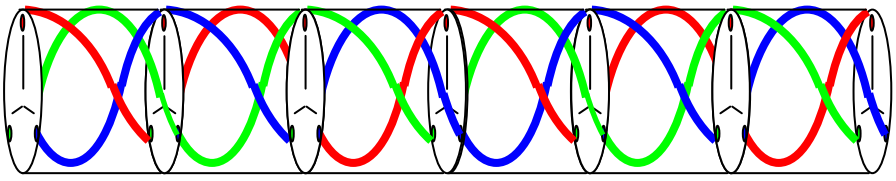


Therefore it is possible to append the first element

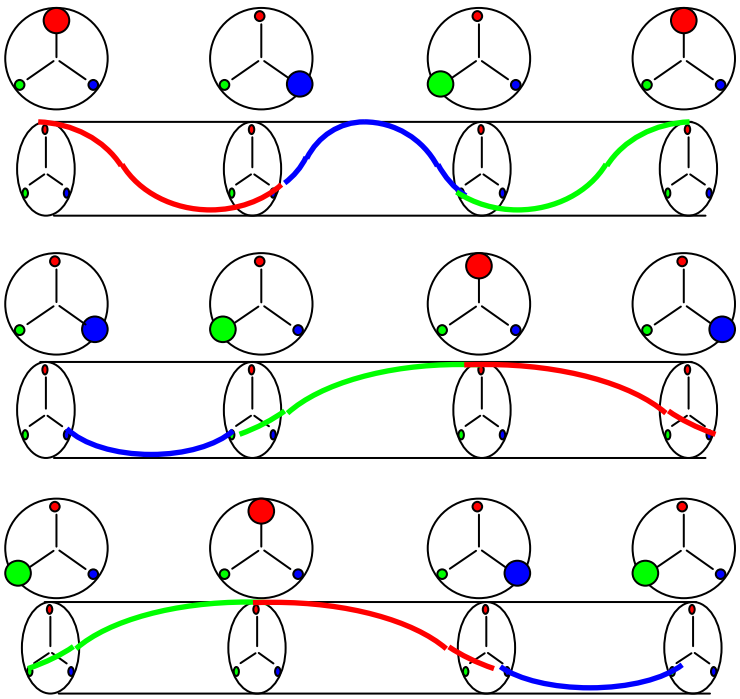


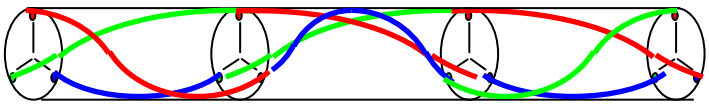
and closing the structure on itself, still a closed single strand will be formed.
This mode of elongation can be repeated indefinitely:





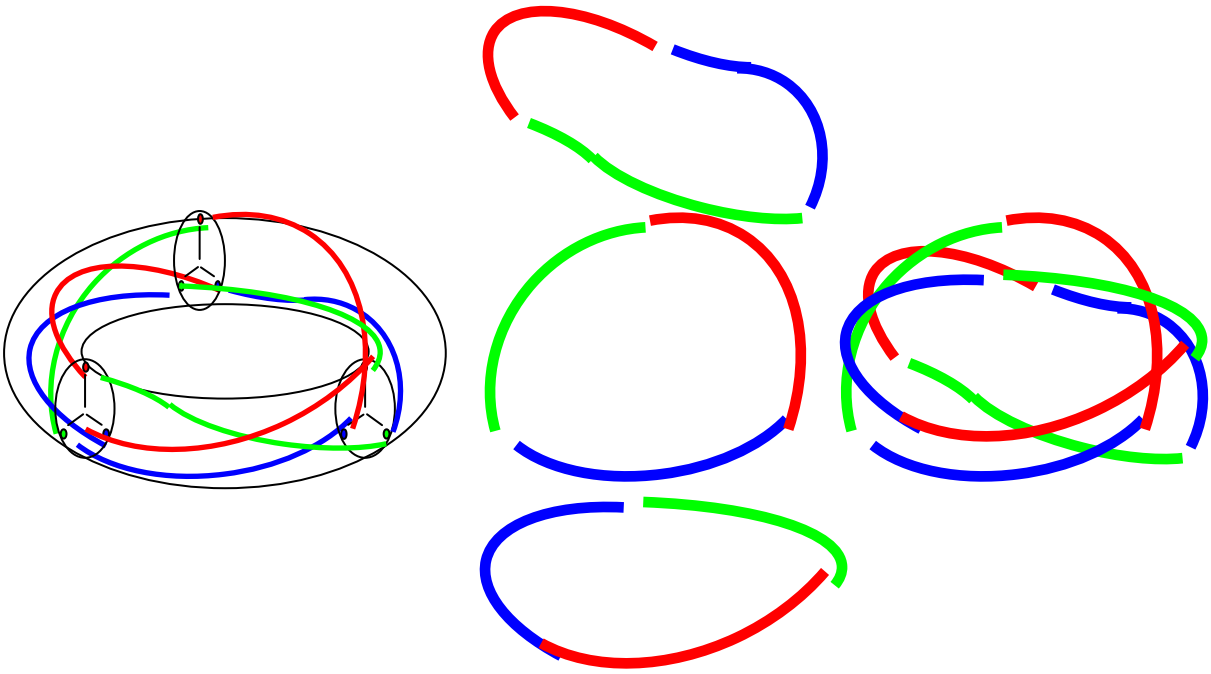
and it is conceivable that the structures formed to maintain the same properties (except grow into energy?).
Now we examine the theory of colored quarks, apply to this variant of the model. It can be assumed also in this case an interpretation for the color. Indeed that is unaffected.
Consider the previous situation and we associate the color to the quarks, giving it a physical meaning.





The figure is imagined a neutron udd.
Outgoing quark is the combination of, say, u red, d blue and green.
The u quark changes color turning 240° left, from red to blue. Rotate 240° left and comes green. With a further rotation, red back.
Instead, quark d blue changes color by rotating 120 degrees to the right, turns green and then goes red, always with rotations of 120° to the right. The same for the d quark green. For each distance D all quarks change color. The continuous color change is caused by the change of color is in each position.

Once again, the essence of the phenomenon is this: each quark, due to internal rotation, constantly changing position. The obligation of the continuous change of position, combined with the obligation to always have all the positions occupied, is synonymous with the triple helix formation and the change of color.
We can imagine a triple helix closed on itself to form a ring.
Each turn each quark change color three times. After a full turn, each quark has regained its color. Also at any time the baryon is colorless.



Models of this kind lends itself very well to "explain", so to speak, the theory of colored quarks.
Consider some statements [35] [36] from the description of the theory of colored quarks.
For example we examine the phrase "a quark of a given flavor has the same properties and the same mass regardless of color" (please note that the characteristic “u” “d” “s” to the quarks is called the "flavor"). This occurs because the color well we tied to location, and a quark changing color is not changed, has changed its position. The quark "u" for example, constantly changing color but it remains a quark u.
Another sentence: "... since the gluons are exchanged continuously, you can not say what color is a quark in a any given moment". This you can clearly see, constantly changing position you never know say that color has a quark.
However, ".. if all the hadrons are colorless, the chances of the three colors are equal". Indeed, as we see, every quark spends his time equally between red green and blue.
The gluons are considered the carriers of the strong force.
Consider the statement ".. when a quark emits or absorbs a gluon (ie change of color), changes color but not flavor".

This is also easily interpretable, in fact the quark changes its position but is always him.
Again: "If the quantum number color is responsible for the link between the quarks, then you can see immediately the absence of strong ties between the leptons, because the leptons have no color". Indeed, the leptons have no positions in a double or triple helix.
The color is also considered responsible for the "confinement of quarks".
This arises from the prohibition that might exist, free, colored particles.
In fact, in our scheme a free colored particle could never exist because, being alone, no longer has a position relative to other, color then it would not. If anything, showing a moment:

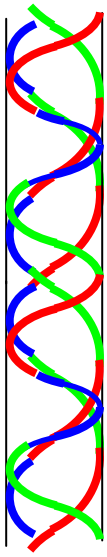
"... An antiquark stick to extract quark, forming a meson. ... So, instead of isolating a colored quark, all that you can achieve is the creation of a colorless meson".

This is interesting.
We will use this in a little to imagine *reproduction*.
But we finish here.
Let's try once again to draw a conclusion.
We can say we have arrived at a final model for quarks?
Certainly not.
The only thing that appears is an invitation to think about models with double or triple helices, with a symmetry of 120 degrees. Interactions and then the binding forces between these helices, that act as coupled electrical circuits, would be electromagnetic in nature, as between strongly coupled coils.
The physical Asim Barut quoted in [5] argues that weak interactions and even strong interactions are actually electromagnetic. More precisely the strong interactions would be short-range magnetic interactions. They would take linked mesons and baryons. Now these forces were the forces that occur between the helices.
Hestenes also uses this idea to imagine an interlacing of helices.
We tried something similar, trying to make us a physical picture of quark justifying the theory of color. But we have not a unique image. Are possible alternatives.
For more on the way we have strayed from the interpretation of electric charge. In the electron there was a plausible justification even for the value of electric charge. Now this justification he's gradually lost its way. Once again we have only clues.
We close with the initial doubt.
It's possible that elementary particles can recreate the forms or certain *helical* forms of biology?
Imagine quarks as pieces of helix does not have a life of its own and go ahead with the imagination.

7.4 Helices and elementary particles

Nature proposes equal forms at different scales.
Let's look at some idea of Hestenes [5].
David Hestenes has proposed a series of hypotheses to explain the structure of elementary particles.
In his model the electron is a roundabout, a circle if it is stationary, which becomes a helix when the electron travels. Neutrino corresponds to a helix travelling at the speed of light.
These are the only simple and stable helices, the stable leptons, ie neutrinos and electrons with their antiparticles.
And the composite particles?
He imagines multiple helices, twisted, intertwined. It is not clear what the nature of this twist. The components helices are simple helices. All particles were formed by helices, single or combined.
The simple helices would be leptons.
The double helices would mesons and baryons triple helices. Particles arise from combinations of helices. For example, Hestenes [5] considers the negative pi (-) meson and a image made of two helices. One of the two helices is an electron. The other helix is an antineutrino. The two helices are twisted. Then we picture the antineutrino helix as winding around the electron helix. The hypothesis is congruent with the fact that the pi (-) meson precisely decays in an electron and an antineutrino.
As for the proton, could be made according to Hestenes three helices intertwined.
Two helices are anti-electrons or positrons. One is an electron. The total charge is +1.
But why, says Hestenes, doesn't the electron annihilate one of the positrons?
Could be twisted by a bond so strong, says Hestenes, to prevent them to separate, except under extreme conditions. *"This seems no more farfetched that explanations for quark confinement"*.
We envisage such circumstances but with a difference.
(In the first draft of the book I was very wide at this point, but now briefly summarize).
The difference is who are these helices component particles.
The internal components of the particles would not leptons, helices with its own life.
The internal components would be just the quarks, as stated in the quark model.
They, as pieces of helix alone can not close in on themselves when taken one at a time, would not have a life outside.
This interprets also the paradox of the existence of quarks, but also of their non existence ... not as isolated particles.
There are, but we should not be isolated. Instead, if we disrupt a particle by forcing them to leave, we would look .... what?
Now we fantasize and imagine something more, a vital structure.
Or at least the resemblance to certain forms of biology.
Biology shows us single, double, triple helices.

Here leptons would replace the single helices. The mesons and baryons than double and triples. Quarks would pieces of helix or members of the strand. It’s possible to support such a view? The mechanisms of particle production are similar to those of biology.

