v. 2, n. 2, 2025

International Journal of Exact Sciences

HADRONIC ORBITAL FIELD MODEL

John Edwar Castro Gonzalez
https://orcid.org/0009-0005-1785-762X

Acceptance date: 30/04/2025

Abstract: The universe uses a base pattern for everything that exists, it is the one that requires the lowest energy, the simplest, most elegant and geometrical model, which operates in any dimension, scale or particle, this basic pattern with few components and due to all its interactions generates all the complexities of the universe we know. This paper proposes the orbital field model as the geometrical basis for the creation and organization of all hadronic particles. This structure, analyzed from its geometry and evolution, locates all the hadronic subatomic particles of the standard model, first those generated by quark combinations (u, d, s) and later extending to those generated by quarks (c, b, t), locating in their place all the known mesons, meson resonances, baryons and baryonic resonances. From this orbital model emerge the subatomic properties, and the reason of the baryonic multiplets, the interaction between particles to generate heavier ones and the disintegration to lighter particles, also following the evolution of the model emerge the chemical elements and properties of matter such as the amount of neutrons in the nucleus, the isotopes and the stability of the atomic nuclei, among others.
Keywords: Atomic nuclei, hadrons, baryonic particles, baryonic multiplets, baryonic octets, prime orbital field model, amplituhedron, nucleons, prime numbers.

INTRODUCTION

The atom and subatomic particles are a puzzle that scientists have wanted to solve for many years, and for this purpose the theories have been created that are currently widely accepted as the standard model, string theory and quantum field theory [1] [1]-[17] that bring us closer and closer to the final unified theory and although they still have several very important gaps that do not end up showing clearly the whole of the universe we know with all its complexity and elegance, (gravity in the quantum world, matter / dark energy and its interactions with matter, etc.), they have been able to bring us closer and closer to the final unified theory and although they still have several very important gaps that do not end up showing clearly the whole of the universe we know with all its complexity and elegance, (gravity in the quantum world, dark matter / dark energy and its interactions with matter, etc.).), they have been able to bring us closer to a unified theory, which has already managed to unite 3 of 4 forces of the universe and thus have explained many of the phenomena we have seen in recent years with the increasingly powerful particle accelerator experiments.

These experiments performed in the accelerators have served to verify the veracity and accuracy of these new theories, after these collisions have generated a large number very precise measurements of the properties of the particles, these data are a great source of experimental evidence that based on its certainty and accuracy will now serve as support to go fitting all the particles and their properties in the orbital field model and confirming that each piece fits perfectly in this model; in addition, symmetries emerge that, according to their locations, determine other properties that will help us to see the general model and its dynamics. With all this accumulated knowledge and standing on the shoulders of giants of the theoretical bases and the data collected and confirmed for many years, we can use them and group them in a simplified model that finally explains in a simple and elegant way the geometric pattern that groups all known hadronic particles.

To begin with and starting from the basics, current physics has been able to confirm that particles are organized into 6 types of quarks (u, d, s, c, t, b quarks and their antiparticles) and 6 leptons (electron, muon, tau and the 3 types of neutrinos and their antiparticles) [1] and that they fit into a geometry such as the

eightfold path (hexagon), multiplets SU(2) SU(3), supermultiplet or hexagonal pyramid[1] that indicate that the "design pattern" fits within a model that geometrically contains all the symmetries and that by their interactions all the particles arise.

With the theoretical quark model it has been possible to demonstrate that all the discovered hadrons are composed of these quarks; so if we initially start from the first 3 quarks (u, d, s and their antiparticles) and if we observe their distribution according to their properties of electric charge, isospin, interactions, disintegrations and directions of spin, we see that in the end all these properties fit together and emerge from the basic orbital pattern that we will explain and thus all the particles that have been found are created, thus confirming that this is the model that nature uses for the organization of everything that exists.

