Particle Physics based on "focal point" representation of particles.

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(This paper is an extract of [8] listed in section Bibliography.)

Abstract

The present work is based on findings of the model "Emission & Regeneration" Unified Field Theory. The model represents subatomic particles as focal points of rays of Fundamental Particles (FPs) that move from infinite to infinite. FPs are emitted by the focal point and at the same time regenerate it. Interactions between subatomic particles are the product of the interactions of the angular momenta of the FPs. The interaction between two charged subatomic particles tend to zero for the distance between them tending to zero, allowing to place the zero of the potential energy at the distance zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. This allows a completely new interpretation of the interactions between quarks and the corresponding energy states.

1 Introduction.

Subatomic particles (SPs) are represented as focal points of rays of Fundamental Particles (FPs). FPs are emitted by the focal point and at the same time regenerate it and are defined as follows.

The total energy of a SP with constant $v \neq c$ is

$$E = \sqrt{E_o^2 \; + \; E_p^2} \qquad E_o = m\, c^2 \qquad E_p = p\, c \qquad p = \frac{m\, v}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{1}$$

The total energy $E = E_e$ is split in

$$E_e = E_s + E_n \qquad with \qquad E_s = \frac{E_o^2}{\sqrt{E_o^2 \, + \, E_p^2}} \qquad and \qquad E_n = \frac{E_p^2}{\sqrt{E_o^2 \, + \, E_p^2}} \tag{2}$$

With the help of the distribution equation

$$d\kappa = \frac{1}{2}\,\frac{r_o}{r^2}\,dr\;\sin\varphi\,d\varphi\,\frac{d\gamma}{2\pi} \tag{3}$$

differential emitted dE_e and regenerating dE_s and dE_n energies are defined

$$dE_e = E_e\,d\kappa = \nu\;J_e \qquad dE_s = E_s\,d\kappa = \nu\;J_s \qquad dE_n = E_n\,d\kappa = \nu\;J_n \tag{4}$$

The distribution equation $d\kappa$ gives the part of the total energy of a SP moving with $v \neq c$ contained in the differential volume $dV = dr\;rd\varphi\;r\sin\varphi\;d\gamma$.

The concept is shown in Fig. 1 where BSP means Basic Subatomic Particles and are electrons and positrons.

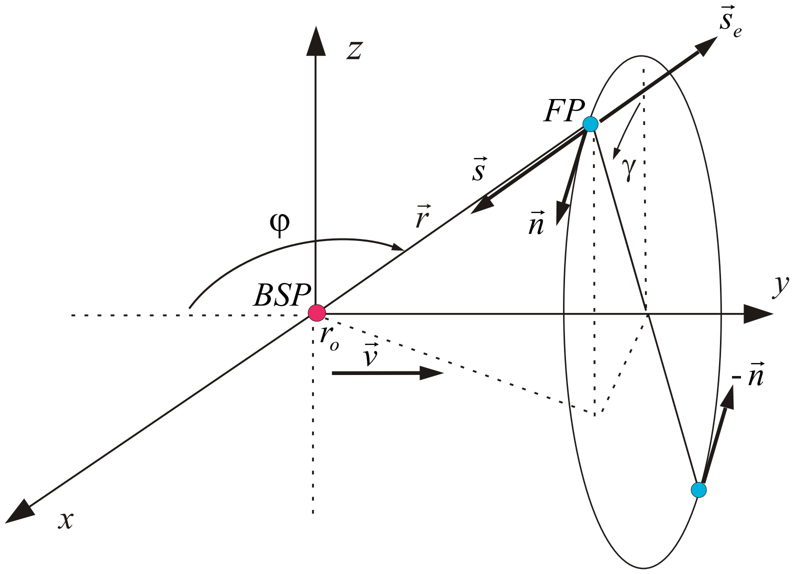

Figure 1: Unit vector $\bar{s}_e$ for an emitted FP and unit vectors $\bar{s}$ and $\bar{n}$ for a regenerating FP of a BSP moving with $v \neq c$

The part E_s of the total relativistic energy tends to zero for the speed v tending to c and defines the longitudinal angular moment J_s of the FPs (4).

The part E_n of the total relativistic energy is zero for $v = 0$ and tends to infinity for the speed v tending to c and defines the transversal angular moment J_n of the FPs (4). The direction of $\bar{J}_n$ is defined by the right screw in the direction of the speed $\bar{v}$ and is independent of the charge of the BSP.

The energy of opposed transversal angular momenta J_n of two regenerating FPs that arrive at the focal point is transformed into linear momenta as shown in Fig. 2.