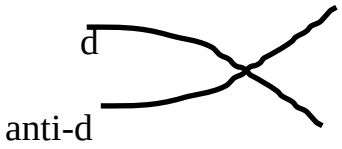


7.5 Reproduction and birth

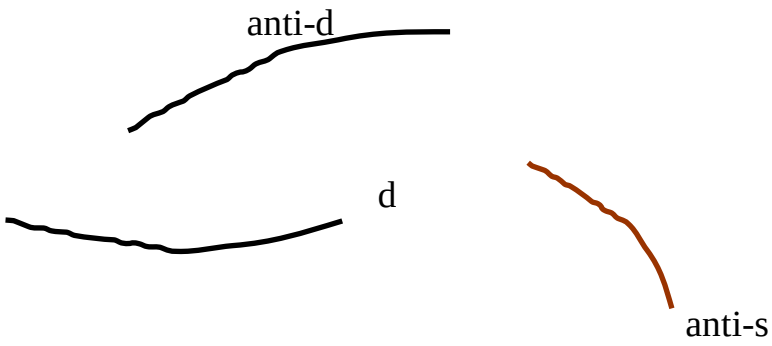
A living organism is born quickly and live long.
With this phrase we mean that usually does not happen that birth and life take place in similar times. For a birth that takes time typically follows a life that lasts much longer.
What happens in the field of elementary particles?
In physics, it is noted and explained that many elementary particles that are produced by shock in accelerators are born for strong interactions and decay for weak interactions.
Tugging at stake as the varying degrees of force in both cases, is justified in the end the experimental fact, that is: they take very little time to born, and then live for a very long time.
If this is not astounding for a living organism, for the particles appeared strange. To explain the strange quark is found, s called, "strange", bringer of strangeness (-1). A strange particle is charged to his creation of this unit of strangeness, and then takes a long time to get rid of it.
Strange particles showed a further property: they born for strong interactions, but born in pair.
The next rule, to justify the creation of particle pairs, was:
"the strong interactions conserve strangeness".
With this, the strong interaction responsible for the birth could not suddenly appear out of nowhere a quark s, which is a unit of strangeness. For the conservation of strangeness between before and after the appearance of s with strangeness (-1) had to be together with the emergence of an anti-s to strangeness (+1). The birth took place then with the appearance of a pair (s, anti-s).
To put things in place the strangeness (-1), ie the quark s, then had to end up in a particle, and instead the strangeness (+1), the quark anti-s, in another particle.
Each particle was loaded so the amount of its strangeness, which would then rid the time of his death or decay.
However a problem arose.
The particles did not die in pair. Each died on his own for "weak interaction".
During the weak interaction decay each of the two particles would necessarily lose its strangeness, no counterpart. With that weak interactions would no longer kept its strangeness.
How do you explain that?
For this purpose, stated the following rule or statement if you prefer:
"the strangeness is not conserved in weak interactions".
All this concerns the strange particles, which have locked in their quark composition a quark s, or an anti s.
And everything works perfectly.
Strange particles created in the collision if there is a lot of energy. If there is no enough energy can not make it to be born and grow just pi mesons or pions.

If we now consider these pi mesons, or pions, they did not know in any s or anti-s but only u, d and their anti-quarks. So they do not apply to the rules of strange particles. However, they also come quickly to strong interaction, they also have long life and also decay, the charged pions, to their weak interaction.
Not being strange, is not necessary that their birth is accompanied by a pair of quarks (s, anti-s), which in fact are not.
But every time they born, it is noted that the process of birth is still accompanied by the appearance of pairs of quarks. A pair (u, anti-u). Or a pair (d, anti-d). Or many couples of that kind, if many pions are born.

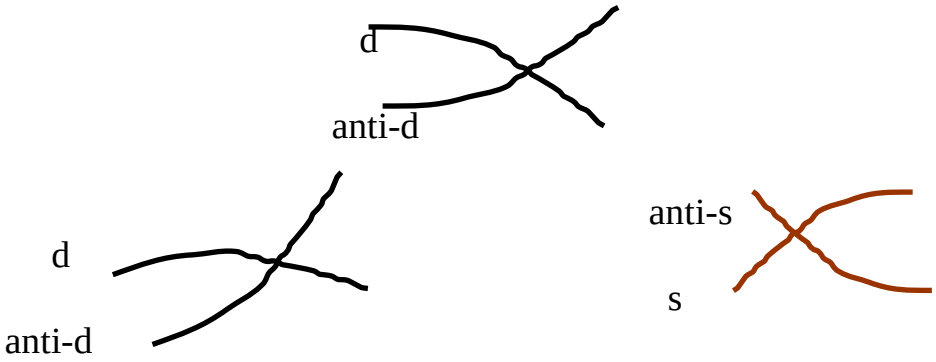
Try reading them in another imaginative way.
Life is propagated through replication on molds.
Imagine something like this for the elementary particles, with an example.
Associate with any pair, (s, anti-s) or (u, anti-d) etc., the image of a double helix.
We draw this double helix, without any claim to guess true with the geometrical shape. For example, us refer to a pair (d, anti-d):



Then attach to a single helix, any of these two, the property on which the tape-mold that replicates its mandatory anti-helix.
To build the replica used construction material.
In high energy physics particle production processes is with a collision.
The collision provides the building material, pure energy, pure electromagnetic field.
In the collision, one of two particles frees at a moment a quark as for example "d", which then absorb immediately.
Or alternately shows outside a quark "d".
Could show its full filament so that you see outside, among others, a quark d.
Immediately it is replicated on an anti-d.
At this stage the energy is extracted from the surrounding material, and d is acting as a template to impose the form of anti-d. If there is a lot of energy available, the mold can form more of an anti-d. Also if there is a lot of energy and some anti-d may give rise to energizing its equivalent energized anti-s.
These replicas are detached from the mold and are immediately ready to act in turn as molds. Example:



Now on every anti-d replicate a d, on every anti-s replicate a s etc. The final situation sees the emergence of couples, couples must of type (d, anti-d) and so on.



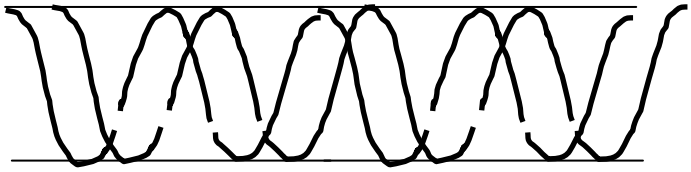
These quark-antiquark pairs could immediately discard in electromagnetic radiation, which for example is the neutral pion, which is translated example into (d, anti-d) but lives just a moment. Or the individual quarks could recompose resulting in more stable particles, charged pions and strange particles.
In this way they should to provide spare components of these various particles.
An example of production of pions in a high energy collision:

$$\pi(+) + p \rightarrow \pi(+) + p + \pi(-) + \pi(+)$$

$$\bar{d}u + uud \rightarrow \bar{d}u + uud + \bar{u}d + \bar{d}u$$

Here is "born" a pair (d, anti-d) that was not there, and a pair (u, anti-u) that was not there.
As you can see an analogy of reproduction and birth appear similar to the forms of biology and functions of DNA.
There is another very simple and obvious. It’s an analogy to the geometric nature. Everybody knows that DNA has a double helix configuration. Much less publicized

is the fact that *the two helices are 120 degrees*. Reappears here this strange and insistent structure of helices to 120 degrees which we have repeatedly met in quarks.



Of course none of this demonstrates something living in the particles, or want to enter here into a discussion of what constitutes "life". Nature shows us, however, insisted on equal forms that reproduce themselves at vastly different scale factors. So this type of scheme could have a reason. It is well suited to interpret the production of pi mesons, or pions occurring in accelerators. The production of many pions are produced by a high-energy collision between a pion and a proton. We can talk about pion production or *reproduction* of pions, by analogy with the reproduction of viruses.
Consider a violent clash between a pion and a proton. Imagine a cell as a proton and the pion as a virus.
The pion, if it is not "frozen", ie if there is enough temperature, or energy, enters the cell proton. Once inside, he opened his DNA helix on which they begin to replicate molds. This is how a number of pions children.
Sometimes, if there is a lot of energy, a pion attacks a proton but come not only replicated samples. Also born other particles.
Then other births of particles require some more general scheme.

7.6-Other mechanisms of reproduction

Consider some examples of the birth of particle by strong interaction.
In the following example:

$$K(-) + p \rightarrow \Omega(-) + K(+) + K^{\circ}$$

a high-energy K meson colliding a proton produces other strange particles. K mesons are reproduced while the proton he's excited at the moment changing in a particle Omega (-), but later return as proton. Look what happened in terms of quarks:

$$\bar{u}s + uud \rightarrow sss + \bar{s}u + \bar{s}d$$

Making a balance between before and after, we see that most were produced in two pairs (s, anti-s). Quarks components were then redistributed between the particles originated. Overall, however, what happened is a copy of K mesons
Let's take another case

$$\pi(-) + p \rightarrow K(+) + K(-) + n$$

$$\bar{u}d + uud \rightarrow \bar{s}u + \bar{u}s + udd$$

Here you add a couple (s, anti-s) that was not there. However, note one more thing: the pi meson produced no other pi mesons, K mesons but.
A third case is as follows:

$$\pi(-) + p \rightarrow \Lambda + K^{\circ}$$

$$\bar{u}d + uud \rightarrow usd + \bar{s}d$$

Pop up a couple (s, anti-s) and is gone a couple (u, anti-u). We can also say that a pair (s, anti-s) has been replaced by a pair (u, anti-u). But once again a pi meson has produced a K meson
We therefore have a more general reproductive mechanism than described in the previous paragraph.
Other reactions leave the fun for the reader (note: $\Xi(-)$ in terms of quarks is dss):

$K(-) + p \rightarrow \Xi(-) + K(+)$

$\pi(-) + p \rightarrow \Xi(-) + K(+) + K°$

So we summarize:
We hypothesized that the particles as it were worthy of existence correspond to the condition that the parts, quarks, we have to make a closed filament or, with the latter variant, double or triple helices. Organisms consider them. The birth of particle by strong interaction, in addition to mere replication of parts through a mould, we see mechanisms of substitution and mutation.

We can still say that you create new organisms, but have the possibility of substitutions and mutations?

Let's stop here with the imagination.
As Hestenes says to finish one of his most imaginative articles [26]:

”That’s enough speculation for one paper!”

7.7 Shapes on shapes

Nature seems to suggest a recurring motif: the organization of forms by stable bricks.
But what is stable? Everything seems to some extent malleable.
Atoms are stable bricks for the construction of matter, molecules.
The molecules are in turn serving as a stable building blocks for more complex constructions.
But the molecules are stable up to a temperature not too high, otherwise disintegrate.
Disintegrate into atoms which, at that temperature, remain unchanged.
Consider synonyms "temperature" or the amount of energy involved in the environment.
We realize then that the atoms remain unchanged until you reach energies (temperatures) such that dissolve them. At this point electrons are separated, stable, and atomic nuclei, stable.
But the atomic nucleus is considered stable as long as we have seen that with higher energies, breaks into stable components.
And so on.
An examination of a little more accurately show that all these bricks behave similarly in three typical regions:
at a temperature for them is low they are stable, frozen, hibernating;
in an intermediate region, involved in reactions, live, combine;
at a temperature for them is high, burn, die, disintegrate.
When disintegrate, they remain the brick components.
These components are stable bricks because the temperature is still low enough *for them* that they are hibernating.
Continuing to increase the temperature, the cycle resumes. Or conversely, if the temperature is not too high, there are forms that appear to be rigid, stable, crystallized. Schroedinger in his historical book "What Is Life" saw in this form of stability the transmission of genetic information, which he attributed to an "aperiodic crystal" anticipating the discovery of DNA.
Very high energy and unimaginable could also discard the last brick instead we seem inexorably stable and eternal, electrons.
What would be next? Perhaps pure electromagnetic field.
We are therefore faced with a fanciful picture, but based on the facts as we know them today.
At high temperatures (energies) of the universe to its original state, formed *by the light* first elementary particles.
Next, and then also at the lowest temperatures of the stars were formed and form the nuclei of atoms.
At lower temperatures of the planets are formed molecules, and so on.
Each form is a "building block" or basis form for the next shape. As long as the temperature of destruction is no longer achieved it (basic form) may remain stable.
What was the beginning?
What is the essence of which all things?