With this hadronic orbital model, we seek to show in a generalized, simplified, scalable and grouped by common properties of the particles (such as electric charge, isospin and mass), how all these hadrons are organized geometrically, using the data collected by experiments and quark theory; in the end we just organize these data and arrange them in such a way that all of these fit together and demonstrate the geometry of hadronic orbital structures and reveal new emerging properties.

HADRONIC ORBITAL FIELD MODEL

QUARKS (U, D, S) AND THEIR ANTIPARTICLES

If we observe the symmetry of the quark--antiquark triplets u, d, s and taking their electric charge and isospin properties, we can observe the formation of the intrinsic geometry that emerges from these particles as shown in Figure 1.

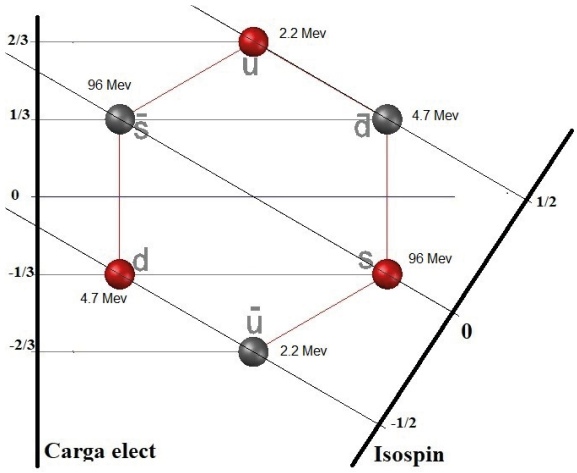


Fig 1. Symmetry of the quark-antiquark triplets (u, d, s). of electric charge and isospin, revealing emergent geometry (masses estimated in approximate range).

In the hadronic orbital model this geometry of the initial triangle generated by the quarks and another inverted one for the antiquarks generates a hexagonal particle-antiparticle orbit (figure 1). This completes what we will call the 0 orbit, which is the basic generation level.

ORBITAL HADRONIC LAYER MODEL

If we follow this grouping pattern in the 0 orbit (figure 1), we can see details such as that 3 important zones of charges are determined, and isospin: a positive zone, a negative zone and a neutral zone, also if we check the masses, the sum of the particles of the generator triangle (u,s,d), subtracted from the masses of the triangle of the anti-particles results in zero (this is obvious knowing that the masses of the particles and their antiparticles are identical, but it only shows the process that we will follow next to advance in the orbital layers), thus giving an overall balance in the 0 orbit, both in electric charge, isospin and masses.

This balance is important because it shows that the 0 orbit is complete and that any interaction or energy increase will break this quantized field symmetry and cause a change in the

1. The historical advances of string theory, the standard model or quantum field theory, are too extensive to list or explain in this text, the reader who wants to deepen in these topics is invited to follow the bibliography indicated.

structure; so with more energy it will be forced to give way to a next orbit 1 of higher energy, in this next orbit its components tend to bind (join) to maintain the stable geometric base structure but with elements of higher energy / mass level to contain that additional energy.

Thus we will have the passage from orbit 0 to orbit 1 and the model of orbital fields begins to be generated; the new particles generated in orbit 1 are emerging bound particles called Mesons of higher mass and that are located in the positions determined by the initial geometry of orbit 0, following the same positive, negative and neutral zones of the previous orbit but with a twist of the structure, which shows a breaking of the initial symmetry of orbit 0.

ORBITAL 1: MESONES

As the 6 basic components of the quantized field of orbit 0 (u, d, s quarks and their antiquarks) have more energy, they begin to group in bound pairs, generating a symmetry breaking of the structure of orbit 0, rotating in the new bound particles of quarks-antiquarks called MESONS [1] (kaons, pions, eta and omega) that will be accommodated in the orbit 1 following these 3 zones of positive, negative and neutral, locating themselves according to their properties in the graph (quarks, charge, isospin). As can be seen in figure 2.