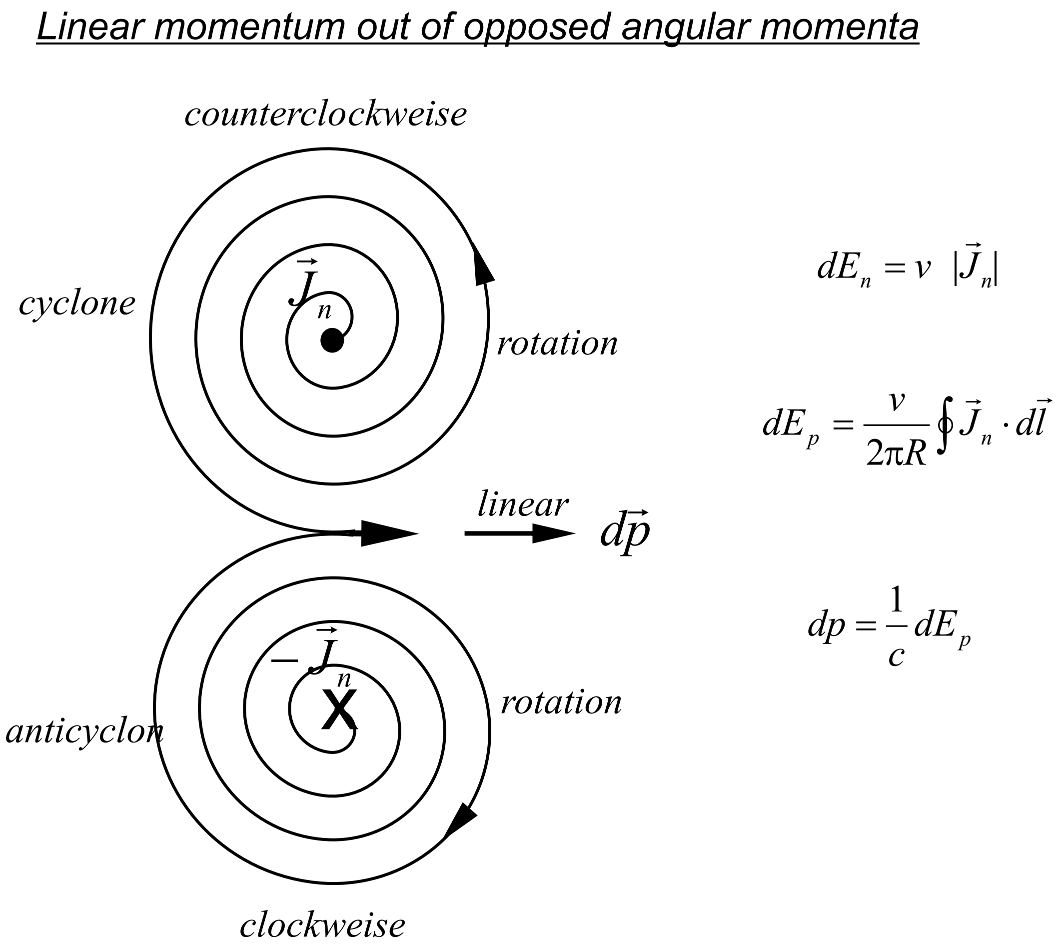

Figure 2: Generation of linear momentum out of opposed angular momenta

The interaction between an electron and positron is the product of the interactions of the angular momenta of their Fundamental Particles (FPs).

The analysis of linear momentum between electrons and positrons according the "E&R" model is shown in Fig. 3. Five regions can be identified along the distance $d/r_o = \gamma$, where $r_o = 1.0 \cdot 10^{-16}\ m$ is the radius of the electron or positron.

