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Keywords: golden number, IQuO, hadron, quark, proton, neutron, meson.

I. The Geometric Hypothesis

The start point of a new path in physics is an apparent coincidence [1]: the numerical ratio between the Compton's wavelength ($\bar{\lambda}_{pl}$) , and ($\bar{\lambda}_p$) is:

$$\left(\frac{\bar{\lambda}_p}{\bar{\lambda}_{pl}}\right) = (1{,}301)(10)^{19} \approx (\phi^2/2)(10)^{19} \qquad (1)$$

Where (ϕ) is the golden number ($\phi \approx 1{,}618$). The scale factor $(10)^{19}$ can be due to the expansion of the universe, which maintains invariant the relation between physical quantities. Recall the golden segments (Fig. 1):

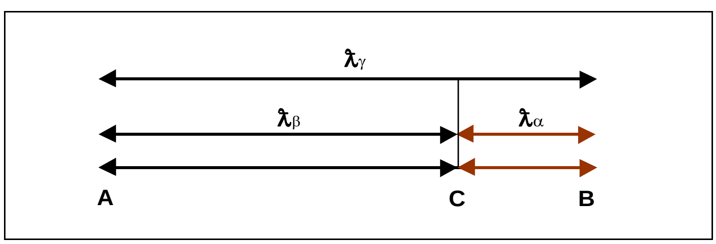

Fig. 1: "Aureus" segments

A property of the is:

$$\begin{cases} \bar{\lambda}_\beta = \left(\dfrac{\bar{\lambda}_\gamma}{\phi}\right) \\ \bar{\lambda}_\gamma = \phi^2 \bar{\lambda}_\alpha \end{cases} \qquad (2)$$

These relations are in a pentagon, between the side, and apothem. As is well known, the protons are composed of three quarks: three centers of elastic diffusion positioned in a triangular form in diffusion experiments with "bullet" electrons. These centers can indicate three vertices in a pentagon, Fig. 2:

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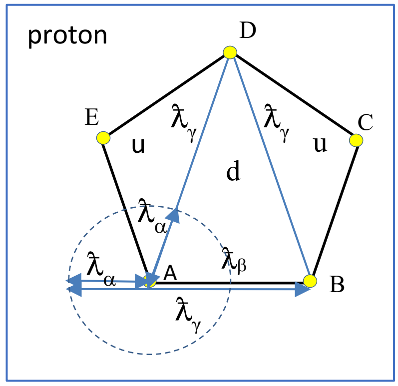

Fig. 2: The internal *geometric* structure of the proton

We could conjecture a proton having a geometric structure, where the component quarks are coincident with three constituent triangles (u,d,u). Specifically [2][3], quarks having a well-defined "***Aurea* G*eometric Structure.***" We will refer to this as the ***Aurum Geometric Model*** of quarks (AGM), where these particles cannot be punctual objects in Space-Time (see the Quantum Relativistic Theory of fields), but "golden" geometric forms of a not separable set of coupled quantum oscillators. The new paradigm consists, so, of affirm that all massive particles are geometric structures of coupled quantum oscillators (geometric hypothesis**)**. Thanks to AGM, it is possible to explain fundamental issues: the origin of the mass of hadrons, and quarks, the hadron spin, isospin, decay, and other aspect fundamentals. To the geometric form of a particle, we associate a ***structure equation,*** by which we can calculate the masses of quarks, mesons, , and nucleons [4]. So, the proton is a golden particle, , and the three quarks (u,u,d) are golden triangles, where [1] the diagonals (AD) or (BD) are proportional to Compton wavelength assigned to the proton ($ƛ_p = \hbar/m_p c$), thus [$ƛ_p = k_p ƛ_u$]. The ($ƛ_u$) is the Compton wavelength of "free" quark, while (k_p) is a coefficient of "***elastic adaptation***" when *(u,d)* quarks reciprocally bind for origin the proton. Just k_p can be in relation with binding gluons of the *(u,d)* quarks; we point out [$V(r)_{QCD} \Leftrightarrow k_p$], where V(r) is gluonic potential in QCD theory [5][6]; so in this theory, the elastic tension k replaces the potential V(r). The ratio between the masses (both bare, and bounded) of the two quarks is: [($ƛ_u / ƛ_d$) = (m_d/m_u) $= \phi \approx$ 1,618] with ($m_d > m_u$)