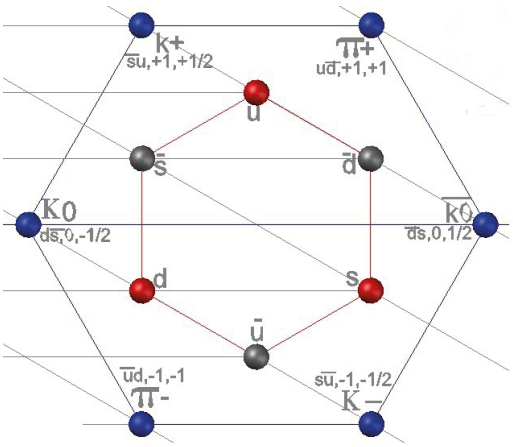


Fig 2. Orbital 1 of the hadronic orbital field model, where Mesons are organized according to their properties (quarks, electric charge, isospin).

Now if we check the stability of orbit 1 in charge and isospin we see that it is completely balanced and at zero.

In electric charge: Negative zone= [π - (-1)]+ [k - -1)]= - 2

In Isospin: Negative zone = (-1) + (-1/2) = - 3/2

In electric charge: Positive zone= [π+ (1)]+ [k+ (1)]= 2

In Isospín: positive zone= (1) + (1/2)= 3/2

In the neutral zone, (k0, anti k0) the charges are 0 and isospin ½ - ½

This zero balance also extends to the masses of the particles, by the subtraction of the original generating triplets, giving that the sum of the masses of the initial triangle minus the sum of masses of the inverted triangle gives zero. (k+,π -, anti k0) - (k-,π +, k0)= 0

Following this structure and increasing the energy of orbital 1 (after it is already balanced and stable), we pass to the next quantized level of BONDED particles in orbital 2, which generates the excited states of the Mesons that are the MESONIC resonances, these are identical to the previous ones but with a higher energy level and are superimposed to the locations of orbital 1 since they have the same characteristics of electric charge and isospin, the only thing that changes is that their masses are quantized to higher energy levels.

In order to better see these particles in their locations, we will place the orbitals in a concentric orbital plot because in addition to these meson orbitals, baryons and baryon resonances converge in the same geometrical points as we will see below, so to better visualize their distributions and properties they will be extended in this concentric plot that will maintain the alignment of the electric charge and isospin axes, as shown in Figure 3.

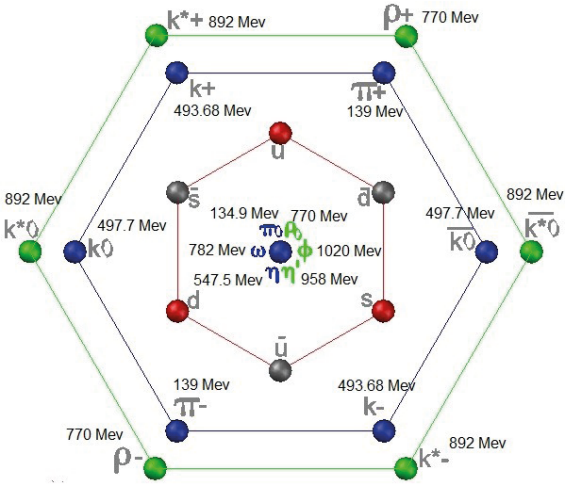


Fig 3. Orbital 2 of the hadronic orbital field model, where the Mesonian resonances are organized according to their properties and with their masses.

The orbital structure in Figures 2 and 3 represents the quantification of mesons and meson resonances particles with electric charges (positive, negative and neutral) in their two--dimensional positions, however, there are also Mesons and Meson Resonances whose electric charge is zero and isospin zero (which would be located at the center of the structure,(π0, ρ0, Ƞ, Ƞ9 , ω , ϕ). These neutral particles all located at the center of the graph, indicate an emergent geometrical property that makes them converge there and that from the point of view they all appear at this point, but that in reality the spatial geometry of all the particles is a 3-cubic orbital structure.