1. From $0 \ll \gamma \ll 0.1$ where $p_{stat} = 0$

2. From $0.1 \ll \gamma \ll 1.8$ where $p_{stat} \propto d^{\,2}$

3. From $1.8 \ll \gamma \ll 2.1$ where $p_{stat} \approx constant$

4. From $2.1 \ll \gamma \ll 518$ where $p_{stat} \propto \frac{1}{d}$

5. From $518 \ll \gamma \ll \infty$ where $p_{stat} \propto \frac{1}{d^2}$ (Coulomb)

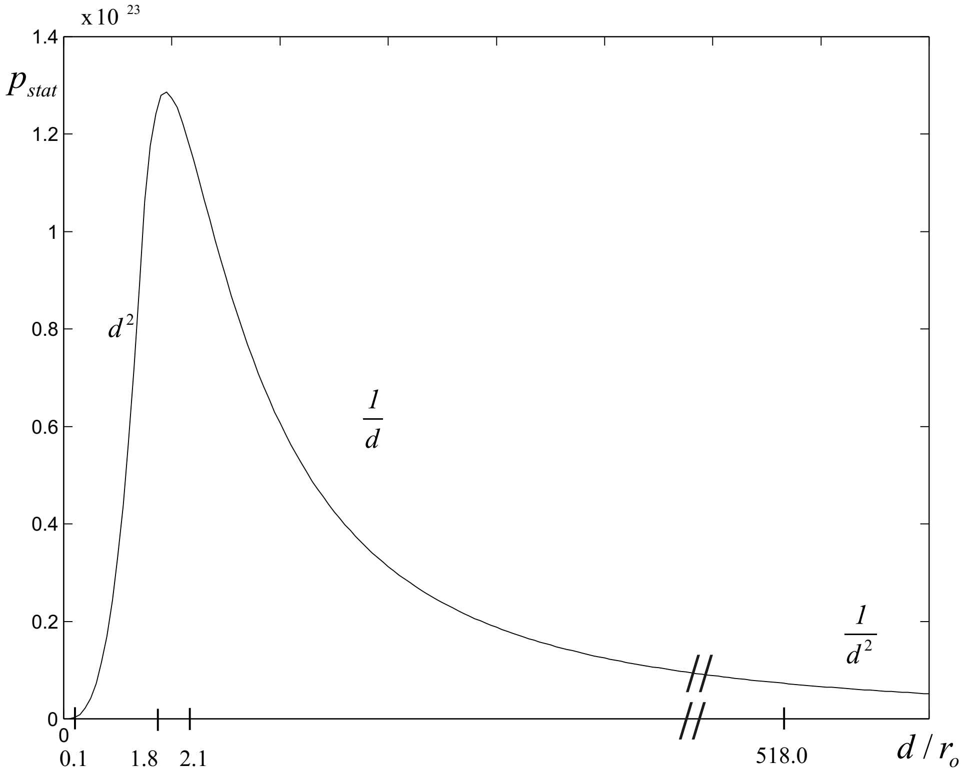

Figure 3: Linear momentum p_{stat} as function of $\gamma = d/r_o$ between an electron and positron with maximum at $\gamma = 2$

Fig. 3 shows the linear momentum p_{stat} between an electron and positron as a function of the distance d. The force is

$$F_{stat} = \frac{\Delta p}{\Delta t} = \frac{p_{stat} - p_2}{\Delta t} = \frac{p_{stat}}{\Delta t} \qquad p_2 = 0 \quad and \quad \Delta t = 5.42713 \cdot 10^{-28}\ s \qquad (5)$$

The curve was calculated for $r_o = 1.0 \cdot 10^{-16}\ m$ and with $K = 5.42713 \cdot 10^4\ s/m^2$ we get $\Delta t = K\ r_o^2 = 5.42713 \cdot 10^{-28}\ s$ constant for all distances d.

Fig. 4 shows a cut trough an atom identifying the five zones.

1. Zone 1 represents the core of an atomic nucleus where electrons and positrons neither attract nor repel each other. They build a swarm of electrons and positrons.

2. Zone 2 is the zone from where electrons and positrons that have migrated out of zone 1 are reintegrated to zone 1 or expelled out of the atom.

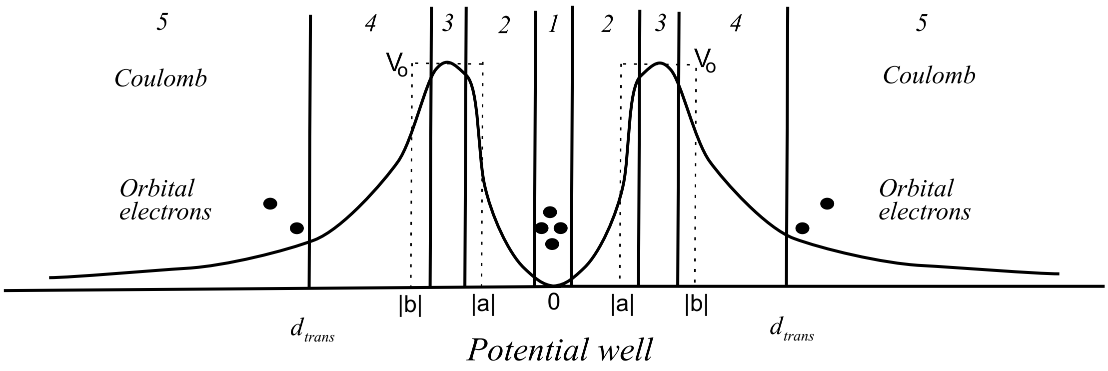

Figure 4: Potential well between charged particles

3. Zone 3 shows the high of the momentum wall p_{stat} through which the expelled electrons and positrons have tunnelled.

4. Zone 4 is a transition zone to the Coulomb zone.

5. Zone 5 is the Coulomb zone that extends up to infinity.

Fig. 5 shows potential energies corresponding to different theoretical models. All potential energies from existing models are not defined for the distance between charged particles tending to zero, what forces to define the potential energy as negative and to place the zero at infinite.

The potential energy of the present approach is defined for the distance between charged particles tending to zero allowing to place the the origin of the potential energy at $d = 0$.