Some argue that the high initial temperatures there was a dense and indistinct "soup" of quarks and electrons, neutrinos and photons. But even before?
Photons are electromagnetic field. If we assume that quarks electrons and neutrinos are made of electromagnetic field, everything is made of the electromagnetic field.
Matter is organized into shapes.
For a long time the basic forms have been identified as dots, little balls. In some ways, if we do not look inside, the atoms are little dots. Even a planet or a star is a dot, if we look from afar.
Biology has begun to discover helices. They in fact are helices so to speak. Biology knows that these sort of spiral staircases have a substructure. They are manufactured in their turn with the bricks that we can represent with little dots.
But they are really little dots? A modern treatise of molecular biology shows us an infinite number of shapes of helices that make up proteins.
We go down to lower level and come up to atom and then electron. Following Hestenes, we continue to find helices up the electron. The most common composite particles, in particular the proton and pi mesons, are intertwined helices.
The constituent helices are few enough, electrons and neutrinos, with their antiparticles if necessary.
Helices of what?
What is the electron? For Hestenes, electromagnetic field. There is indeed in the Hestenes model a point charge, a point, without mass, which justifies the charge q = e. Here we have presented a hypothesis that makes even less of this point, the electrical charge is justified herself by pure electromagnetic field.
However, even for Hestenes, after all, this is not a phantom point charge more than what the electromagnetic field. There is in fact [5]: *".... a kind of electromagnetic wave particle duality where the electron is both wave and particle"*.
The point is therefore nothing more than another way to see the wave. I tried to explain it in section 9.1 “waves and particles”.
Therefore supposed a electromagnetic constitution for the electron and then for the proton, did exactly two positrons and an electron ..... all matter is composed of electromagnetic field.
Hestenes never makes this claim explicitly, at least as I understand it.
But it is *implicit* in his model.
My personal impression is that these statements are dangerous, you risk criticism and controversy.
Schroedinger, despite the fact that .... Schroedinger was, was subjected to jeers for his ideas that everything was made of waves. Furthermore it risks being misunderstood.
Probably, indeed certainly, Schroedinger proposed scientific hypotheses much more articulate the simple statement "everything is made of waves", but this then becomes easy formulas joke.
A similar situation faced by the phrase "everything is electromagnetic field" or worse *"everything is light"*
But it’s a hypothesis to be investigated.

Could serve as some kind of new equations. Could develop some new and more complete view of the electromagnetic field.
And then what the electromagnetic field? Basically do not *really* know what it is. My physics professor said: "The current is that which is measured by the ammeter".
By this he meant that a physical quantity is defined by how they can be measured, namely physics, ultimately, says something like it is measured but physics does not pretend to say *what it is*.
So maybe, in fact it is certain that in future we will better understand the electromagnetic field.
Certainly, as we understand today, a bit as we know and a little work of fantasy, if it is common ground that all is electromagnetic field there would be consequences ... very embarrassing. Matter would lose its importance, its central role.
Be the case that Schroedinger believed a predominance of form over matter.
And a form is malleable.
So as today an electromagnetic wave is modulated to create an image on television, so you could theoretically shaping, modulating the electromagnetic field to produce the matter. Produce objects, and imagination ... even living organisms, and that *someone* might be able to do.
An example? Perhaps we have received or we receive such messages. These messages may be that complex molecules or biological molecules or strip of genetic information, do not know.
What is certain is that it seems to me that the SETI, search for extraterrestrial civilizations using radio telescopes and hunting of coded or modulated radio signals be ..... not so much, I would say, a lack of wisdom as ... a lack of sense of humor.
I always think of this example:
in a galaxy far, far away ... .. a highly developed civilization has reached, say, the level of development that has made him discover the drum. Thus begins the search for other civilizations in the universe by looking for large antennas to hear drums.
Obviously what makes us smile, because we will use electromagnetic signals. But they do not know, because they confuse the drum as the highest level of technical means for transmitting information.
Exactly the same way, with the same ingenuity, we seek .... modulated electromagnetic signals.
But suppose that everything, including matter, is modulated electromagnetic field, or something similar to what we call electromagnetic field, and that someone .... knows how to modulate.
(Note "en passant" that someone who knows how to modulate, according to Veda thinkers and also Erwin Schroedinger could also be ourselves, because we are that, following the Sanskrit sentence "TAT TVAM ASI", which reads “you are that” or rather "THAT-YOU-ARE”).
In this case the highest level of technology that they imagine, to see if there are others listening, could be. ... sending these items, or three-dimensional modulated signals, if we call them. The amount of stored information is potentially much greater than any one "Beep Beep".

Because of the low binding energy of these objects, a good way to preserve them during the trip would be to avoid their environments with high energy particles or high energy photons, that use a low temperature, which is to use a refrigerator ... that is ..... comets as good container as possible for the post. In fact our stuff so we receive a mess but no one, so to speak, considers them.
These ideas are, for example, Fred Hoyle, but on this I do not enter.
What I say is that certainly we can not confuse our current modulation capabilities with the "top" as possible from others, for the simple fact that years ago we thought the telegraph, and then to radio, then television and then coherent multiphase coded signals, and then and then and then.
Here's how the restatement of all of us to one substance to trigger endless debate, like this. You should reconsider much of our philosophy, our religion and our worldview.

Chapter 8
Conclusions

As Bertrand Russell said, if I can not explain how does the electric current to flow in a wire, and then I invented a number of Devils inside that push the electrons to the wire, I did not a lot of progress, then I have to explain why the Devils.
As to say if to explain a strange thing I invent something equally strange, I did not really advanced much.
It is different if a hypothesis seems potentially able to interpret many things. This seems the current situation with respect to the electromagnetic model we proposed for the electron.
And then we saw that spring from this further explanation, also unexpected. Born plausible or at least fascinating perspectives, such as that of subnuclear world structure resembling biology.
However on another occasion says David Hestenes [25]:

"For many years I mulled over(……). I was reluctant to publish my ideas, however, because the supporting arguments were mainly qualitative, and physics tradition demands a quantitative formulation which can be subjected to experimental test".

In my case also there is not for most of the things I wrote a quantitative formula, as would be required in physics or engineering.
For this have long been uncertain whether to write a book. That's why I spoke of clues. On the Internet there is plenty of enthusiastic theories on "electromagnetic vibrating universe", and the like. I tried not to refer back to them. But this idea that trouble, seriously, even more serious science.
Some scientists say.
They speak little, and grudgingly. I tried to tell something about these things, with the seasoning of some personal idea.
What is missing?
Missing what was missing at the beginning of the book.
The electron.
"You know, it would be sufficient to really understand the electron" –Albert Einstein.

Chapter 9
Appendices

9.1 - Waves and particles

How *do you see* an electromagnetic wave? And once you manage to look, as would be *seen*?
The answer to all problems raised by the wave particle duality is here.
And maybe the answer is easy: you would see that points, corpuscles.
With this, we might say, the paragraph entitled "waves and particles" is over.
But after starting this provocative must say something more.
What is the problem?
A particle behaves at times like this and sometimes like a wave. In what sense?
There are mountains of literature on the subject, is the classic example "of the two slits", but essentially this happens: suppose for example to examine the behavior of an electron beam.
We equip with all the practical tools and theoretical physics that we make available and to have before we discover nothing more than clear and incontrovertible *waves*.
Now should organize another experiment, otherwise, always with the same electrons.
Discover so incontrovertible that these balls are, moving *corpuscles*.
This impacts against common sense.
Some people think the question now outdated. Some people considered beyond common sense in the sense that we can not, in the subatomic, to argue with the usual common sense.
It is a fact which, as Schroedinger [4], ".. both in the particle image in that wave is a content of truth, we could not give up. But we do not know how to merge these two truths". Niels Bohr and his disciples invented the concept of complementarity, but always Schroedinger [4] says:

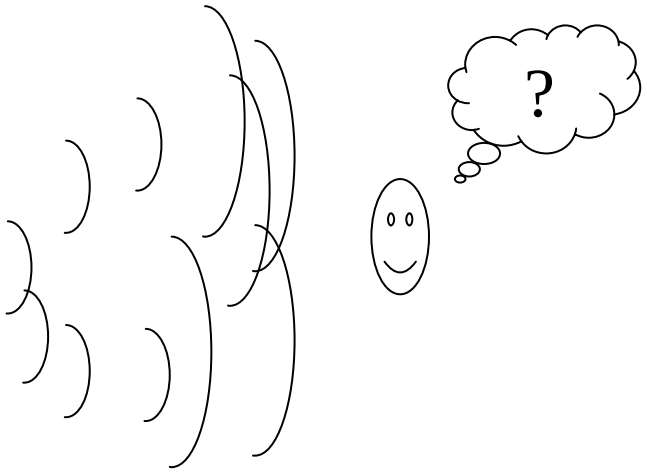
I must confess that I do not understand. For me it is avoidance. (…)In fact we end up admitting that we have two theories, two images of matter that can not agree, so that sometimes we must make use of one, sometimes the other. Once (...) when such a fact occurred, it was concluded (...) that the research was not over yet. It is now the invented word "complementarity" (.....). The word "complementarity" always makes me think of the words of Goethe: "Why where there are no concepts, is a word at the right time".

There is evidence, though not all physicists agree [7]:

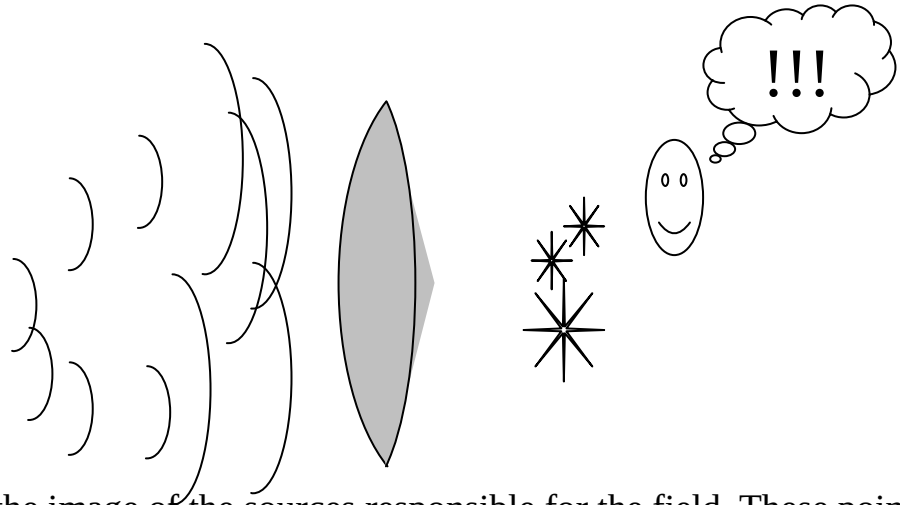
Only when the particles manifest as particles is when we watch.