Dimensions, the particles (π0), Eta (Ƞ) and the resonances (ρ0) and (Ƞ9) are the additional hidden vertices of the cube (forming the axis of zero electric charge and zero isospin) and the omega meson (ω) and (ϕ) will be located at the center of the cube.

Neutral axis that joins these 2 vertices, so they do not affect the stability of the structure, with this we see a similarity to a crystallization structure type BCC (body centered cubic). Figure 4.

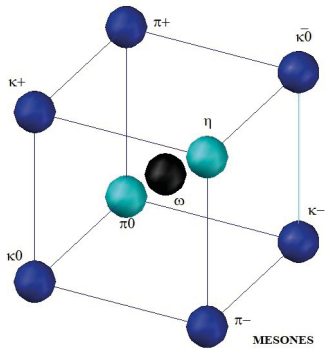


Fig 4. Meson cubic orbital structure including pions, kaons and the neutral particles eta, omega, pion 0.

MESONICA DISINTEGRATION

This cubic orbital structure determines the decay paths of all these particles to lower mass particles and finally to the stability of the leptons or photons as can be seen in figure 5.

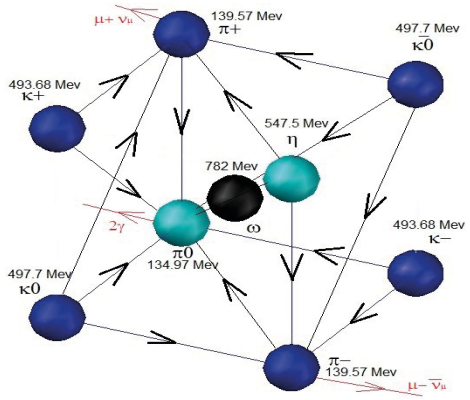


Fig 5. Decay paths for Mesonian particles, following lines between vertices by maximum cubic orbital mass differential.

Now with this disintegration we determine what we will call the disintegration energy of the orbital, (which would be the energy contributed or subtracted to go from one particle mass to the next), and the process to make the total balance of this energy is comparing the masses of neighboring particles following the lines of the hexagonal structure in a clockwise direction until completing a full turn, with this we determine the tendency to the disintegration of the particles of the orbit including the neutral ones; if we do this procedure for orbit

1, it will be you can see that to go from particle 1 to π+ (139.5 Mev) to particle 2 the anti k0 (497.7 Mev) are required to be supplied 358.2 additional Mev, and so we continue up to k+ including the particles of the neutral vertices (π0, ω ,Ƞ)(to complete the entire orbital cube), the result is +408 Mev, which indicates that this orbital in its total structure is unstable and makes that the quantized particles in this orbital have an unbalance of total energy to spare in the orbital and to balance it uses the path of decay in particles of lower mass; if we analyze the decay paths of the particles in figure 5, these correspond mostly to the line of union of the vertices of the cubic orbital and prioritizes in the disintegration, the greater mass differential between particles, now if the resulting particle is also unstable it will follow the sequence until reaching the stability of the leptons as can be seen in figure 5.

The disintegration of 0 pions, being the lowest mass pions in orbital 1, and not having a bound state of lower mass quarks directly, disintegrate into photons [3].

If we do the energy balance particle by particle but in the 0 orbit (u, s, d quarks) (the mass data are still not very precise due to the experimental difficulty for its measurement, so we will use the current established data of apparent masses, but that although these data have a large variation, in the future, the trend that we want to show will be maintained) it is determined that it is required to contribute approx. +93.8 Mev, confirming that this orbit is unstable and that this instability is the one that generates the exchange between the u and d quarks and s by weak interaction since they cannot disintegrate in particles smaller than the up quarks and by the confinement they have to reorganize at the lowest possible energy between these 3.