The potential is given by

$$V(d) = \int_0^d F_{stat}\, \delta d = \frac{1}{\Delta t} \int_0^d p_{stat}\, \delta d \qquad for \quad d \to \infty \quad we \quad get \quad \approx 1.0\, GeV \tag{6}$$

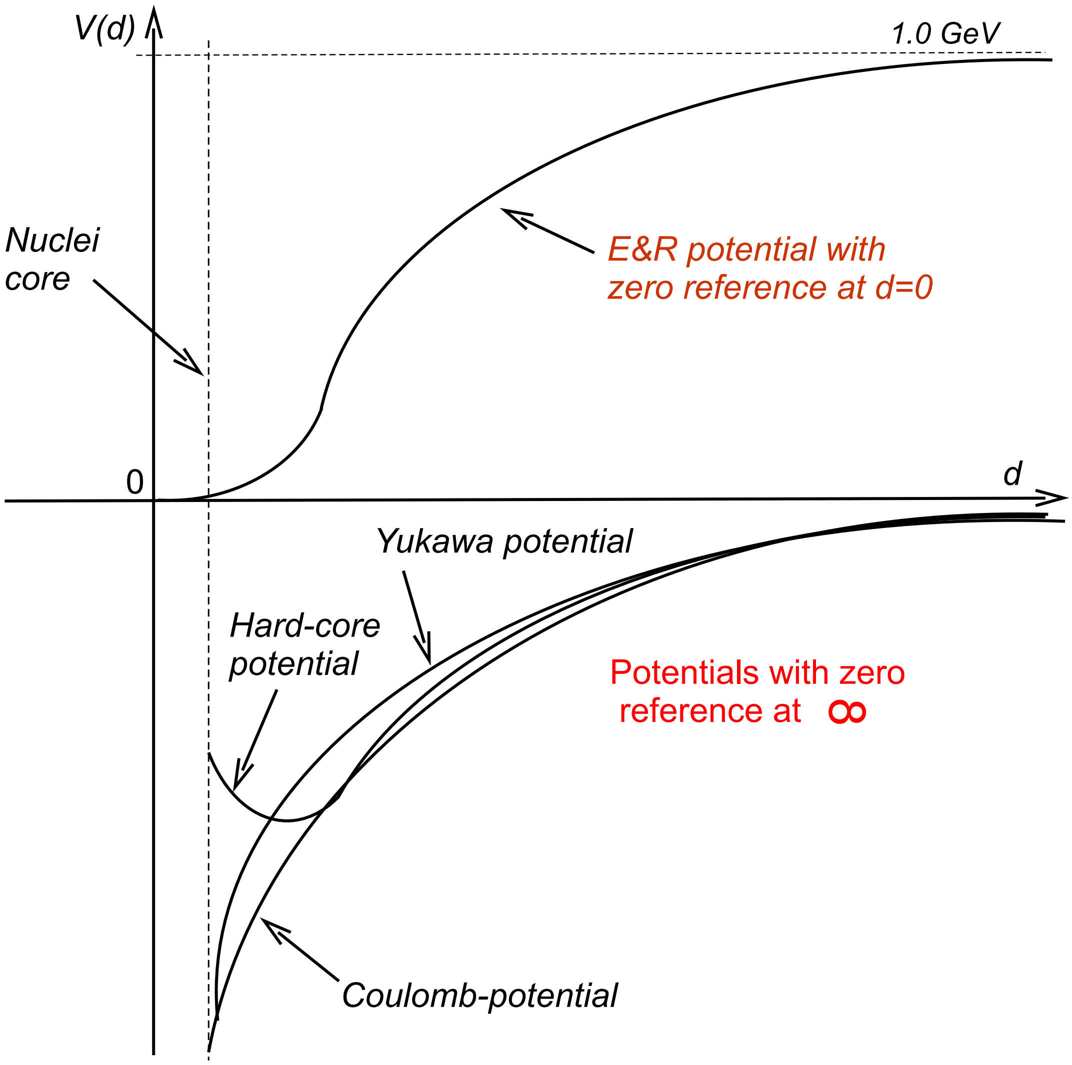

Figure 5: Comparison of potential energies between charged particles

2 Electron and positron compensation and annihilation.

The representation of electrons and positrons as focal points of rays of FPs, where the energy is stored in the angular momenta of their FPs, explains the compensation and annihilation of electrons and positrons as follows: (see also Fig. 1)

Fig. 6 shows the electron positron compensation. When the electron shown at a) and the positron shown at b) are moved slowly together, they compensate each other for the interactions with other external charged particles. At c) the compensation is shown as the result of the compensation of the longitudinal angular momenta J_s of all their FPs.