For example, experiments suggest that when the electron isn't observed to behave like a wave. You see a particle when is observed.

We can help to clarify once again the radar: the Fourier transform and the design of the invisible aircraft, the "stealth".
We begin with a reflection that is the previous one. How do you see an electromagnetic wave? And once you manage to look, as would be seen?
Imagine being in a field of vibration, for example, be immersed in the electromagnetic field radiated by one or more items, electrical charges oscillate, or in the electromagnetic field - light coming from any source station. Vibrations. Light. An extensive system of waves.
Imagine being immersed in this field. We can also think of perceiving this vibration, we can imagine to feel the heat on the skin, but we can not in any way with this immersion of ourselves in the field, see something.



To see something, we need our eyes.
We need a lens.
This lens can be a magnifying glass if the sources are on the table before us. Will be a telescope if the sources are distant. May be the lens of a camera. May be the eye itself, but in this case is just the eye with its lens is a lens. With the lens we see finally some points, those that emit the field.

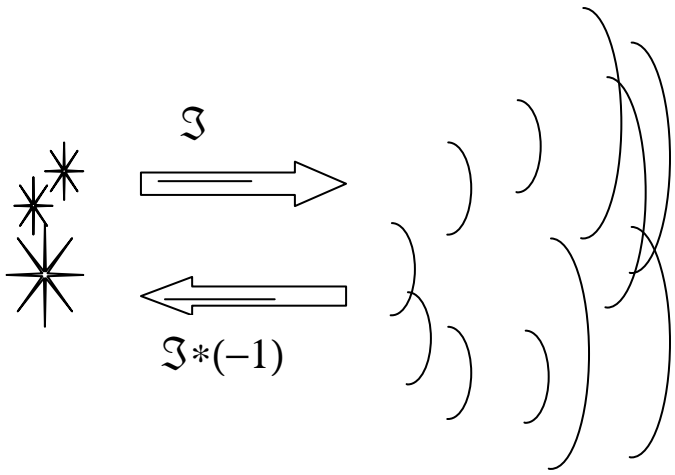


Thus forming the image of the sources responsible for the field. These points are formed on a plane - a dummy image in our brain, or on photographic film, but

quickly our brain puts them where they are truly and finally we say,. “Here they are! Were there".
The operation was performed by the lens or eye is a mathematical operation called "two-dimensional inverse Fourier transform”. It passes from the field in terms of points on a lens-plane to points on image-plane.
But the math is also an expression of a deeper physical fact.

the source of an electromagnetic field generated the field by the operation "Fourier transform" $\mathfrak{I}$.

Expressed brutally simple words it says that the sum of all the vibrations from the point source generating the field.
There is the reverse, "inverse Fourier transform” denoted $\mathfrak{I}*(-1)$. It's called reverse because the two, applied one after the other, shall return to the starting point. Tantamount to doing nothing. It says that the sum of all the vibrations of the field generates the source points.



The physical link between field and source is given by these mathematical operations. (Note: for those who had doubts about the reverse $\mathfrak{I}*(-1)$ we can do the following reasoning. As $\mathfrak{I}$ and $\mathfrak{I}*(-1)$ applied in sequence nothing is done, and as we move using $\mathfrak{I}$ from source to the field, is shown that with the reverse $\mathfrak{I}*(-1)$ returns field to sources).
So maybe this is the bond that fuses these two truths.
Maybe they are our processes of perception that confuse us and particles aren’t *waves or particles* but are *waves and particles*. In fact sources and field trip course in tandem. They are not separate entities. So we have no need to merge these two truths, they have already merged. We then we, through a process of partial perception that, as in the lens, we see a part of this one truth.

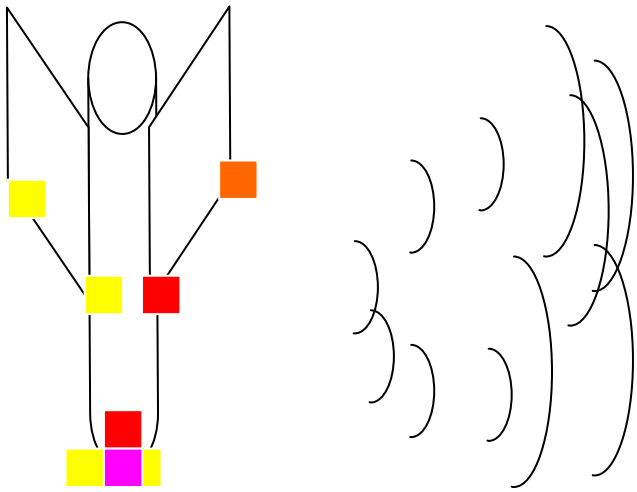
We can now take another step.
If we see points to a static situation, in a situation in motion will see points in motion, which describe the lines. An electromagnetic field is then connected to a line crossed by an electrical point charge, a circuit. In the electron model we have repeatedly spoken of the circuit. We have also agreed to speak, as a synonym of field rotation. Now we understand in what sense can we consider them synonyms. The attempt to see the field through a lens physical or hypothetical, we show a running point, or a circuit.
Hestenes makes such a step, and even now we can appreciate the subtle differences and similarities between the two models. We have assumed a spatial current, an oscillating electromagnetic field, which justifies, among other things also the electric charge. We may call a charged field. Hestenes assumed an oscillating electromagnetic field that warrants only the mass and spin, not in itself justify the charge.

“This oscillating field is a kind of electromagnetic De Broglie wave, so let us adopt a term of De Broglie’s and call it the *pilot wave* of the electron. We may think of the complete electron as a point particle with a pilot wave attached to it. Thus, the *zbw* implies a kind of *electromagnetic wave particle duality* where the electron is both wave *and* particle” [5].

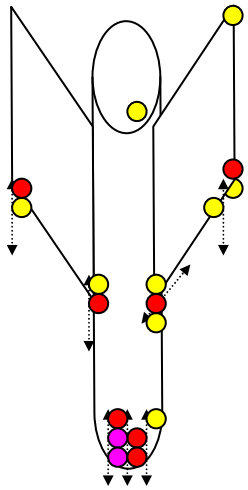
Where is the electric charge? He then Hestenes in the "point particle" without mass, moving on a circle. As it was not otherwise justified the electric charge, we are forced to buckle "e" electric charge of the electron, to the moving point, as the number written on the shirt of a cyclist.
Overall, the final result of the two models become similar.
But let us now examine a case in which the vision of a wave shows points.

9.2 Waves, particles and Stealth

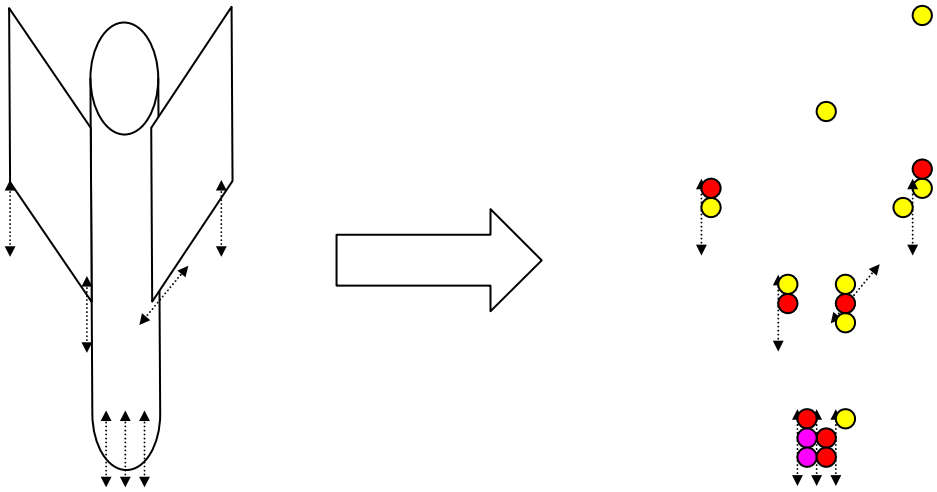
"Looking at" an electromagnetic field can be seen in a suggestive a series of points. These are possibilities that the radar technology has made possible only recently.
In designing the plane invisible to radar, the so-called stealth aircraft, trying to minimize and even if it could zero the radar cross section. This is the meaning of the word “invisible”.
Let's see how the plane is visible, that is how it is seen.
The technique and technology have made great strides here. Many of the advances that have been made, and indeed all occurred under the pressure of military research. So many activities are secret.
But something is largely in the public domain.
We say that the old concept that the target reflects the radar signal was possible to substitute a more sophisticated concept. What to see in detail the radar?
Investing the target with an appropriate radar signal. The target reflects and generates an electromagnetic field. We look at this field with a large electronic lens, which performs the Fourier transform. In practice it is an expensive and complex device that has to do with an antenna and software and, who knows what it is, works with something that resembles the holograms. But we can imagine a big lens, but instead to focus the light focuses the electromagnetic field.
What you see? You see points, hot spots.
Show them in color according to their intensity.



These points are placed in certain places. Are large, say, half a meter, while the target is a few dozen meters.
If you increase the resolution increases the detail.
The points become four inches, one inch.
And more and more. Each point is shown in turn spot size smaller.



Who are these points?
To begin with is not planning to connect them .... to the electrons.
To get to "see the electrons", whilst it may be that it was possible, resolutions serve millions and millions and millions of times higher.
They are in effect responsible for the reflected signal from the target. Are the sources of field.
Are a “mapping" of currents on target.
It’s important to realize that they have to do not with the target as the material body. Are not linked to it so to speak, are only indirectly. Are linked instead to the electrical phenomenon that is established on the target. If we could ideally remove the target as material body leaving this electrical phenomenon (currents, charges) both these points and the radiated field would remain unaltered. What is certain is that from the perspective of the reflected radar signal the "hot spots" and reflected field are the same thing and, paradoxically, we could instead say that the physical body of the target is not involved.
Obviously acts to modify (and possibly reduce) all these points, their position and their intensity. But the kind of action is so done, that the physical body of the target supports the currents and then determine the points.
What does this mean? It means we're seeing these currents. We are seeing an electromagnetic entity, not the plane.
We therefore have a direct link between points and field. Between "hot spots" and field. Field and points are equal.

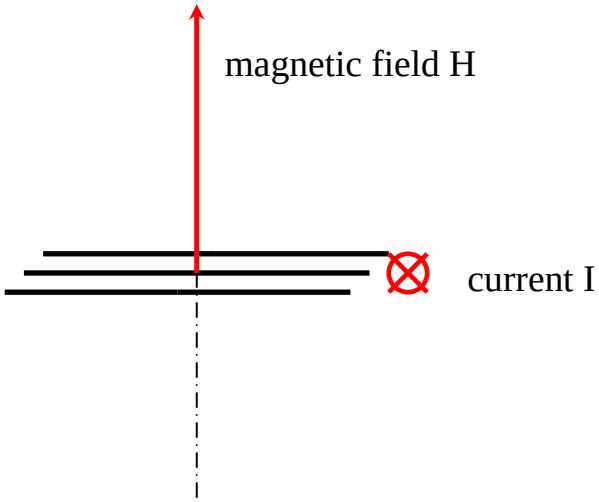


In summary:
the field surrounding a complex object is equivalent to several points, and the two entities points and field go, so to speak, in tandem. The link consists of a "Fourier transform" (direct or reverse), which is moving from points to field or field to points.
The Fourier transform expressed in words says that the sum of all vibration coming from points is the field, and the sum of all the vibrations of the field is concentrated in the points.
Naturally, or rather significantly, you can not alter anything in one without affecting the other and vice versa.
It 's interesting that each point has not its own life. You can not. ... delete a point, or reduce in intensity, acting *on him*.
To change a point must act on the whole, in practice intervene whole shape of the target, or at least close the form there.
Of course there are simple objects with very few points. A case with very few points, indeed one, is achieved by illuminating a tip, the terminal end of a long cone that you do not see the end.