The charge balance and isospin of orbit 2 (meson resonances) is:

In electric charge: Negative zone= [p-(-1)]+ [k*- (-1)]= - 2 In Isospin: negative zone = (-1) + (-1/2) = - 3/2

In electric charge: Positive zone= [p+ (1)]+ [k*+ (1)]= 2

In Isospín: positive zone= (1) + (1/2)= 3/2

In the neutral zone, (k*0, anti k*0) the charges are 0 and isospin ½ - ½

The triplet mass balance is: [(k*0)+(k*-)+(p+)] - [(p-)+(k*+)+(anti k*0)]= 0 [892 + 892 + 770] - [770+892+892] = 0

The meson resonances (p0, ϕ, Ƞ'), are of neutral charge and zero isospin, and are located as in orbit 1 (mesons) in the neutral axis of the cubic orbital, so they do not affect the stability of the structure and its function is the phase transition quantizandose to make the complete transition between orbits.

The orbital decay mass balance of the meson resonances is: +188 Mev resulting in this orbital being unstable and having decaying particles, following the paths of the overlapping hexagonal cubes as can be seen in Figure 6.

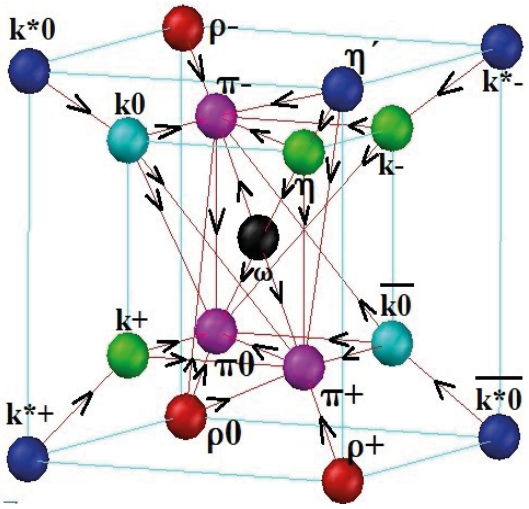


Fig 6. Decay paths of meson resonances following the lines of mass differentials in cubic orbitals.

These decay lines mostly follow the vertex junctions to join the 2 orbital cubes, and create other direct decay probability lines to reach lower mass particles by the fastest paths.

ORBIT 3: BARYONS

Now that orbit 2 is balanced, it no longer accepts energy variations, so having energy increments will generate bound states of 3 quarks that will be the particles that will settle in the next level which will be orbital 3 where the Baryons (bound states of 3 quarks) will be accommodated, as can be seen in figure 7.

The baryon orbital follows the same configuration of the previous orbitals by positive, negative and neutral zones, the balance of charges, masses and isospin of orbital 3 is:

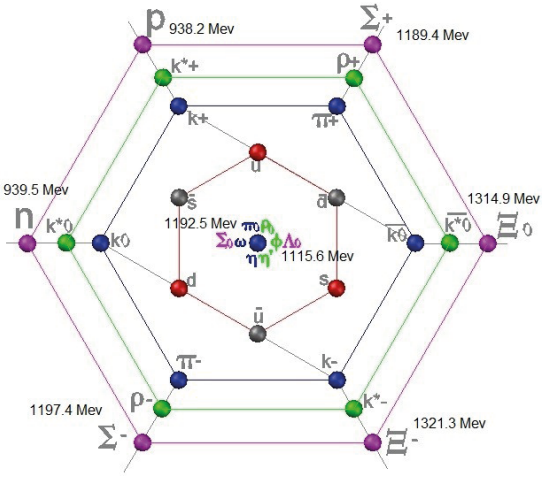


Fig 7. Orbital 3, organization of the baryons in orbital, organized according to positive, negative and neutral zones as all the previous orbitals.

