Architecture of elementary particles

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The particles that constitute our Universe, in its so-called "ordinary matter and radiation" component, are all electromagnetic in nature, defined by the unification of their three possible interactions. We know that the fourth interaction (gravitational) is significantly different in nature from the other three. Here, we intend to describe how the so-called "stable" particles of ordinary matter can be composed of those that constitute their most fundamental building blocks. These particles decay in a time ranging from 10^{-6} s to 10^{-16} s, except for the proton, which is extremely stable

Introduction

To date, quantum physics equates an elementary particle with its interaction field via the Higgs field, which gives it its mass. Ordinary matter is then composed by starting on three fermions (electrons, neutrinos, and quarks) into their interaction modes, unified by the model… Each interaction has a “messenger” or exchange particle, which is a boson: photon, W boson, gluon, to which must be added the Higgs boson. These particles are considered the most fundamental, at the basis of all forms of matter.
Here, we present another model of constitution, notably different but entirely compatible, which allows us to access the wave composition of “stable” massive particles (muons, pions, kaons, protons) and to account for their mass energies as well as some other properties.

The fundamental building Waves

We postulated that elementary particles, such as the electron [1], must be composed of real waves. Here, we formulate a hypothesis that forms the basis of our model, namely that the corresponding wave functions are all solutions to Maxwell's general equation and that they are governed by the fundamental wave number **ko**, just as with the electron, as we have shown. Recall that ko corresponds to the distance separating two QFs (fundamental quanta) from the medium constituting Space at the minimum energy level [2].
QFs are equivalent to complex harmonic vibrators; they are indivisible and their threshold energy is extremely low (approximately 10^-51 J) [2], they constitute the basic elements of the quantum fluid medium that "materializes" Spacetime [3].
Our second basic assumption is that all the particles are composed by two fundamental building waves which are the ownership of perfectly stable fermions that are the neutrino and the electron. We will call the building wave associated with the neutrino a **nuon** and the one associated with the electron an **electronuon**. These building waves can be identified with these same two particles but with an energy defined by the fundamental wavenumber **ko**.

Wave composition of fundamental elementary particles

We make several assumptions here:
- The simplest waves are rotators with a moment of 1/2 ($h/2\pi$) and spin S = 0.5.
- Vibrators are bi-rotators with a moment of ($h/2\pi$) and spin S = 1.
- Roto-vibrators are a combination of the first two (three rotators), whose the moment is 3/2 ($h/2\pi$) and spin S = 0.5.
- The QF is a double-vibrator (four rotators) with a moment of 2 ($h/2\pi$) and spin S = 2.

The neutrino and the electron (basic particles) are simple rotators, the photon is a simple vibrator, and the nuon (nu) idem the electronuon (nu) are roto-vibrators; most of their energy is therefore the rotational effect that puts the basic particles into a stationary state

Internal energy of the two basic elements

We consider the value ko = pi/Lo, with Lo equal to the distance between two QFs in the lattice, which corresponds to the wavelength, 2Lo, of the basic photon.
The wavelength of the nuon is then 4/3 Lo (corresponding to its moment), which allows us to calculate its internal energy, taking in account that, at the same frequency, the neutrino wave has half the weight of the electromagnetic wave, because his spin is half.
So we get: E(nu) = 3hc/(8Lo), with Lo = 1.39×10^{-14} m [3], which leads, in intrinsic space, see [4], to:
E(nu) = 33.395 MeV.

For the electronuon, we have to consider the rotation of an electron around a nuon. This rotation has a spin modulus S = 0.5. The distance d between the two particles must be the sum of their natural wavelengths, i.e.: d = 4Lo + (4/3)Lo = (16/3)Lo.
The two particles are in a "relativistic" state, therefore governed by Einstein's equation:
E^2 = (p c)^2 + Eo^2, with p(i) = h/[2pi d(i)] for each of the components.
We observe, by calculation, that the system has a minimum energy for d(e)/d(nu) = 1.96 which is the minimum value for nearest coating of the two particles and so corresponds to the electronuon, this value is : **E(nue) = 38.350 MeV**.