We can depict the geometric form of a quark [1] by three *spheres* (Vertex) being placed at the vertices of a golden triangle and connected by springs (Joining). We notice that this structure can be realizable only through "particular" quantum oscillators, point out by the acronym (**IQuO**) [7][8]. We emphasize the necessity that the vertex – oscillators, and junction oscillators must have a structure with two "hooks" at the far end. This last aspect induces us to talk about a "sub-structure" into the quantum oscillator, highlighted only in a quantum oscillator coupled to other oscillators (you see forward). Because the three quantum oscillators constitute a unique physical object, *i.e.* a unique quark, they cannot be detected separately, as shown in Fig. 3:

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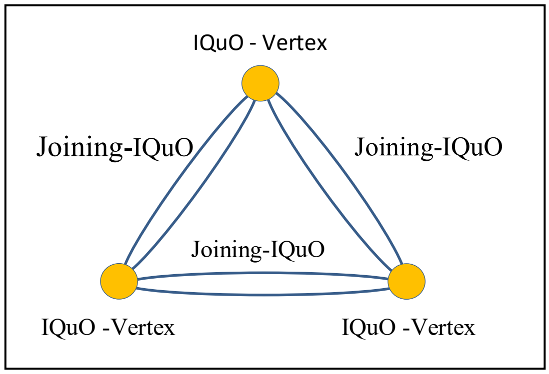

Fig. 3: Quark sub-structure

We have mathematically confirmed the golden hypothesis of two quark (u,d) in two articles [9][10]: we have coupled three quantum oscillators (vertices) placed at energy level (n = 2) with quantum oscillators of junction (sides) at energy level (n = 2) of sides , and base junction (n = 1). In ref. [11], we have also shown the golden geometric structure of quark (s,c,b,t) , and demonstrated that the number of quarks structures is six.

II. The Geometric Structure of the Pion

Recalling the light mesons composed of quark-antiquark pairs, in pion [1], the structure equation is: $[(\pi^{+}) = (u \oplus \underline{d}),\ (\pi^{-}) = (\underline{u} \oplus d)]$. The elements (u,d) are matrices built by the representative operator of IQuO [1][2]. The sign (⊕) point out the dynamics coupling between quarks; it could involve both gluon coupling, and electromagnetic: $[\oplus = \oplus_g + \oplus_{em}]$. Then, the representation is, see Fig. 4:

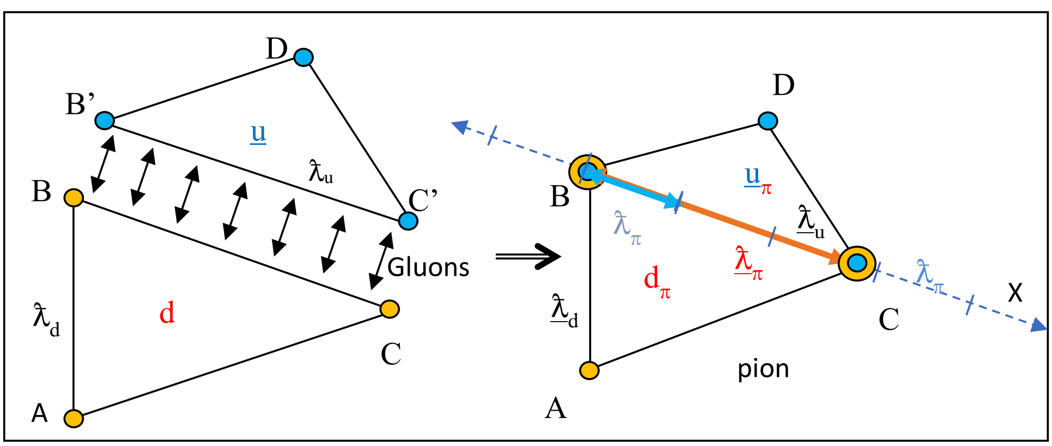

Fig. 4: The geometric form of pion

So, a quadrangular structure (ABDC) expresses a pion propagating along the X-axis. The bonds (gluons) between two ***free*** quarks ($u \Leftrightarrow d$) increases the elastic tension between the IQuO components of quarks $[(k_u , k_d)_{free} \rightarrow (\underline{k}_u , \underline{k}_d)_{bounded}]$: so, increasing the "free" frequencies $[(\omega_u , \omega_d) \rightarrow (\underline{\omega}_u , \underline{\omega}_d)]$ or masses $[(m_u , m_d) \rightarrow (\underline{m}_u , \underline{m}_d)]$. The π-structure is a similar system to two coupled oscillators ($u \Leftrightarrow d$), which oscillates with frequency (ω_π), period (τ_π), and (λ_π,m_π). Each quark (u,d) contributes to total mass (m_π) with its mass value ($\underline{m}_u$, $\underline{m}_d$), maintaining the golden ratio $[(\underline{m}_d / \underline{m}_u) = \phi]$. We can admit that in the ($\underline{k}_i$) are contained the mass defects (recall that k replaces the potential V(r)), so that we have [$m_\pi = \underline{m}_u + \underline{m}_d$]. To the frequency ω_π we associate k_π elastic coefficient, which is related to the ***gluon potential*** V(r) of the QCD [5] , and thus, in turn, is related to coupling (⊕).

III. The Quarks' Masses (u,d)

Then, combining the two massive relations in pion, we have [1]:

$$\begin{cases} \underline{m}(u_\pi) + \underline{m}(d_\pi) = m_\pi^\pm \\ \underline{m}(d_\pi) / \underline{m}(u_\pi) = \phi \end{cases} \tag{3}$$

with solutions

$$\begin{cases} \underline{m}(u_\pi) = (53{,}31)MeV \\ m(u_\pi)\phi = (86{,}26)MeV \end{cases} \tag{4}$$

Where $m(\pi^\pm) \approx (139{,}57)$ MeV.

The two quarks (u_π, d_π) with their gluons are called ***dressed quarks***. We have also calculated the free masses of quarks from mass defect between charged pion, and that neutral π^0. A system of two equations can give the ***bare masses*** of quarks (*u*,*d*) if we admit their masses in golden relation:

$$\begin{cases} (1/2)[m(u_f) + m(d_f)] = \Delta m_\pi^0 \\ m(d_f)/m(u_f) = \phi \end{cases} \Rightarrow \begin{cases} m(u_f) = (3{,}51)MeV \\ m(d_f) = (5{,}67)MeV \end{cases} \tag{5}$$

IV. The Hadron Spin

The possibility of more relative orientations between two quarks implies a reciprocal *rotation* of two quarks *(u*, and *d)* around the X-axis (as orbital motions) [1][2][3]. Thus, these configurations, or orientations, can induce us to think about ***spin*** [4]. If the quarks are fermions, then the oscillation propagating along sides is described by a spinor, with an *intrinsic spin* (s_q). Besides, we associate an *orbital spin* (s_l) to rotations of (u,d)-quarks around the X-axis. Note the rotations of quarks around X-axis involve the gluons; therefore, there is a *gluonic orbital motion* (s_g). This model is so consistent with experimental observations [12][13], where the spin is: [$s_h = s_q + s_l + s_g$]