In electric charge: Negative zone= [Σ- (-1)] + [≡ - (-1)]= - 2

In Isospin: Negative zone =(-1)+(-1/2)=- 3/2

In electric charge: Positive zone= [Σ+ (1)]+ [≡+ (1)]= 2

In Isospín: positive zone= (1) + (1/2)= 3/2

In the neutral zone, (≡ 0, N) the charges are 0 and isospin ½ - ½

The triplet mass balance is: [(((≡0)+(Σ)+(P)] - [(Σ+)+(≡ -)+(N)] = 0.3

[1314.9 + 1197.4 + 938.27] - [1189.4 + 1321.3 + 939.56] = 0.3

And the orbital decay mass balance is: -73.72 Mev, which indicates that the zero decay limit was exceeded and that this orbital instead of receiving energy from the vacuum, releases some energy to the vacuum, so this orbital has stable particles (proton and neutron) and the larger particles of the orbital disintegrate into these stable particles and leptons.

ORBIT 4: BARYONIC RESONANCES

Following this structure and increasing the energy of the baryonic orbital 3 (after it is already balanced and stable), we pass to the next quantized level of BONDED particles in the orbital 4, which generates the excited states of the Baryons that are the BARIONIC resonances, this orbital 4 a

Unlike all other orbits, they break the hexagonal symmetry and generate a triangular orbit with sides segmented in thirds to locate 10 particles including the neutral particle as shown in figure 8.

This geometry completes all possible combinations of the quarks u, d, s, and closes the orbit in a triangle with a delta baryon resonance with an electric charge of 2.

In the electric charge balance and isospin of orbit 4, both in positive, negative and neutral zones, the zero balance is maintained even though there are more quantized particles in this triangular orbit, thus closing the orbital structure of the u, d, s quarks, as can be seen in Figure 8.

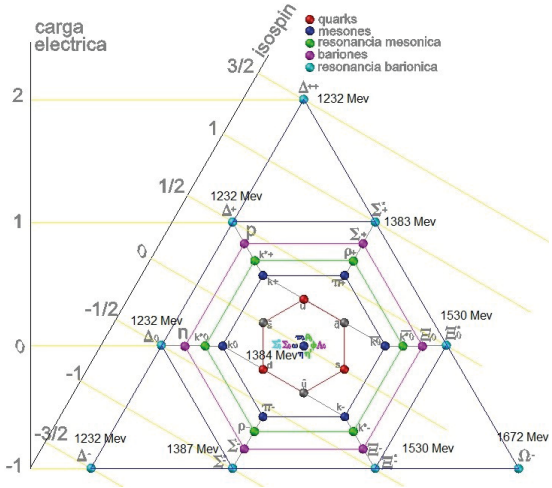


Fig 8. Orbital 4, organization of the baryonic resonances in orbital, breaking hexagonal symmetry, and image of all particles formed by the u, d, s quarks.

But the mass balance of the triplets taking only the hexagonal orbital and the 2 opposite triplets, no longer remains at zero in this orbital, the final value is around -4 Mev; now, if we additionally take the triangular orbital and add the negatively charged particles minus the positive charge, the final result is 1672 Mev, which is a surplus energy that remains as a transition to the next orbital level 5 corresponding to the particles formed by the charm quark (charm - c), whose effective mass is around 1270 Mev.

The decay energy balance of orbital 4 of baryonic resonances is 1 Mev, so this orbital requires an energy input, so these particles are unstable and disintegrate into smaller stable particles such as proton, neutron or mesons and finally into leptons and photons.

ORBITAL DECAY ENERGY

Observing graph 1, from the values obtained in the decay energy of orbitals 0, 1, 2, 3 and 4, (quarks, mesons, meson resonances, baryons and baryonic resonances), we can see the tendency in orbital 3 towards baryonic stability whose values are the only ones under the stability line, the other orbitals are in the zone of decay instability as shown in graph 1. (the values are extended to the next 2 orbitals to better appreciate the trend).