Binding energy

This is, of course, the "cement" that binds the two fundamental building elements to form particles. The energy of this bond is, of course, much lower than the energies of the two building blocks and show a minimal value for the nearest coating of the two particles.
Its calculation is more complex, although based on the same principles as before; we have included a description of the method in the appendix.
Calling this binding element **li**, we have obtained:
E(li) = 0.345 MeV

This is for the bond between two nuons and 0.5 E(li) for the bond between a nuon and an electronuon (see appendix).

Justification of the three basic elements (building waves and binding module)

The three elements and the calculation of their energies may seem arbitrary at this stage; however, they respond to two logical necessities: the need to construct from the two perfectly stable unitary fermions, the electron and the neutrino, and the need to determine them around the fundamental wavenumber ko, the true determinant of elementary particles [3].
Of course, other combinations exist that respond to this logic, but we will see that the one we have chosen allows us to directly construct (linearly) the "stable" particles that we know.

Consider the muon mu; it ends its life by decaying into two neutrinos and an electron.
The bonding element is li = 1.5; there is one (nu-nu) bond and one (nu-nue) bond.
We can therefore write:
E(mu) = 2 E(nu) + E(nue) + 1.5 E(li) = 105.658 MeV, which is precisely the experimental value of the muon's mass energy.
Applying the same treatment to the charged pion Pi, it decays into a muon and a neutrino.
Its construction therefore involves:
E(Pi) = 3 E(nu) + E(nue) + 3 E(li) = 139.570 MeV, which is also the experimental value.
Here, we have assumed that the bonds are in orthogonal positions, which means that the four components of the pion can be represented by the vertices of a square.
The neutral pion Pio has all four vertices of its square occupied by nuons and antinuons, so we have:
E(Pio) = 4 E(nu) + 4 E(li) = 134.960 MeV, which is also, precisely, the known value.
This structure also explains its decay into two photons by the composition:
2 nuons + 2 antinuons.
These three precise overlaps (10^-5) are the best justification for our three basic elements, in agreement with the spin values and decay products of the three particles considered.

This allows us to go further.

Rules for fermion composition, application to the Proton

In this section, we will show how we can access the structure and internal energy of the proton through a logical combination of our three basic elements in a high-symmetry building configuration.
If N be the number of constituent building blocks, and n(nu) and n(nue) are the respective numbers of nuons and electronuons, we have N = n(nu) + n(nue).
We hypothesize that a stable particle is always composed of an equal number (n) of elementary waves (building blocks) in the three dimensions of space; thus, the muon has one building block per dimension. It is also necessary that the angular momentum vectors can be

added in one of the planes; this implies the relation (n) = n(nue), which is found in the composition of the muon.

For Pions, one of the three waves is a "nuon-antinuon" pair, which explains the four building blocks of their constitution.
These considerations lead us to a generalization using the following three relations applicable to fermions: The first is N = 3(n)^2, which expresses the sum of the wave amplitudes in one dimension (the energy is proportional to the square of n) as well as the equal occupation of the three dimensions. We must add another condition: n(nu) = an odd number (the spin must be a half-integer); for the muon, n = 1 and n(nue) = 1.
Let's analyze the solution n = 3; It corresponds to N = 27 with n(nue) = 3 and n(nu) = 24.
The geometric figure of highest degree of symmetry corresponding to this composition is a motif of three **square antiprisms** with a nuon at each vertex and doubly binded to its neighbors, an electronuon forms an additional bridge.
The whole can be visualized as an equilateral triangle whose vertices are occupied by the three electronuons and whose sides are occupied by the three binded antiprisms.
The figure in the appendix also shows the exploded projection of a square antiprism; it allows us to easily determine the number of bonds between two nuons, which is the number of edges of the polyhedron plus the four bonds. This number is 20 and we must add one for the two bonds (bridge between two antiprisms) of the electronuon
Thus, for the set of three groups, we have the number of bonds **n(li) = 63**

We thus have all the elements to calculate the mass energy of the proton, (Fermion corresponding to n = 3) :

E(p) = 24 E(nu) + 3 E(nue) + 63 E(li) = 938.27 MeV.