V. The $\underline{\otimes}$- Operation of Hadronic Mass Calculation

Thanks to the structure equation, it is possible to calculate, by a mathematical procedure, the masses of the light mesons composed of quarks (u, d), and two nucleons. We used a similar procedure to one of QCD but without using its potentials: to incorporate the binding energy of the quarks, consisting of binding gluons, into the global mass of the quarks [1][2][4]:

$$[m_{\text{global hadron}} = m_{\text{quarks}} + m_{\text{binding}}]$$

This way, the bonded quarks inside the hadron would have enough mass to reach the mass value of the hadron. The pion mass can be placed as a base mass to determine the mass of the most massive mesons. We proved (see the calculations in [2][3]) that all light mesons, following the pion, are elaborated structures of pion compositions , and $\{d,\underline{d}\}$-lattice of d-quarks, see the structure equations. However, for obtaining the mesons masses, and nucleons, we need to introduce a new operation of mass calculation ($\underline{\otimes}$-operation). This operation considers both interactions, and ***interpenetration*** between quarks; this last is an aspect purely quantum-undulatory, see the superposition of particles-waves. The latter may exist if we admit that two different structures (states) of coupled quantum oscillators (or quarks) can overlap without exchanging energy. In the global mass of a hadron must be in account all the possible configurations of quark components, both the ones with interpenetration, and the ones with interactions. The $\underline{\otimes}$ operation is a combination of two operations (⊕,⊗): the (⊕) represents dynamics interaction, while the (⊗) is the operation of interpenetration.

The interpenetration must be considered as a mere "representation" of a quantum state associated with different configurations; see Fig. 2, and 4: recall spin connected with possibilities of spatial orientations. Thus, between the interpenetration and spin there is a reciprocal correlation in a quantum way**.** The interpenetration leads us to review the concept of mass of a composite particle. We need to consider all possible configurations of its structure components inside the calculation of its mass. The ⊗-operation of interpenetration follows, in algebraic calculations, the properties of the multiplication. Instead, ⊕-operation follows, in algebraic calculations, the properties of the sum. For the calculation of meson masses, and mass defects, we have used two functions [(F_m), $(F_{\Delta m})$]. The (F_m) is an application on the components of the structure equation, which gives us the mass values (m_i) of the component particles.

To obtain the mass defects ($\Delta m > 0$, $\Delta m < 0$), we have used [3] a Function $(F_{\Delta m})$, represented by a matrix A_{ij}, applied to structure equation [3][4], of the mass defects (Δm_i), see table 1:

Table 1: Table of the coupling with the interaction of quarks

$\Delta m(X)$	q_1	q_2	…	q_n
q_1	$\Delta m(q_1, q_1)^R_\oplus$	$\Delta m\,(q_1\, q_2)^G_\oplus$	…	$\Delta m\,(q_1\, q_n)^B_\oplus$
q_2	$\Delta m\,(q_2, q_1)^G_\oplus$	$\Delta m\,(q_2, q_2)^R_\oplus$	…	$\Delta m\,(q_2\, q_n)^G_\oplus$
…	…	…	…	…
q_n	$\Delta m\,(q_n, q_1)^B_\oplus$	$\Delta m\,(q_n, q_2)^G_\oplus$	…	$\Delta m\,(q_n\, q_n)^R_\oplus$

Where q_i are the particles (in mesons are pions) which compose the particle X. Besides, it is $\Delta m(q_i, q_j)^{R,B,G}_\oplus = \Delta m(q_i \oplus q_j)^{R,B,G}$

Here, we report the values of mesons masses obtained by calculations, see table 2:

Table 2: Mass values of mesons

Meson	Level	Structure Equation	Theory Mass (MeV)	Exper. Mass (MeV)
π^0	1	$[\pi^+\otimes\pi^-] \oplus [(u\oplus\underline{u})\otimes (d\oplus\underline{d})]$	(134,97)	(134,97)
η^0	2	$(\pi^0)_r\otimes(\pi^0)_r = (\pi^+\oplus\pi^-) \otimes (\pi^+\oplus\pi^-)$	(547,95)	(547,86)
η'	3	$\{(\pi^0)_r\otimes(\eta)\} = (\pi^0)_r\otimes(\pi^0)_r\otimes(\pi^0)_r$	(957,44)	(957,78)
ρ	3	$[(d,\underline{d})_\pi]\otimes\{[(2\pi^+\oplus\pi^0{}_r) \otimes(2\pi^-\oplus\pi^0{}_r)]\}$	(775,49) (774,91)	(775,26)
$\rho^\pm$	3	$[(d,\underline{d})_\pi]\otimes\{[(2\pi^+\oplus\pi^0{}_r) \otimes(2\pi^-\oplus\pi^\pm{}_r)]\}$	(776,44) (777,52)	(775,26)
ω	4	$[(d,\underline{d})_\pi] \otimes\{[(2\pi^+ \oplus 2\pi^0) \otimes (2\pi^- \oplus 2\pi^0)]\}$.	(782,33)	(782,65)
ϕ^0	4	$\phi^0 = \{[(d,\underline{d}) \otimes (2\pi^0 \oplus \eta)] \oplus (\eta)\}$	(1019,87)	(1019,41)

By this model, it is possible to calculate the masses of all other mesons more massive. Not only, but we can also calculate the mass values of the nucleons [4].

VI. The Calculation of Proton Mass

In a preprint [4], we have calculated, by theoretical physics aspects, and suitable mathematical procedure, the masses of the nucleons, while in a next study of light baryons without strangeness ($\Delta°$, Δ^-, Δ^{++}). In light mesons, we highlighted a mass spectrum built employing lattices of base pions $\{\pi\}$, and quarks $\{d,\underline{d}\}$[3]. In proton, the coupling of quarks with interpenetration is expressed [4] by $\underline{\otimes}$-operator: $(q_1 \underline{\otimes} q_2 \underline{\otimes} q_3)$. The product $[u\underline{\otimes}d\otimes\underline{u}]$ implies the combination of all possible configurations between quarks (u, d, u). The structure equation of the proton is:

$$[u_1 \underline{\otimes} d \underline{\otimes} u_2] = \{[(u_1)\otimes(d\oplus u_2)]_{A_1} \oplus [(d)\otimes(u_2\oplus u_1)]_{A_2} \oplus [(u_2)\otimes(u_1\oplus d)]_{A_3}\}_{A_3} \quad (6)$$

By this equation, and using the F_m-function, the partial proton mass is: m(p) = (964,45) MeV. The mass defect, by the matrix A_{ij}, is, see table 3:

Table 3: Table of the coupling with the interaction of quarks in the proton

$\Delta m^*(p)$	u_1	d_1	u_2
u_1	$\Delta m(u_1, u_1)^R_\oplus$	$\Delta m\ (u_1\ d_1)^G_\oplus$	$\Delta m\ (u_1\ u_2)^B_\oplus$
d_1	$\Delta m\ (d_1, u_1)^G_\oplus$	$\Delta m\ (d_1, d_1)^R_\oplus$	$\Delta m\ (d_1\ u_2)^G_\oplus$
u_2	$\Delta m\ (u_2, u_1)^B_\oplus$	$\Delta m\ (u_2, d_1)^G_\oplus$	$\Delta m\ (u_2, u_2)^R_\oplus$

We obtain the total mass defect of (25,48) MeV. In ref. [3][4] to each element in the red color of the A_{ij} matrix, relative to all mesons, we gave the values of (1,15) MeV. In the proton, we assume the same value. Then, the total mass of the proton is:

$$m_{tot}(p)=m(p)-\Delta m_{\gamma}(p)=[(964{,}45)-(25{,}48)]MeV=(938{,}97)MeV \quad (7)$$

Value very next to that experimental.

VII. New Quantum Aspects

Giving a numerical value of mass defect to the terms $(q_{we}\otimes q_i)_R$ would imply the interpenetration with the interaction of a quark with itself [3][4]. A quark in rotation around an axis is equivalent to a quark with different configurations of itself to the time flow. Recall the QM admit a not space locality: the superposition of states in the experiments with two fissures. A superposition of states in time is possible only in proper space spin, and not in space translations. The new quantum aspects of the proper rotation, and of not time locality of quarks leads us to conjecture that the elements in red color (in diagonal) of the mass defect matrix can represent the kinetic energy of rotation of quarks around to the side AB; see fig. 2. Therefore, we can have $\Delta m\,(q_{we}\otimes q_i)_{\oplus}\neq 0$. To this orbital kinetic energy, we associate in calculations a mass defect negative $\Delta m_{Kin}<0$.