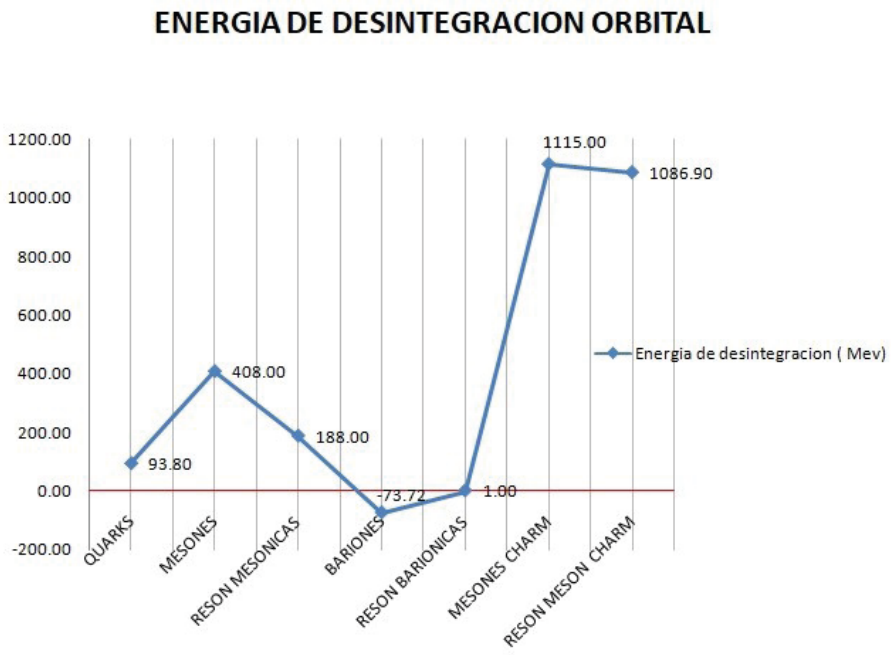
NUCLEOSYNTHESIS

Following with the disintegration pattern of the hadronic particles conformed by the quarks u, d, s, it can be seen that mesons and meson resonances disintegrate in their great majority in pions, leptons and photons, so their final emissions are neutrinos, antineutrinos, electrons, positrons and photons, [14] so they do not generate protons or neutrons that are the stable particles to form an atomic nucleus, their products are only radiation emissions and leptons.

Orbital 3 of the baryons and orbital 4 of the baryonic resonances are the ones that can generate stable particles such as protons or neutrons, as well as electrons, neutrinos, antineutrinos and photons [6], this results in the disintegration of baryons in orbital 3, where all elements for the conformation of the atomic nuclei of hydrogen, helium and lithium are found, since orbital 3 in its decay of baryons $\Sigma(+,-,0)$, $\equiv(-,0)$, $\Lambda 0$. at the end of the highest probability decays at least all protons, neutrons, electrons, are produced for the formation of hydrogen (1 proton, 1 electron) and hydrogen isotopes in smaller proportion (deuterium (1p+1n+1e-) and tritium (1p+2n+1e-)), helium and its isotopes (helium3 (2 protons, 1 neutron, 2 electrons), helium4 (2 protons, 2 neutrons, 2 electrons) and lithium with its natural isotopes (Li6 (3 protons, 3 neutrons, 3 electrons), Li7 (3 protons, 4 neutrons, 3 electrons) and of end products also additionally neutrinos, antineutrinos both electronic and muonic.

From the disintegration of orbital 4 of the baryonic resonances [3] we obtain the protons, neutrons and electrons necessary for the formation of the natural stable nuclei and atoms of the elements beryllium 9 (4 protons, 5 neutrons, 4 electrons), boron 11 (5 protons, 6 neutrons and 5 electrons), carbon 12 (6 protons, 6 neutrons and 6 electrons) and its natural isotopes.