This is, very precisely, the mass energy of the proton.
The strong stability of this particle must be due to the high symmetry level of his wave determining structure, providing a particular wave resonance (…).

A word about the stability criteria, which must be characterized by the lifetime of the particles; it appears that the presence of the electronuon is a major factor, as illustrated by the difference between the charged pion and the neutral pion, or the stability of the muon.
We illustrate this with a semi-empirical formula providing the number of bonds:
[(n(nu) – n(nue)][n(nue) + i] = n(li) (1) , **i** can take the values of the sequence :
i = [0 , 0.5 , 1]. According to this formula; i = 0.5 for the muon and the charged pion, i = 1 for the neutral pion and only the proton has the value i = 0 : this indicates that stability minimizes the value of i, that is to say the number of bonds necessary for the structure. The degree of symmetry of the motif is also a factor in stability, but probably to a lesser extent than the presence of the electronuon.

Constitution of Pi and K mesons

The numerical rules are different from those of fermions; cancelling the spin; each electronuon must be compensated, which translates to the relation: $N = 3n^2 + n$
n = 1 for Pions and n = 2, for Kaons which lead N = 4 for Pions and N = 14 for Kaons.
The number of electronuons is 0 for the neutral Pion (Pio) and 4 for the neutral Kaon (Ko).
The value two seems excluded for both (…).
The characteristics of the bosons can be summarized in the following table:

	N	**n(nu)**	**n(nue)**	**n(li)**	**(i)**	**Structure**	**E(MeV)**
Pi	4	3	1	3	0.5	Square	139.57
Pio	4	4	0	4	1	Square	134.96
Ko	14	10	4	30	1	Antiprism	497.70
K	14	11	3	32.5	1	Antiprism	493.62

The values of the internal energy E are, of course, calculated from the compositions indicated, and they are very consistent with experimental data.
The basic motif for Kaons is a square antiprism with additives, depending on the particle.

Let's express the composition of the bosons in terms of the bond indices of their constituent building blocks; this is the number of bonds formed for each elementary building block (0.5, 1, 2, 3…) without any repetition; the sum of these indices is therefore the total number of bonds of both types for a particle.
The following table of bond indices provides information on the representative structure of the particle; this is how we show that there are two neutral Kaons, Ko(l) and Ko(s), which have the same mass energy, we know that they differ in their lifetime and decay mode.

Pi	1 nu(1) + 2 nu(0.5) + 1 nue (1)	Square
Pio	4 nu (2)	Square
Ko (l)	4 nu (2) + 6 nu (3) + 4 nue (1)	Square Antiprism
Ko (s)	2 nu (0.5) + 3 nu (2) + 7 nu (3) + 2 nue (1)	Square Antiprism
K	3 nu (2) + 8 nu (3) + 2 nue (1) + 1 nue (0.5)	Square Antiprism

A complete analysis of the information that can be gleaned from these tables, combined with other data, is beyond the scope of this study; let us simply say that the similarity in composition observed for K and Ko (s) is probably related to the fact that these two particles decay into two other particles, while Ko (l), with its different structure, decays into three particles. Furthermore, the difference in lifetimes between the two Ko is probably related to the difference in the degree of symmetry of their representative shape.

Proton binding Indices

The formulation concerning the square antiprism bounded allows us to specify the binding indices of the proton, namely: 12 nu (1) + 12 nu (4) + 3 nu (1).

This indicates the very particular ternary symmetry of this constituent particle of atoms, whose lifetime exceeds that of the universe.

However, it should not be considered that the representative geometric figures express fixed structures; they constitute sets of components of periodic motions, more or less bounded, which define the complex wave that is the particle.

The energy is concentrated in half a Compton wavelength, which is:

$\pi/(2n^2\ ko)$, so 0.8×10^{-15} m for the proton whose n value is 3; here, it is the total frequency that defines this wavelength. We will return to this point in a future publication.

Conclusion

The main result of this study is the calculation of the mass energy of seven "stable" elementary particles, particularly that of the proton.