VIII. The Calculation of Neutron Mass

In works [2][3] for calculating the mass values of mesons, we needed to admit the presence of a background lattice of pairs {d,$\underline{d}$}, which comes included in the structure equation of mesons. The same it also occurs in the light neutral nucleon, in a submission [4], where a couple (d,$\underline{d}$), belonging to background lattice, is being in "loan" for being incorporated in the structure: then, it needs to add, into calculations of mass a quarks' pair (d,$\underline{d}$). Therefore, the structure equation could be:

$$(n)=3\kappa_n\left(\left\{(d\otimes\underline{d})_A\ \underline{\otimes}\ [d_1\underline{\otimes}\,u\,\underline{\otimes}\,d_2]_B\right\}\right) \quad (8)$$

With configuration, fig. 5:

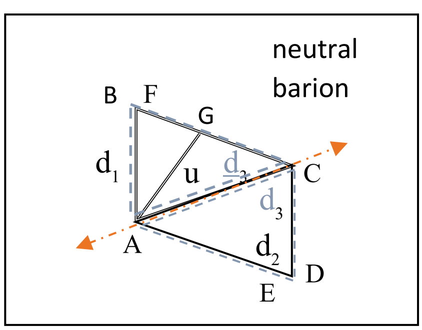

Fig. 5: The neutron configuration

The matrix A_{ij} is, see table 4:

Table 4: Table of the coupling with the interaction of quarks in a neutron

$\Delta m^*(n)$	d_1	u_1	d_2	d_3	d_4
d_1	$(d_1\ d_1)^R$	$(d_1\ u_1)^{G1}$	$(d_1\ d_2)^{B1}$	$(d_1\ d_3)^{B1}$	$(d_1\ d_4)^{G2}$
u_1	$(u_1\ d_1)^{G1}$	$(u_1\ u_1)^R$	$(u_1\ d_2)^{G1}$	$(u_1\ d_3)^{G1}$	$(u_1\ d_4)^{B2}$
d_2	$(d_2\ d_1)^{B1}$	$(d_2\ u_1)^{G1}$	$(d_2\ d_2)^R$	$(d_2\ d_3)^{B1}$	$(d_2\ d_4)^{G2}$
d_3	$(d_3\ d_1)^{B1}$	$(d_3\ u_1)^{G1}$	$(d_3\ d_2)^{B1}$	$(d_3\ d_3)^R$	$(d_3\ d_4)^{G2}$
d_4	$(d_4\ d_1)^{G2}$	$(d_4\ u_1)^{B2}$	$(d_4\ d_2)^{G2}$	$(d_4\ d_3)^{G2}$	$(d_4\ d_4)^R$

With mass defect of (19,58) MeV; then, it is:

$$m_{tot}(n)=m(n)-\Delta m_{\gamma}(n)=\{(959,23)-(19,58)\}MeV=[(939,65)]MeV/c^2 \tag{9}$$

Next to that experimental m(n) = **(939,57) MeV**

IX. The Intrinsic Quantum Oscillators (IQuO)

In sec. one, we have said that, see fig. 3, the oscillators realizing these structures need be "particular" quantum oscillators: the vertex – oscillators , and junction oscillators must have a structure with "hooks"[1][3]: this induces us to talk about a "sub-structure" into quantum oscillator [7][8]. Indication of a "composite structure" in quantum oscillator derives from its wave function, see fig. 6. The probability peaks of detecting the energy quanta in the oscillation can describe some sub-units of oscillation or "sub-oscillators".