The next orbital 5 and 6 in the orbital structure will be generated by the charm quark and the D mesons and their meson resonances, these, like the mesons and baryons of quarks u, d, s, are organized in the same hexagonal cubic structure as the previous orbitals but with a twist in the structure, this we will see and explain in a future article, as we will also see its orbital disintegration and which chemical elements are formed with the protons and neutrons that are generated with its disintegration.



Graphic 1. Graph 1. Orbital decay energy, for mesons, resonances and baryons of quarks u, d, s, c. The tendency to baryonic stability and the decay tendency of the other orbitals can be seen.

CONCLUSION

With the hadronic orbital field structure, the location of all the hadronic particles consisting of the quarks u, d, s, with their electric charge and isospin properties, and their interactions can be verified in a single image to generate a geometrical pattern that brings out properties and explains phenomena such as particle disintegration.

It is also proved that this pattern is the one used by nature to generate the matter that conforms the atoms we know and an explanation can be given as to why the isotopes of the chemical elements are formed, since with the disintegration of the particles in each orbital all the components necessary for this conformation remain as a product and that following lines of increasing energy the atoms can be conformed using these components giving the possibility of the nucleosistesis of the atoms, which is the reason why the isotopes of the chemical elements are formed, since with the disintegration of the particles in each orbital all the components necessary for this conformation remain as a product.

Afterwards, other forces will intervene that will give more energy to these orbital components and due to this additional energy and following the same hexagonal cubic pattern, larger and larger particles will be generated, which when they disintegrate will form heavier and heavier atoms.

In the end, what can be observed is that nature is not complicated, that all the emergent properties of the universe arise from a basic pattern established with a few simple guidelines that serve as a mold to generate the physical laws we know so far. And although this approach is not new, the difference is the point of view, since until today we start looking for the pattern in the most complex when already after many interactions the systems are already in a complete and chaotic dynamics, and that make the search for patterns too complex, so the current approach is to start from the beginning of the pattern and look for the original pattern in the early stages of creation of the structures and decant the basic patterns that are those that ultimately create all the subsequent complexity and thus explain the complex phenomena that we observe at the experimental level.

REFERENCES

[1] Gerard´t Hooft : Particulas Elementales, Editorial Planeta. Barcelona, España. 2018.

[2] Amsler-DeGrand-Krusche. Quark Model, august 2011

[3] RL workman. Review of Particle Physics, Particle data group, 2022.

[4] J Martin Camalich. Introduccion a la fisica de particulas, el Modelo Estandar. CERN (2017)

[5] R. Fernandez-M. Ramon Medrano. Particulas Elementales Tablas 2016.

[6] Review of Particle Physics, Particle data group. Baryon Particle Listing, pag. 1987-2175, 2022.

[7] Wikipedia, encyclopedia libre online, Hadrones y particulas elementales, 2023: http://www.wikipedia.org/hadrones.

[8] Laura Xiomara Rodriguez, Mesones Pion, Rho y los Diquarks, Univ.

[9] San Nicolas de Hidalgo, Agosto 2012

[10] Capitulo 4, Fisica Hadronica, pag. 197-215 edicion 210.

[11] Lic. Manuel Jenaro Ordoñes. Fisica Nuclear y Particulas, particulas elementales, Ingenieria Industrial N4. 1992.

[12] Eduardo Ros. Fisica de Particulas, Historia del modelo Quark. Univ. de Valencia. 2020.

[13] Ma. Jose Borge-Alfredo Poves. Estructura Nuclear: a la busqueda de los limites, 2008: www.rsef.org

[14] Illana Jose Ignacio. Los Hadrones y modelo quark. Univ. Granada. Depto. De fisica Teorica y de cosmos. 2020.

[15] Franz Muhein. Quark Model. Nuclear and Particle Physics. Univ. Edimburgh 2006.

[16] C. Amsler. Particle Data Group. PL B667, 2008.

[17] K. Hagiwara. Particle Data Group. D66. 2002

[18] Nima Arkani-Hamed. The Amplituhedron. Univ. Princeton, 2014