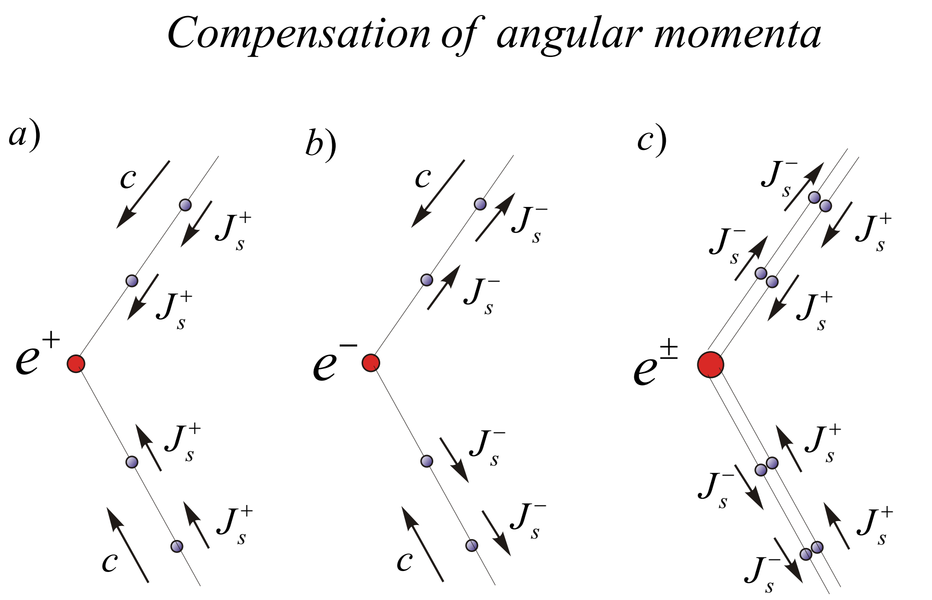

Figure 6: Electron positron compensation

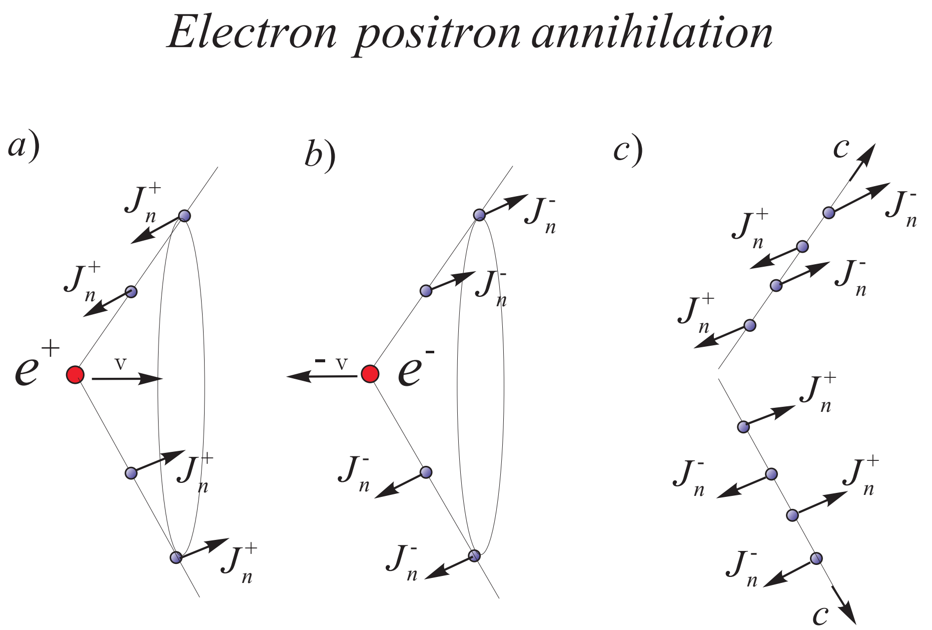

Figure 7: Electron positron annihilation

Fig. 7 shows the annihilation of an electron with an positron. At the regenerating FPs of moving electrons or positrons transversal angular momenta J_n are generated as shown at a) and b. When the electron and positron collide, trains of pairs of FPs with opposed transversal angular momenta (photons) are expelled with the speed “ c “, as shown at c). Also individual pairs of FPs with opposed transversal angular momenta (neutrinos) may be expelled with the speed c. The photons and neutrinos are entities where the sum of their angular momenta is equal zero and therefore they can become independent entities of the focal point.

3 Differences between the Standard and the E & R Models in Particle Physics.

An important difference between the two models we have in particle physics. The concept is shown in Fig.8