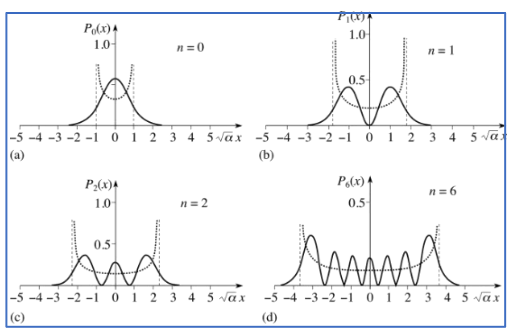

Fig. 6: The probability function of a quantum oscillator

The presence of more components in an oscillator causes the splitting of its quanta of energy into two, and more sub-oscillators: this introduces the idea of half-quanta ("semi-quanta") or individually half-quantum ("semi-quantum"). A quantum oscillator with a sub-structure constituted by sub-oscillators, and "semi-quanta" is an oscillator of type "IQuO" [7][8][10]. The operators (a,a^+), projected in the space of semi-quanta operators, give us the mathematic representation of an IQuO:

$$[\Psi(t)]\equiv\begin{pmatrix}\hat{a}^+_{r'}(t)\\ \hat{a}_{r'}(t)\end{pmatrix}=\begin{cases}\hat{a}^+_{r'}(t)=(\hat{\bullet}^+)_{el}[\exp(ir'\omega t)]+(\hat{o}^+)_{in}[\exp(i(r'\omega t-\pi/2))]\\ \hat{a}_{r'}(t)=(\hat{o})_{el}[\exp(-ir'\omega t)]+(\hat{\bullet})_{in}[\exp(-i(r'\omega t-\pi/2))]\end{cases} \tag{10}$$

$$\text{with } \vec{\Psi}(t)\equiv[\vec{a}^+(t)+\vec{a}(t)]=[(a^+_{el}(t)+a^+_{in}(t))+(a_{el}(t)+a_{in}(t))]$$

Where the parameter (r'= ± 1) is connected to the direction of phase rotation, and subscripts [el = elastic component; in = inertial component]. Besides, the operators [(•),(**o**)] are the components of $[a,a^+]$, and, thus, operators of full semi-quantum (•), with energy [(½) $\hbar\omega$)] , and empty semi-quantum (**o**),with energy [(¼)$\hbar\omega$)]. This representation relieves the presence of an internal degree of freedom into IQuO, which allows of highlight the direction of phase rotation of an oscillator: this direction expresses the electric charge sign. By IQuO oscillators, we can know the meaning of fundamental physical properties [1], such as the mass of the particles, the sign of electric charge [7][8], the Y hypercharge , and the isospin in the quark [9][10][11]. Looking at fig. 6, we can associate to quarks an IQuO at level (n =3), and 3-sub-oscillators. In these IQuO, it is possible to find another internal degree of freedom: the **color charge** [10]. So, in the IQuO model, the sub-oscillators can define the "**gluons**" [10] , and color charge. Here, in the phase plane, we report the representations of the oscillations of the elastic components , and inertial (el, in) associated with the gluon (R$\underline{B}$), see fig. 7:

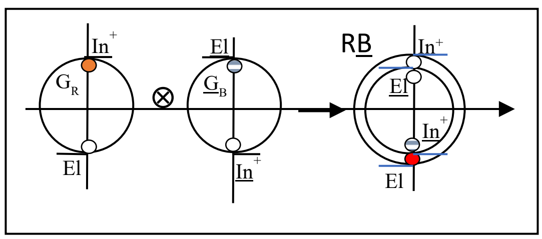

Fig. 7: The R$\underline{B}$-gluon

X. Conclusions

Thanks to this paradigm, innovative solutions to experimental problems about particles can be exposed. The IQuO idea (and the AGM) allows us of:

- calculate the masses of quarks, and hadrons using the structure equations by of calculation operations.
- know the origin of the electric charge, and color
- know the gluon structure
- find the structures of leptons, and bosons W, Z
- show decay, and interactions of particles

So, the IQuO idea (, and the AGM) constitutes a new paradigm in physics that allows us of describes with depth the physical phenomenon of particles, and to open new descriptive scenarios of interactions between particles of the Standard Model.

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