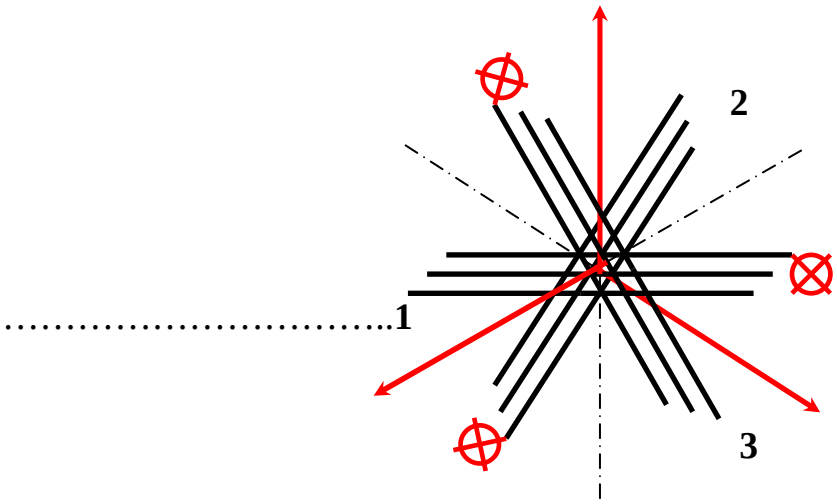
Instead, contrary to what you might think, this does not happen for a ball. A ball, looked at high resolution, shows more complicated things.
We can say that the *hot spots are the electromagnetic field in the sense of wave particle duality?*
Deductions leave to the reader's imagination.

9.3 Quarks and rotating electrical machines

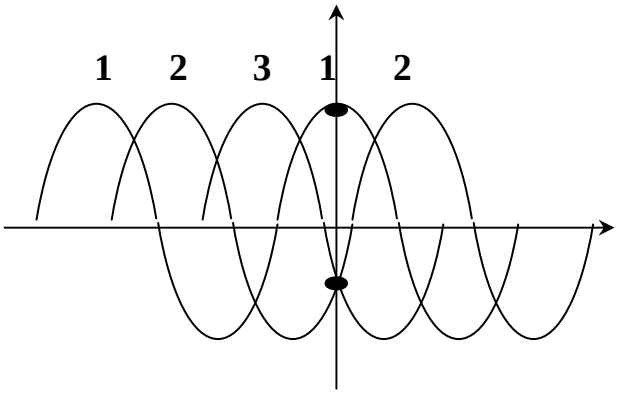
Consider the example of the rotating magnetic field that uses rotating electrical machines.
A rotating magnetic field can be produced with three coils placed 120 degrees between them in space. The three coils will have to be driven by three currents 120 degrees out of phase in time.
The operation is explained in the elementary books of electrical engineering as follows [37]. A coil traversed by a current I generates a magnetic field, directed along the axis, and whose value will be denoted by H.



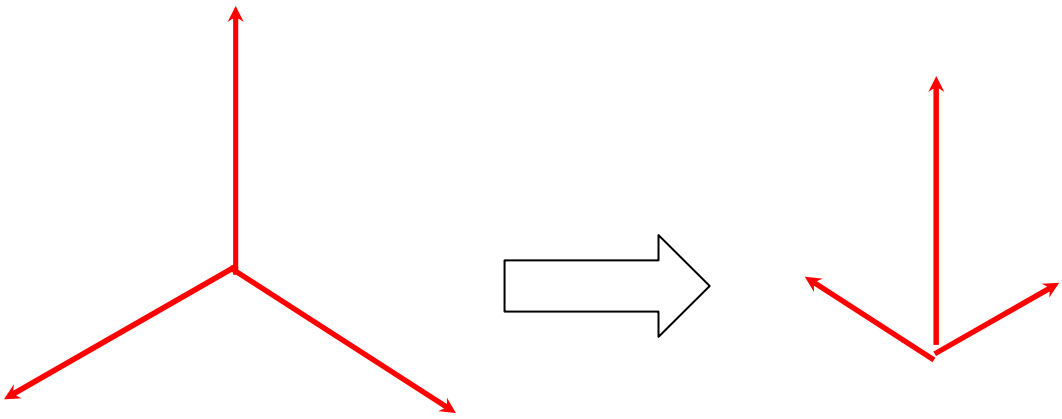
The direction of the field H depends on direction of the current in the coil. In the figure the arrow is the magnetic field and red cross indicates the direction of movement of current in the coil.
Three coils placed at 120 degrees between them, each will behave in the same way. Each generates its own magnetic field H directed according to its axis.



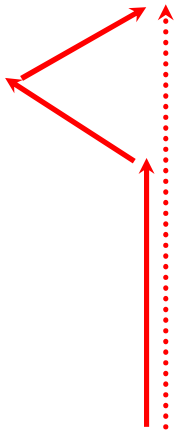
Note incidentally that in these conditions field resulting from the sum of the three magnetic fields would be zero.
All this if each coil is traversed by the same current I.
But suppose instead that the coils are traversed by three sine currents 120 degrees out of phase in time, a current 1 in the coil 1, the second current 2 in the coil 2 and 3 in 3. These currents are shown in the figure below.



Consider the moment when the current 1 in the coil 1 has its maximum value I. At the same instant the currents in 2 and 3 are one half, and negative.
Then the fields produced by coils 2, 3 will be one half and negative, then opposition at first.

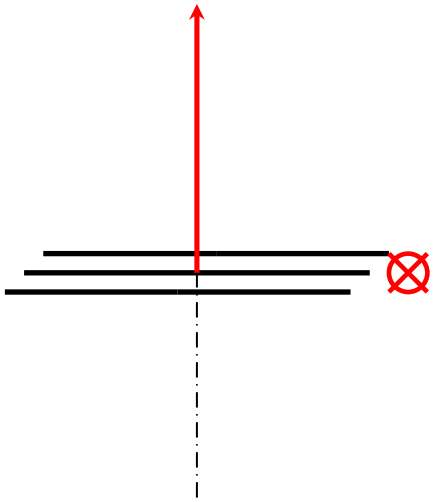


The vector field resulting from the sum of these three is, making calculations, no more H but 3/2 H.

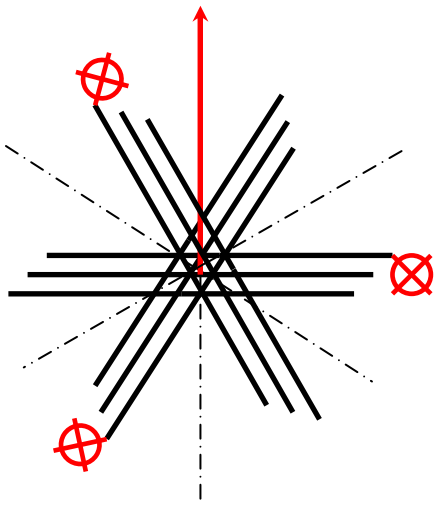


It can be shown that in the moments afterwards, varying the three current, the field rotates.
Nikola Tesla claimed that he identified the concept of the rotating magnetic field in 1882. In 1885, Galileo Ferraris independently researched the concept. This way to obtain a rotating field had various applications in electrical machines.
But what we now want to see is something else.
We want to focus on this value 3/2 H.
If the instant considered the current was (2/3 I) instead of I, and the other two a half of this and negative, ie (-1/3 I), a brief reflection shows that the resulting field would not have value 3/2 H., but H.
We can summarize as follows.

A field H is obtained in this structure with a current of value I.



The same field H you get into that structure at 120 degrees with three current of value +2/3 I, -1/3 I and -1/3 I.



In conclusion, it appears current *and therefore electric charges* in relations 2/3 and 1/3. Are strange values attributed to the quark electric charge.
Clear the situation.
In the electron we have assumed an electromagnetic field and intimately associated with it an electric charge q = e. In a charged particle composed of quarks, there is still a total charge q = e, but it is assumed that there are internal charges, which nobody has ever seen free, taking fractional values +2/3 and -1/3. Now with the example of electrical machines we see the same phenomenon of electromagnetic field can be produced in two ways. Or a current I or currents taking fractional value 2/3 I or -1/3 I, with windings at 120 degrees.
This shows something? In truth we have only one set of tricks, the similarities between currents, windings at 120 degrees and charges of quarks. But analogies are very suspicious.
We could at least draw the assumption that 120 degrees appearing in abstract schemes for quarks have a real physical meaning.

9.4 C P invariance and the magic mirror

Before coming to talk about the magic mirror we must make two premises.
The first concerns the spins in abstract spaces.
Appear in physics spin in abstract spaces.
To "spin" is a rotation. By "abstract spaces" means that this rotation is not to say that is true, in space. But the mathematics in a mathematical space just "abstract", says there is a rotation. For example, in weak interactions such a thing happens.
The weak interactions are those in which intervenes the "weak force", one of the so-called four fundamental forces of nature, the electromagnetic, weak, strong and gravitational.
The theory of weak interactions considers a rotation in an abstract space inside the particles.
In fact, we repeat, this is half mathematician, an abstract internal rotation that occurs in an *abstract space*, where a spin up-spin down, ie a change of rotation from right to left ... what does?
Changing the electric charge.
Now we, supported by the evidence for those who want to reread the preceding chapters, or a free flight of fancy, we assume that this internal rotation, which appears in the theory of weak interactions is not abstract but real.
In truth there is no need to invent ad hoc, since we had previously faced an internal rotation that needed to be interpreted. So tempted to match it in some way to weak interactions. In physics would not be possible but in a science-fiction novel.
What can we find supporting evidence?
The most obvious that come to mind is that can be linked to the charge. Since *abstract* internal rotation appears in weak interactions is linked to the charge, we think that a *real* internal rotation is related to the charge. In the theory of weak interactions that a change of spin changes the charge. So we think that a change of internal rotation changes the charge. We can not pretend to lay down about a theory that reproduces all the exact requirements of the theory of weak interactions. But we can examine whether it is reasonable at least qualitatively link the internal rotation to the charge.
Let the second premise. The second premise concerns the symmetries.
(Before I continue honestly to warn the reader who have not had a headache that some people are mad about the symmetries, but they are a headache to others).
So how much has been written about the weak interactions to the parity violation by the weak interactions has been written even more.
I will not repeat the thousand conjectures about this violation of parity. It arose from a famous experiment of Mrs. Wu, is famous for at least for those who know him, and led to tell someone that perhaps nature is left-handed.
Before the experiment of Mrs. Wu thought with perfect faith that there should be a "symmetry" between the world and its mirror image.
In physics this was and is called P invariance, related to the P symmetry, the symmetry of the mirror. How to say that, against a phenomenon, would also be

possible anyway, in the mirror. This was a profound belief of physicists, and when he showed no real in weak interactions an uproar was born, because the experiment done in 1956, could have been done much earlier and nobody had thought.
Not only exists the violation of parity in weak interactions.
Together with the P invariance exists in physics C invariance.
This requires the application of another symmetry, the C symmetry "charge conjugation", an exchange of charge (more specifically and more generally: the exchange particle - antiparticle). It switches from a phenomenon to another phenomenon also possible.
But weak interactions showed violate C invariance also
Conversely, weak interactions do not violate, they satisfy the combined C P invariance.
Ie, reflect the phenomenon in a mirror, and then do an even exchange of charge (more specifically the exchange particle - antiparticle) then get another phenomenon also possible.
The whole thing is quite mysterious.
Quote an effective summary sentence of Ford [33].