This was done using the energy of two fundamental building blocks and their binding additional energies. From the accuracy of the values obtained, three main lessons can be drawn: The first is the necessity of defining the constituent waves based on the fundamental wavenumber ko, which itself depends on the distance between the vibrators (QF) composing the spacetime (Lo).

Furthermore, this construction can only be carried out using the two fundamental waves of the neutrino and the electron, whose energy is adapted to the value of ko (nuon and electronuon).

Finally, this construction must conform to rules concerning the saturation of space (n waves per dimension), the vector addition of angular momenta leading to integer or half-integer spins, and the number of electrically charged elements that must satisfy the known overall charge, as well as other elements yet to be discovered.

It also appears that the square antiprism corresponds, in all cases, to a construction figure…

In this study, we considered the three spatial dimensions to be equivalent, which is sufficient for mass calculation, but probably not if we want to address other properties such as the occurrence of decay modes or even simply sensitivity to certain interaction modes (electro-magnetic, weak, strong, etc.), or even stability as expressed by lifetime. This is how formula (1) that we used could be demonstrated and expanded.

It also remains to apply our model to other known "stable" particles such as heavy bosons or hadrons, but also and above all, to explain the Neutron by interpreting its properties.

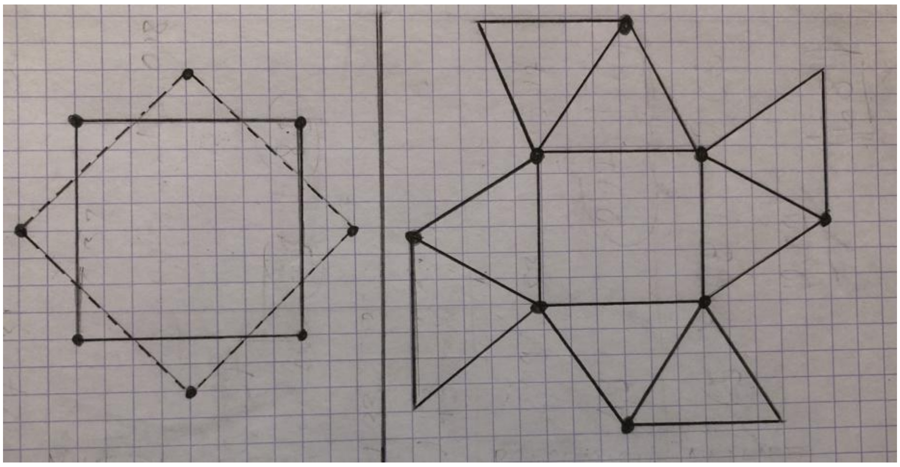
It is likely that, to clarify the whole picture, we will need to develop deeper into establishing the properties of superfluid spacetime. Symmetry group theory could also be useful in this research to support the results obtained here.

Appendix

--- Binding Energy E(li)

The calculation is more complex here; it requires solving the relativistic equation (Klein-Gordon) of the interaction between the two nuons: E^2 = (Enu - V)^2 + (p c)^2, applied to the function **F(nu) = Ae^-(kx) cos (kx),** where E is the energy of an activated nuon, V is the interaction potential, and p = h/λ.
The function F(nu) is one of the solutions to the general equation Dal.(F) = 0 (Dal. is the Dalembertian). Here, λ = 8πLo, the first common harmonic of the nuon and the nuon-antinuon pair, which figure the rotative moment. All of that allows us to calculate E, and with the help of the Wolfram-Alpha logic for calculating V;
We perform a double integration of the square of the function F(nu) between 0 and π (S1) and between 0 and 2π (S2), giving us V = Enu (S2 – S1) / S1.
We then obtain: **E(li)** = 2 (E – Enu) = **0.345 MeV** with a precision of 0.0005 MeV for an equal contribution from the two nuons bonded by the first harmonic π --- 2π.
The binding energy between a nuon and an electronuon is half, this because of given its nature, the latter cannot contribute (…), this fact have to be justified …

---Square Antiprism



Front view Unfolded view projection,

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