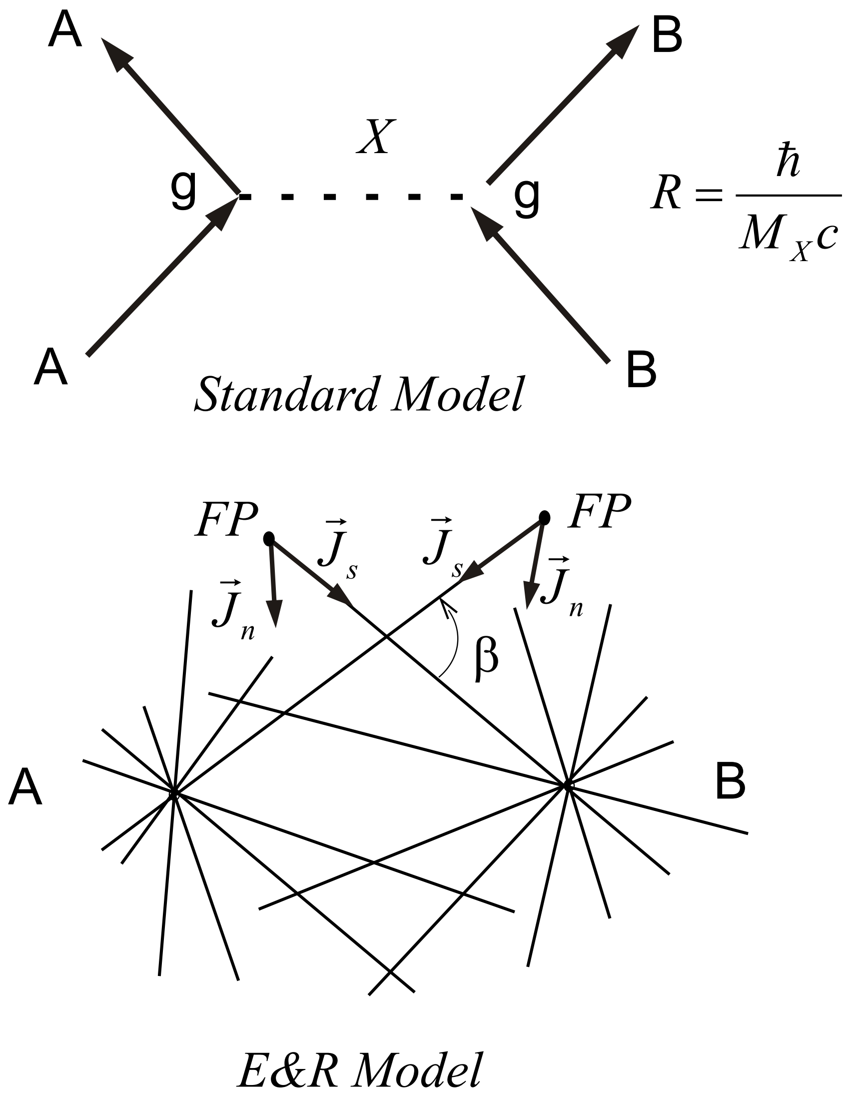

Figure 8: Differences between the Standard and the E & R Models

The SM defines carrier particles X for the interaction between particles A and B and leads to energy violation during the time $\hbar/\Delta E$. The range R of these carrier particles defines the distance over which the interaction can take place and is given by

$$R = \frac{\hbar}{M_X\ c} \tag{7}$$

where M_X is the mass of the carrier particle with the coupling strength g to the particles A and B. For electromagnetic interactions the carrier particles are the photons with $M_X = 0$, the range is $R = \infty$. For the weak interactions the carrier particles are the W and Z bosons with masses in the order of $80 - 90\ GeV/c^2$ corresponding to a range of $2 \cdot 10^{-3}\ fm$. For the strong and gravitation interactions the carrier particles are the gluons and gravitons respectively with $M_X = 0$ and range $R = \infty$.

The E & R model has no carrier. The particles A and B are formed by rays of FPs that go from ∞ to ∞ through a point in space which is called "Focal Point". FPs are continously emited from the Focal Point and FPs continously regenerate the Focal Point. The regenerating FPs are the FPs emited by other Focal Points in space. The particles A and B are continously interacting through their FPs, independent of the distance between them. There is no difference between subatomic particles and their FPs which are the constituents of subatomic particles.

FPs have no rest mass and are emitted with the speed c or ∞ relative to the Focal Point. They have longitudinal and transversal angular momenta and their interaction is given by the cross product of their angular momenta, cross product which is proportional to $\sin\beta$. To get the total force between the particles A and B, the integration over the whole space of all the interactions of their FPs is required.

All interactions are **electromagnetic interactions** and are generated out of the combinations of the interactions of the longitudinal and transversal angular momenta of the FPs.

The **strong interaction** is explained with the zero electromagnetic force between electrons and positrons, which are the constituents of nucleons, for the distance between A and B tending to zero. No force is required to hold nucleons together.

Weak interactions is an electromagnetic interaction between migrated electrons or positrons that interact with the remaining electrons and positrons of the nuclei core. The small electromagnetic force is explained with the small distances between A and B, force which is proportional to the cross product which is proportional to $\sin\beta$. See Fig. 8.

Gravitational interactions are the result of electromagnetic interactions between electrons and positrons that have migrated slowly out of their nuclei and are then reintegrated with high speed.

4 Mass and charge in the E & R Model

The SM defines mass and charge as different physical characteristics, although it cannot explain what charge is. It defines particles like the neutrons having mass but no charge.