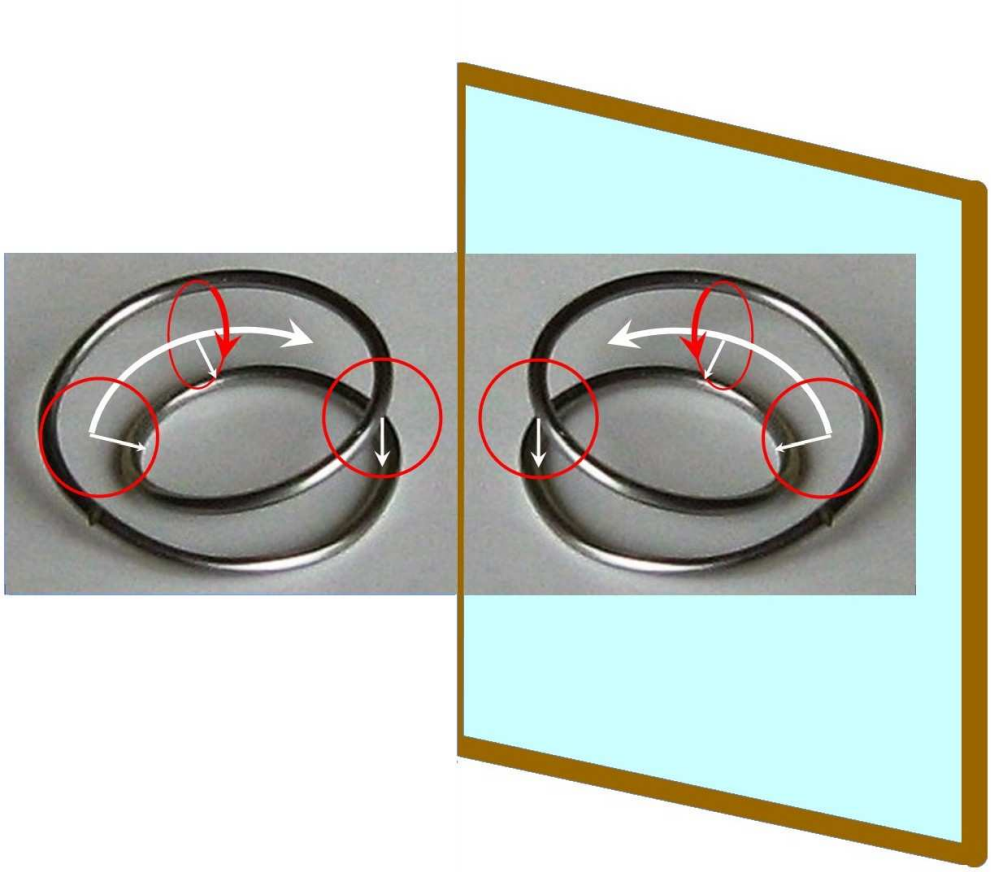
Nobody knows why the weak interactions obey only the law of combined C P invariance, but the fact that this is done has led physicists to look more closely mirror images. Essentially, the question raised from C P invariance is: ***how do we know that the mirror image of a particle is a particle and not an antiparticle? Perhaps the reverse particle - antiparticle for some deep reason goes hand in hand with spatial inversion, and is perhaps the C P combination that represents the "real" mirror image****".*

(Italics in the text of Ford. The bold is mine).
Also says Ford:

“How do we know that the mirror image of a positive charge is still a positive charge? (....) If we decide to do the opposite hypothesis (and a careful examination will show that no one can disprove) that the image of a proton is an antiproton, then the C P invariance looks more natural".

This means to assume a magic mirror, a “C P mirror”.
He should reflect the objects and .... change the sign of electric charge. The procedure of this mirror is thus quite unique, and ultimately explain a strange and unexplained fact with another strange and inexplicable.
Conversely, the model we have built also explains that odd without introducing any additive hypothesis.
Manufacture with the help of the wire a charged particle, explicitly representing his charge with internal rotation, an helix inside. We do not know if the negative charge should be a rotation left or right, whatever is a rotation, and that of the corresponding antiparticle will rotate opposite.

We manufacture a particle and watch it in the mirror.
An ordinary mirror.



The spin, rotation around the vertical axis, whatever it was, is reversed, as it should be. This is the action of P parity.
But something more happens. Looking in the mirror the figure also shows that the internal rotation, necessarily, is reversed. Then changes the charge. This is the action of C. Overall, the mirror image of a particle is its antiparticle, as Ford wanted.
Then the mirror work in a natural way reversing C P.
But isn't a magic mirror.
It's a standard mirror, the P invariance has put in place to automatically C invariance.
What has it right was the fact that he had assumed, and then later represented the charge with a rotation. An internal rotation.
We can then resume the sentence for Ford but removing the "perhaps" and the mystery of "for some deep reason".
We can simply say:

The reverse particle - antiparticle goes hand in hand with spatial inversion, and is the C P combination that represents the "real" mirror image.

10-NOTES

[n1]
All properties mentioned are simply mathematical properties of what are called "two-dimensional analytic functions". The analytic functions are functions mathematically defined by the so called Cauchy Riemann conditions.
Cauchy Riemann conditions are written succinctly:
$\partial * f = 0$.
Especially with the work of Hestenes and colleagues has made it quite clear that Maxwell's equations are nothing but the Cauchy Riemann conditions, written this time in four dimensions, space and time. By requiring a bivector be an analytic function, you get in one fell swoop Maxwell's equations.
Two books written by Maxwell are summed up in brief but cryptic formula:
$\partial * F = 0$.

[n2]
To simplify we can compare the formula of a particle energy in relativity theory, with the formula of the propagation speed in a waveguide. The energy of a particle is:

$$E = \frac{mc^2}{\sqrt{1-\frac{V^2}{c^2}}}$$

The propagation velocity in waveguide is:

$$V = c\sqrt{1-\frac{f_C{}^2}{f^2}}$$

where f_C is the cutoff frequency. Note that the formula applies equally well for TE modes than for TM modes.
Identifying the rest energy mc^2 with the cutoff frequency f_C and frequency f with energy E the two formulas coincide. In fact obtaining f from the second one with some step is obtained:

$$f = \frac{f_C}{\sqrt{1-\frac{V^2}{c^2}}}$$

We also give a visual representation of what happens In relativistic mechanics the momentum, which is for low speeds $p \cong mV$, holds:

$$p = \frac{EV}{c^2}$$

From here, with some step the energy formula is rewritten:

$$E^2 = p^2c^2 + m^2c^4$$

The formula, as written, clearly interpret the graph relationship in the text. The total energy E is the hypotenuse of a right triangle. The part at rest mc^2 and the part pc due to motion are the sides. The formula $E^2 = p^2c^2 + m^2c^4$ is the Pythagorean theorem.

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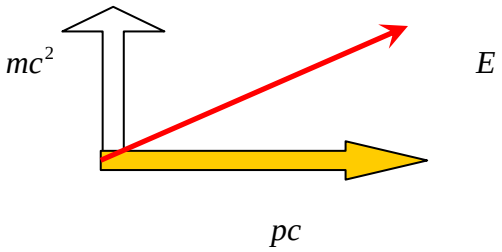
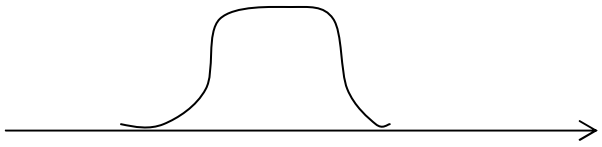


[n3]
Calculations iron.
Consider a current pulse I of duration T . Associate more or less arbitrarily to duration T a frequency ν equal to $1/T$. Then impose the values of charge and energy of the electron:

$$E = h\nu$$

$$e = IT$$



Calculate the power dissipated in a resistance R using the expression of electrical engineering:

$$P = RI^2$$

From power can calculate energy,

$$E = RI^2T$$

Substituting here the values $T = 1/\nu$ and $I = e/T$ gives:

$$E = e^2\nu R$$

that equate to energy $E = h\nu$:

$$E = e^2\nu R = h\nu$$

For comparison would be:

$$e^2R = h \qquad \rightarrow \qquad R = h/e^2$$

This is the value of resistance required, which can give a specific symbol R_K which is the symbol adopted for the von Klitzing constant

$$R_K = h/e^2$$

It can give an alternative expression through the fine-structure constant α and the impedance of vacuum Z. It starts for this from the α and Z expressions:

$$\alpha = e^2/(2\varepsilon hc)$$
$$Z = \sqrt{\mu/\varepsilon}$$

With some steps and $c = 1/\sqrt{\mu\varepsilon}$ to reach:

$$R_K = Z/2\alpha$$

The value is 25812.8 .. ohm plus more and more decimal digits.

[n4

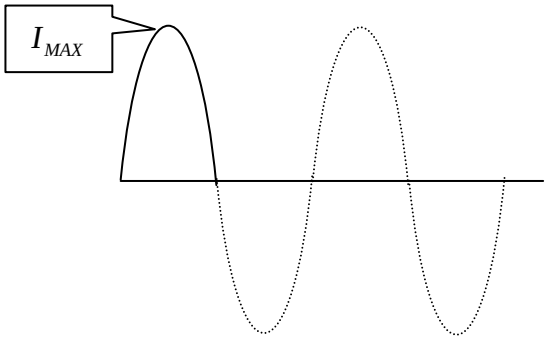
Consider a permanent oscillation in a L C circuit.
The values of inductance L and capacitance C set the resonance frequency:

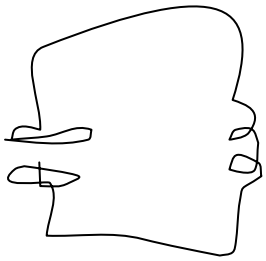
$$\omega = 2\pi\nu = \frac{1}{\sqrt{LC}}$$

and the characteristic impedance or "circuit effective resistance" Z:

$$Z = \sqrt{\frac{L}{C}} = \omega L$$

Let $T = 1/\nu$ the period and I_{MAX} the maximum value of current.





The electric charge associated with a half-wave is

$$q = I_m \frac{T}{2}$$

where I_m is the average value:

$$I_m = \frac{2}{\pi} I_{MAX}$$

The energy in the circuit can be calculated either when is all inductive or all capacitive. It holds:

$$W = \frac{1}{2} L I_{MAX}^2$$

Impose the charge q is equal to the charge e of electron.
Must be:

$$e = q = \frac{I_{MAX}}{\pi} T$$

From here we get:

$$I_{MAX} = \frac{e\pi}{T} = e\pi\nu$$

which can be substituted in the expression of W:

$$W = \frac{1}{2} L e^2 \pi^2 \nu^2$$

Doing here display the circuit characteristic impedance $Z = \omega L$ to reach:

$$W = \frac{\pi}{4} Z e^2 \nu$$

If this energy must be equal to the energy of the electron, and thus expression:

$$E = W = h\nu$$

must be:

$$\frac{\pi}{4} Ze^2 = h$$

The circuit impedance so must be:

$$Z = \frac{4}{\pi}\frac{h}{e^2}$$

Conclusion: apart from the discrepancy of a factor $4/\pi$ appears here *almost exactly* the value of von Klitzing constant
You may impress the mistake of a factor $4/\pi$, but this is not what should impress. A priori calculations of this kind could lead to the need for resistance 0.0000000000000001 ohms or 50000000000000000000 ohms which would be awkward to interpret. Instead it is a value of *about 26,000 ohms!*

[n5]

Here I must say that based on our previous evidence the bond would be possible: it is that the energy of the electron, Planck's constant multiplied by frequency ν, can be interpreted by a small current due to a charge "e", electric charge of the electron, and this alloy quantum mechanics to electromagnetism.
Interrelate by quasi electric formulas.
The fine structure constant is:

$$\alpha = e^2/(2\varepsilon hc)$$

From:

$$\alpha = e^2/(2\varepsilon hc)$$
$$Z = \sqrt{\mu/\varepsilon}$$
$$E = h\nu$$

with some steps and $c = 1/\sqrt{\mu\varepsilon}$ to reach:

$$E = \frac{Z}{2\alpha} e^2\nu$$

This terribly reminds the power - current binding into a resistance

$$P = Ri^2$$

and even more so remember when we consider that there is a resistance in experimental physics with a value

$$R_K = Z/2\alpha$$

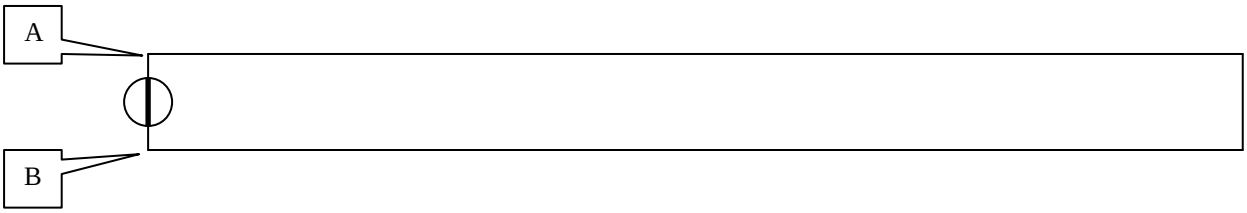
whereby

$$E = R_K e^2\nu$$

The value R_K is equal to 25,812 ohms, with more and more decimal digits.
Of course it can be considered completely random that if there is a small current that has energy $E = h\nu = R_K e^2\nu$ this equates to transit for a small charge e equal to the electron charge. But it's hard to be a coincidence.

[n6]

Calculations from [21] (Soldi).
As an example we determine the equivalent circuit of a short circuited two-wire line, taken from [21].
A Dirac delta impulse $\delta(t)$, applied between A and B gives rise to a series of pulses that occur with alternating signs between points A and B, at intervals of 2τ, being τ the line travel time.



For who knows what it is, it refers to the Laplace transforms.
The impedance Z_{CC} seen from A and B is equal to the voltage $V = Z_{CC} I$ for $I = 1$. In the field of inverse transforms which means the voltage between A and B for an input current equal to a Dirac impulse $\delta(t)$. The expression in time:

$$Z_{CC} = Z_O \left[\delta(t) + 2\sum_{K=1}^{\infty} (-1)^K \delta(t - 2K\tau) \right]$$

corresponds to the expression in Laplace transform with $p = \sigma + j\omega$

$$Z_{CC} = Z_O th\tau p$$

The hyperbolic tangent has a series development using the formula:

$$thx = \sum_n \frac{2x}{x^2 + \frac{n^2}{4}\pi^2} \qquad \text{(n odd).}$$

With a few step you can so write the impedance Z_{CC} in the form:

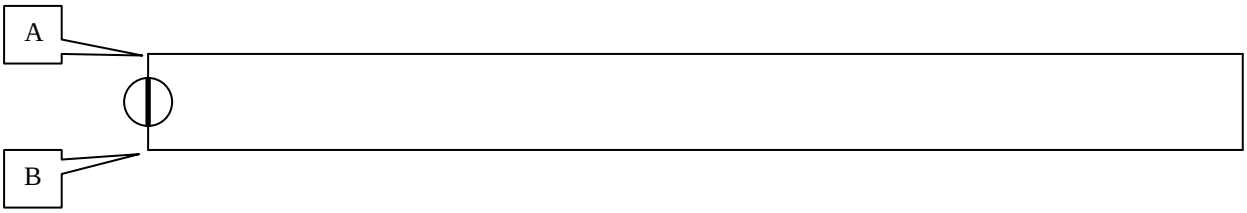
$$Z_{CC} = Z_O th\tau p = \sum_n \frac{1}{pC_n + \frac{1}{pL_n}} \qquad \text{(n odd)}$$

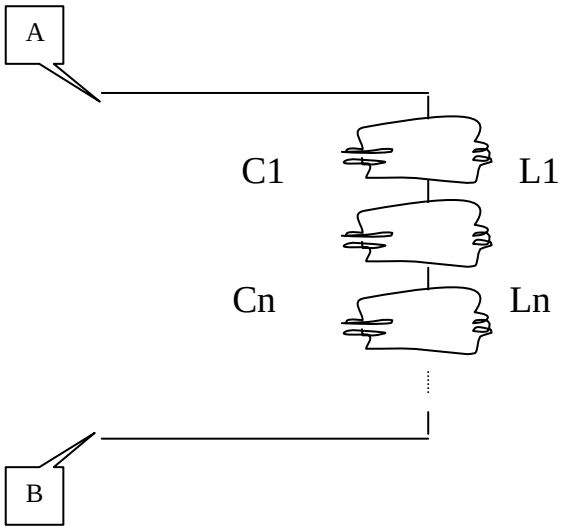
$$L_n = \frac{8Z_O\tau}{n^2\pi^2}$$

$$C_n = \frac{\tau}{2Z_O}$$

This formula is a series of oscillating L C circuits.

The final result is the following:
the line seen from A and B has a lumped element equivalent circuit made of an infinite number of oscillating L C circuits.





The first resonant frequency is:

$$\omega = \frac{\pi}{2\tau}$$

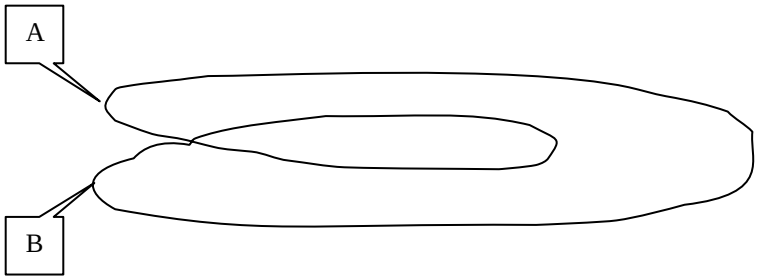
The characteristic impedance of this oscillator that resonates is *almost* equal to the characteristic impedance R_K of the line. Its exact value is

$$\sqrt{\frac{L1}{C1}} = \frac{4}{\pi} R_K = \frac{4}{\pi} \frac{h}{e^2}$$

These values will serve us in a following computation.

[n7]

Calculation oscillating circuit with factor $4/\pi$.
Assimilate the wire seen between points A and B to a short circuited line with characteristic impedance $Z_O = R_K$.



A Dirac delta impulse $\delta(t)$, applied between A and B and running (example) clockwise gives rise to a series of pulses that occur with alternating signs between points A and B, at intervals of 2τ, in this case amounted to a distance $\lambda_C/2$ travelled at the speed of light. In formula:

$$2\tau = \frac{\lambda_C/2}{c}$$

With these values of 2τ and $Z_O = R_K$ we can calculate all the parameters of equivalent circuit.
The circuit consists of an infinite number of L C oscillators.
The first L C oscillator has a resonant frequency that, by using the method already, is given by the formula:

$$\omega = \frac{\pi}{2\tau} = \frac{2\pi c}{\lambda_C}$$

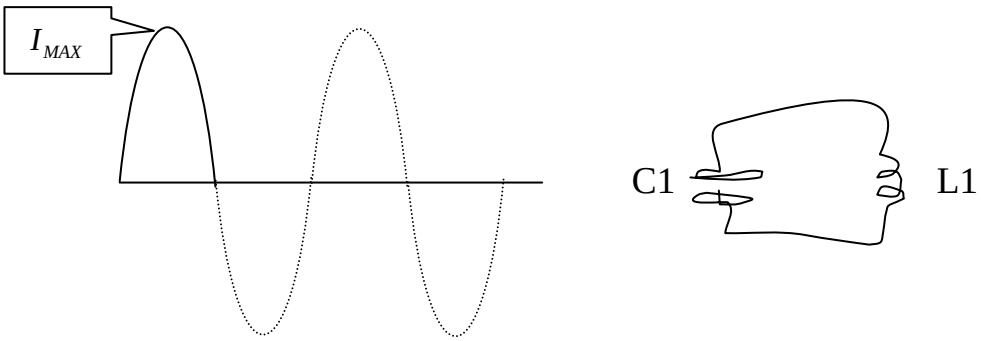
from which follows:

$$\nu = \frac{c}{\lambda_{COMPTON}}$$

ie precisely the frequency associated with the Compton wavelength of the electron or briefly "the frequency of the electron".
The characteristic impedance of this oscillator that resonates is *almost* equal to the characteristic impedance of the line. Its exact value, using a calculation already done is:

$$\sqrt{\frac{L1}{C1}} = \frac{4}{\pi} Z_O = \frac{4}{\pi} R_K$$

The energy involved in *this* oscillator can be calculated.
Let I_{MAX} the maximum current at resonance:



The electric charge associated with a current half-wave is

$$q = I_m \frac{T}{2}$$

where I_m is the average value:

$$I_m = \frac{2}{\pi} I_{MAX}$$

The energy in the circuit can be calculated either when is all inductive or all capacitive. It holds:

$$W = \frac{1}{2} L1 I_{MAX}^2$$

If the charge q is equal to the charge e of the electron:

$$e = q = \frac{I_{MAX}}{\pi} T$$

we get:

$$I_{MAX} = \frac{e\pi}{T} = e\pi\nu$$

which can be substituted in the expression of W:

$$W = \frac{1}{2} L1 e^2 \pi^2 \nu^2$$

Doing here display the circuit characteristic impedance $Z = \omega L1 = \sqrt{L1/C1}$ to reach:

$$= W = \frac{\pi}{4}\left(\frac{4}{\pi}\frac{h}{e^2}\right) e^2 \nu = h\nu$$

which is *exactly* the formula that gives the electron energy:

$$E = W = h\nu$$

For ν we introduce the characteristic frequency of the electron. What is the characteristic frequency of the electron? It's that experimentally exhibited in collision experiments

$$\nu = \frac{c}{\lambda_{COMPTON}} = \frac{mc^2}{h}$$

where m is the electron mass. From this substitution we have:

$$E = W = h\nu = mc^2$$

Conclusion: The current circulating in this circuit in this justifies charge frequency and energy of the electron.

[n8]

For a current travelling in a circle is associated an energy which corresponds to the electron mass. We saw in the previous calculation:

$$W = \frac{1}{2} L1I_{MAX}^2 = h\nu$$

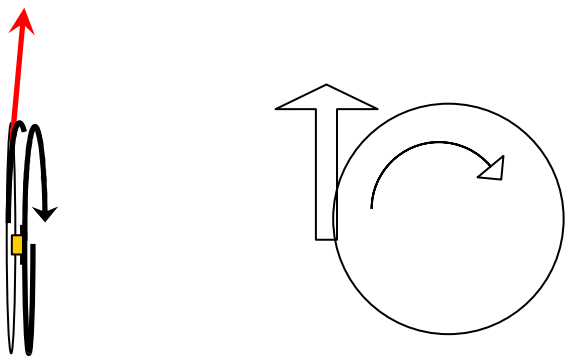
[n9].