The E & R Model defines mass and charge as physical characteristics that are intrinsic to particles and cannot be separated. The charge of an electron and positron is defined by the sign of the longitudinal angular momentum of emited FPs. Positive rotation in moving direction corresponds to a positive charge and negative rotation to a negative charge. Neutrons are composed of equal numbers of electrons and positrons so that their longitudinal angular momenta of emited FPs compensate, resulting an effective zero charge.

A mass unit is associated with a charge unit. To the mass $9.1094 \cdot 10^{-31}\ kg$ of a positron or electron corresponds a charge of $\pm\ 1.6022 \cdot 10^{-19}\ C$.

For complex particles that are formed by more than one electron or positron we have for the Coulomb force

$$F = 2.307078 \cdot 10^{-28}\ \frac{\Delta n_1\ \cdot \Delta n_2}{d^2}\ N \tag{8}$$

The charge Q of the Coulomb law is replaced by the expression $\Delta n = n^+ - n^-$ which gives the difference between the **constituent** numbers of positive and negative particles (positrons and electrons) that form the complex particle. As the n_i are integer numbers, the Coulomb force is quantified.

The expression $\Delta n = n^+ - n^-$ corresponds to the nuclear charge number or atomic number Z.

$$\Delta n = n^+ - n^-\ =\ Z \tag{9}$$

As examples we have for the proton $n^+ = 919$ and $n^- = 918$ with a binding Energy of $E_{B_{prot}} = -6.9489 \cdot 10^{-14}\ J = -0.43371\ MeV$, and for the neutron $n^+ = 919$ and $n^- = 919$ with a binding Energy of $E_{B_{neutr}} = 5.59743 \cdot 10^{-14}\ J = 0.34936\ MeV$.

5 Quarks composed of electrons and positrons.

The existence of Quarks were first infered from the study of hadron spectroscopy. Infered means that they were reconstructed from the final measured products obtained after collisions of particles. The final products are neutrons, protons, pions, muons, electrons, positrons, photons, and neutrinos. As neutrons, protons, pions and muons are composed of electrons and positrons according the $E\&R$ model, the real final products are electrons, positrons photons and neutrinos. And as also according to the $E\&R$ model the photon is a sequence of neutrinos, the final products are reduced to electrons, positrons and neutrinos.

The concept is shown in Fig: 9

To explain the interpretation given with the model $E\&R$ UFT we calculate an example with the proton.

Example: The proton has a mass of $938.2723\ MeV/c^2$. With the mass of an

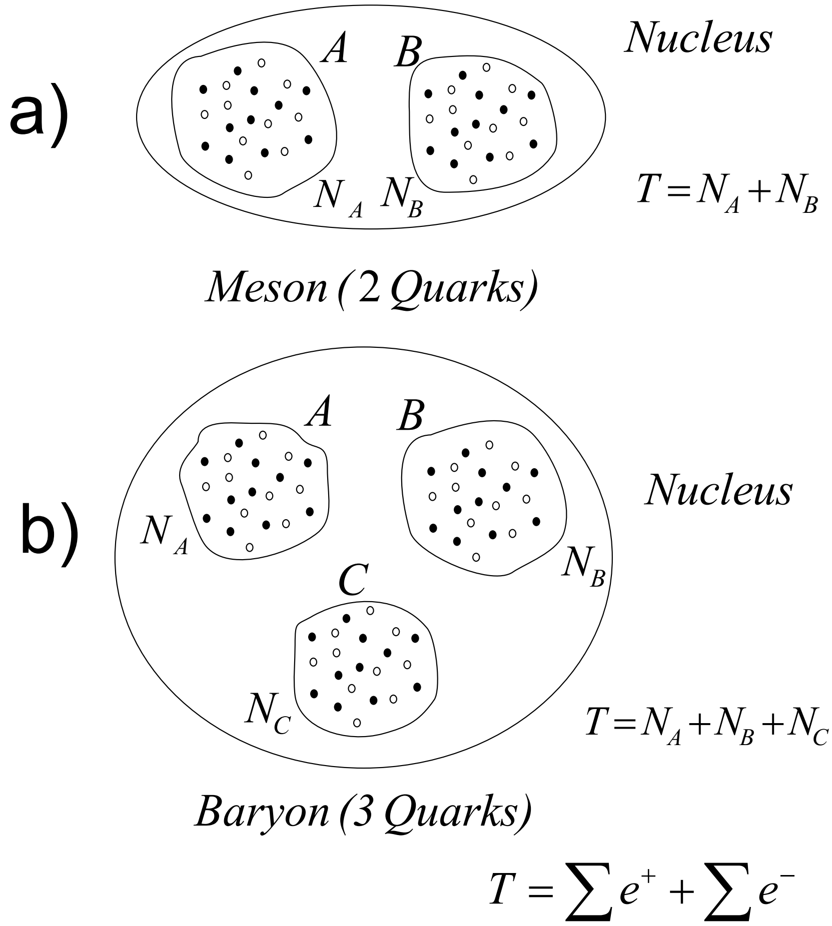

Figure 9: Nucleus composed of quarks.

electron or positron of 0.511 MeV/c^2 we get $\approx$ 1837.00 electrons and positrons from which $n^+ = 919$ are positrons and $n^- = 918$ electrons. The mass of the proton m_p is equal 1837 times the mass of an electron plus the binding energy.

$$1837\ m_e + m_{binding} = m_p \tag{10}$$

The total number of electrons and positrons at the proton are

$$T = N_A + N_B + N_C = n^+ + n^- = 1837 \tag{11}$$

where N_i is the total namber of electrons and positrons at Quark i.