The rotation of momentum p justifies the exact value of the electron spin.
The angular momentum, spin, the electron is:

$$S = \frac{\hbar}{2}$$

Remind as an angular momentum is defined and why spin appears to be half of what one would expect.
A momentum p rotating on a circle of radius r by definition gives rise to an angular momentum that is:

$$S = pr\,.$$



We recall the expression:

$$\lambda_{COMPTON} = \frac{h}{mc}$$

To a circle $\lambda_{COMPTON}/2$ is therefore a radius:

$$r = \frac{\lambda_{COMPTON}/2}{2\pi} = \frac{1}{2}\frac{\hbar}{mc} = \frac{r_C}{2}$$

half of the so-called "Compton radius" r_C : The momentum in rotation is:

$$p = mc$$

and therefore gives the correct angular momentum:

$$S = pr = mc\left(\frac{1}{2}\frac{\hbar}{mc}\right) = \frac{\hbar}{2}$$

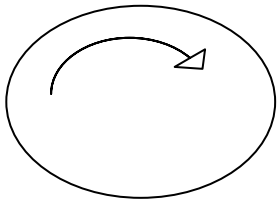
[n10].

The charge in rotation provides the exact value of the magnetic moment of the electron
The magnetic moment of the electron is, subject to minor corrections:

$$\mu \cong \mu_B = \frac{e\hbar}{2m}$$

where μ_B is the “Bohr magneton”.
Recalls how a magnetic moment is defined.
A current I running on a loop (circle) with area A by definition gives rise to a magnetic moment:

$$\mu = IA$$

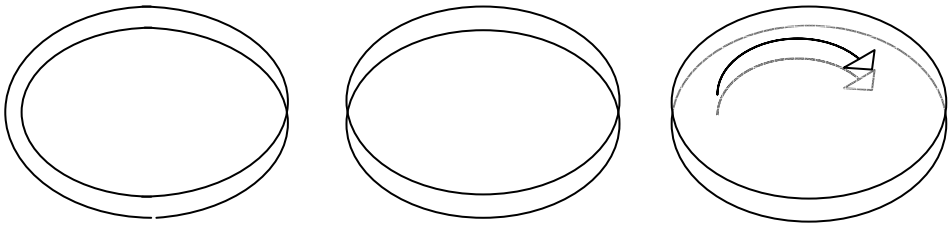


More exactly if there are N turns equal to this, overlapping, each providing its contribution to the total magnetic moment, which becomes N times larger:

$$\mu = NIA$$

In the Moebius strip $q = e$ is the electric charge in rotation. It along the wire that is the edge of the Moebius strip runs on *two coils* of radius $r_C/2$ contributing both to the magnetic moment. Therefore:

$$\mu = 2IA$$



The current has been calculated as an average value associated with a half-wave, and can be rewritten as:

$$I = I_m = \frac{e}{T/2} = 2e\nu$$

The area A holds:

$$A = \pi\left(\frac{r_C}{2}\right)^2$$

and replacing with some step you get right:

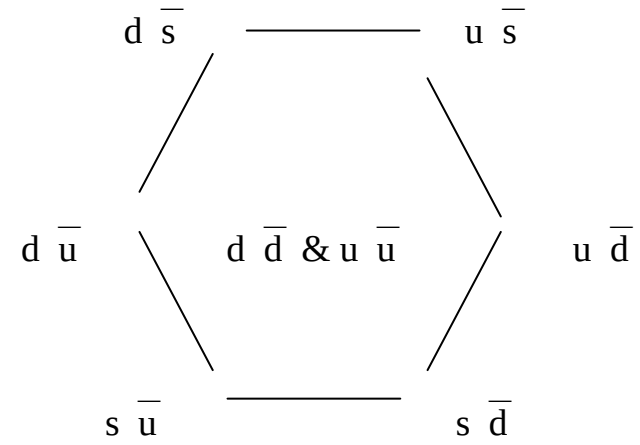
$$\mu = 2IA = \frac{e\hbar}{2m}$$

[n11]. When everything is in motion are exactly satisfied formulas that provide the mechanical behavior of an elementary particle. Left as an exercise.

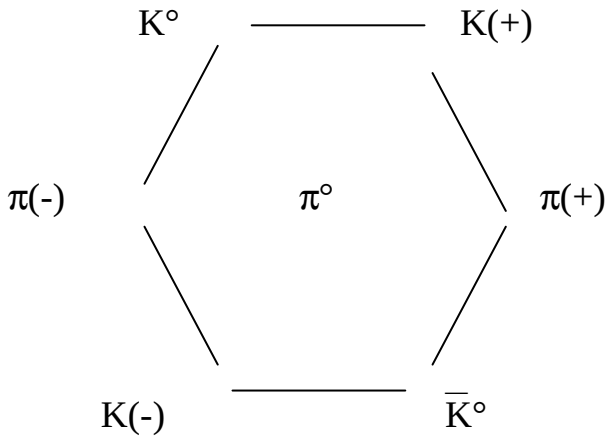
[n12] The system, still or in motion, performs exactly the values of wavelength that provides the "psi" wave of quantum mechanics. Left as an exercise.

[n13]

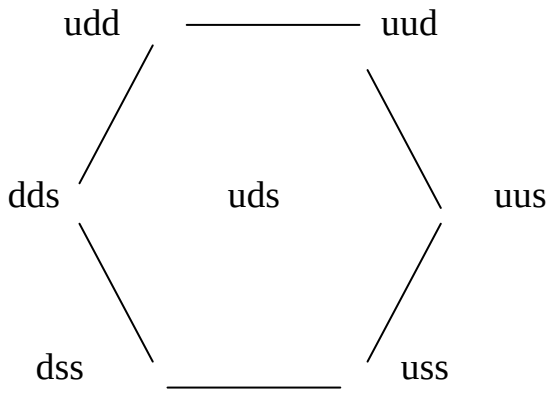
The quark compositions (from Franzinetti [34], quark model) are summarized here.
Mesons octet:



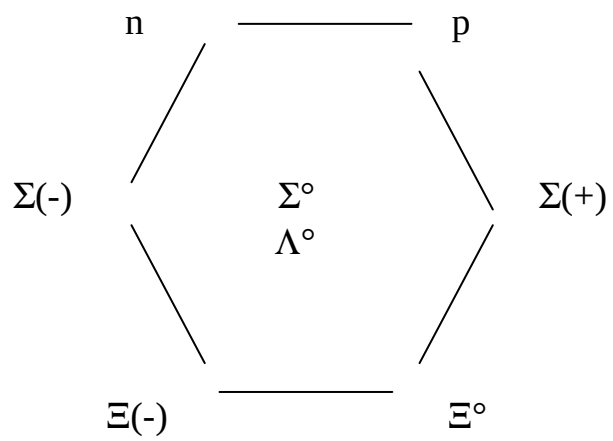
so forming pi and K mesons according to this scheme:



The compositions for the baryons octet are these:



They thus form the proton p, neutron n or other baryons that have these names:



REFERENCES

[1] M. Jammer, “Storia del concetto di massa”, Feltrinelli (1974)

[2] K. R. Popper, “Poscritto alla logica della scoperta scientifica. III. La teoria dei quanti e lo scisma nella fisica”, il Saggiatore (1984)

[3] A. Sommerfeld, “Lectures on theoretical Physics. III. Electrodynamics”, Academic Press (1952)

[4] W. Heisenberg et al.,”Discussione sulla fisica moderna”, Universale scientifica Boringhieri (1980)

[5] D. Hestenes, “Quantum mechanics from self – interaction”, Found. Phys. 15, 63-87 (1985)

[6] D. Bohm, B.J. Hiley, “The undivided universe. An ontological interpretation of quantum theory”, Routledge (2003)

[7] M. Talbot, “The holographic universe”, HarperPerennial (1991)

[8] C. Quigg, “Particelle elementari e forze”, Le Scienze Quaderni, n. 103 (1998)

[9] A. Einstein, “Il significato della relatività”, Einaudi (1955)

[10] S. D’Agostino, “L’elettromagnetismo classico”, Sansoni (1975)

[11] D. Hestenes “A unified language for Mathematics and Physics”, in “Cifford Algebras and their Applications in Mathematical Physics”, NATO ASI Series, Reidel (1986)

[12] C. Doran et al., “Physical applications of geometric algebra”, Internet Release

[13] G.E.Silov, “Analisi matematica. Funzioni di una variabile”, Ed. MIR, Moscow, 1978

[14] M.I. Skolnik, “Radar Handbook”, Mc Graw Hill (1970)

[15] F. Musto, “Storia della tecnologia radar”, Bariletti Editori (1990)

[16] S. Ramo, J. R. Whinnery, T. van Duzer, “Fields and Waves in Communication Electronics”, John Wiley (1994)

[17] A.E.Fuhs “Radar Cross Section Lectures” , American Institute of Aeronautics and Astronautics, New York, No-See-Um Book

[18] K. von Klitzing, “L’effetto Hall quantistico”, Le Scienze Quaderni, n. 35 (1986)

[19] E. Kruger et al. “New determination of the fine structure constant using neutrons”, PTBnews 96.2, Internet release

[20] R. Gouiran, “Particelle e acceleratori”, il Saggiatore (1967)

[21] M. Soldi, “Elementi di tecnica delle forme d’onda”, Levrotto & Bella, Torino (1955)

[22] E. Persico, “Fondamenti della meccanica atomica”, Zanichelli (1939)

[23] D. Hestenes, “Space time algebra”, Gordon and Breach (1966)

[24] S. Gull et al., “Imaginary numbers are not real – the geometric algebra of spacetime”, Found. Phys. 23(9):1175, (1993)

[25] D. Hestenes, “Zitterbewegung modeling”, Found. Phys. 23, 365-387,(1993)

[26] D Hestenes, “The zitterbewegung interpretation of quantum mechanics”, Found. Phys. 20, 1213-1232 (1990)

[27] D. Hestenes, “Clifford Algebra and the interpretation of quantum mechanics”, in “Cifford Algebras and their Applications in Mathematical Physics”, NATO ASI Series, Reidel (1986)

[28] J. G. Williamson, M. B. van der Mark, "Is the electron a photon with toroidal topology?", Annales de la fondation Louis de Broglie, Volume 22, n. 2, 133 (1997) and T.S. Natarajan, "Do quantum particles have a structure?", tsn@acer.iitm.ernet.in Department of Physics, Indian Institute of Technology (Internet release)

[29] Qiu-Hong Hu, “The nature of the electron”, arXiv:physics/0512265v1, (2005)

[30] D. Hestenes, “Space-time structure of weak and electromagnetic interactions”, Found. Phys. 12, 153-168 (1982)

[31] G. Bettini, “Clifford Algebra and Dirac equation for TE, TM in waveguide”, viXra:0910.0059 and G. Bettini, “Electroweak Forces Acting on TE, TM, TEM”, viXra:0910.0060

[32] T. Dorigo, “Electroweak Symmetry And The Chocolate Interaction”, A Quantum Diaries Survivor, Scientific Blogging, Internet release (2010)

[33] K. W. Ford, “La fisica delle particelle”, Mondadori (1965)

[34] C. Franzinetti, “Particelle”, Editori Riuniti (1982)

[35] Y. Nambu, “Il confinamento dei quark”, Le Scienze 102 (1977)

[36] S. L. Glashow, “Quark dotati di colore e sapore”, Le Scienze 89 (1976)

[37] A. Barbagelata, P. De Pol, “Macchine e apparecchi elettrici”, Tamburini Editore (1964)