As the proton is a baryon it has three quarks with the electric charge uud. With the SM we get the charge of the proton adding the fractional charges

$$u \ + \ u \ - \ d = \frac{2}{3} + \frac{2}{3} - \frac{1}{3} = 1 \tag{12}$$

Charges that are a fraction of the charge of an electron or positron violate the charge conservation principle.

The finding of the "$E\&R''$ model that electrons and positrons neither attract nor repell each other when the distance between them tend to zero, allows to interprete the charge numbers Q of quarks as the relative charge

$$u = \left| \frac{N_i^+ - N_i^-}{N_i} \right| \qquad and \qquad d = - \left| \frac{N_i^+ - N_i^-}{N_i} \right| \tag{13}$$

where N_i^+ and N_i^- are the number of positrons and electrons at the quark i and $N_i = N_i^+ + N_i^-$ and $\Delta N_i = N_i^+ - N_i^-$.

As the sum of the differences between electrons and positrons at each quark must give the charge of the proton we write

$$u \ N_A + u \ N_B + d \ N_C = \frac{2}{3} N_A + \frac{2}{3} N_B - \frac{1}{3} N_C = 1 \tag{14}$$

With equations (11) and (14) we can calculate N_A, N_B and N_C if we know one of them. If we fix for the moment arbitrarilly $N_A = 499$ we get

$$N_A = 499 \qquad N_B = 114.33 \qquad N_C = 1223.66 \tag{15}$$

We should get integer numbers, but this is irrelevant for the moment to understand the new interpretation and continue with the obtained results and get

$$\Delta N_A = \frac{2}{3} N_A = 332.66 \qquad \Delta N_B = \frac{2}{3} N_B = 76.22 \qquad \Delta N_C = -\frac{1}{3} N_C = -407.886 \tag{16}$$

or

$$\Delta N_A + \Delta N_B + \Delta N_C = 332.66 + 76.22 - 407.886 = 0.994 \tag{17}$$

The **rest masse**s of the quarks are, with m_e the mass of the electron

$$m_A = N_A \ m_e = 4.54558 \cdot 10^{-28} \ kg \qquad m_B = N_B \ m_e = 1.03847 \cdot 10^{-28} \ kg \tag{18}$$

$$m_C = N_C \ m_e = 1.11498 \cdot 10^{-27} \ kg \tag{19}$$

Note: The rest masses m_A and m_B which belong to the same type u of quarks of the proton are not equal.

As chemical elements are composed of protons and neutrons, the atomic number Z of an element can be expressed as the sum of the ΔN of its quark constituents.

$$Z = \sum_i \Delta N_i \tag{20}$$

Note: All hadrons have a total charge equal -1, 0 or 1 while chemical elements have charges $Z \geq 1$. Quarks play a similar function at hadrons as protons and neutrons play at chemical elements.

Now we come back to the fractional numbers of N and ΔN. If we round the fractional numbers slightly to get integer numbers as follows

$$N_A = 499 \quad N_B = 114 \quad N_C = 1224 \qquad to\ \ get \qquad T = 1837 \tag{21}$$

$$\Delta N_A = 333 \qquad \Delta N_B = 76 \qquad \Delta N_C = 408 \qquad to\ \ get \qquad \sum \Delta N = 1 \tag{22}$$

we get for the relative charge of the quarks

$$u_A = \frac{\Delta N_A}{N_A} = 0,6673 \qquad u_B = \frac{\Delta N_B}{N_B} = 0.6666 = \qquad d_C = \frac{\Delta N_C}{N_C} = 0.33333 = \tag{23}$$

and if we compare with $\frac{2}{3} = 0.6666666$ and $\frac{1}{3} = 0.333333$ we see that they are in the error range of measurements.

More examples:

For the π^+ **particle** we have that $n^+ = 137$ and $n^- = 136$ and that it is an $u\bar{d}$ particle.

$$T = N_A + N_B = n^+ + n^- = 273 \tag{24}$$

$$u\ -\ \bar{d} = \frac{2}{3} + \frac{1}{3} = 1 \tag{25}$$

With the equations

$$\frac{2}{3}\, N_A - \frac{1}{3}\, N_B = 1 \qquad and \qquad N_A + N_B = 273 \tag{26}$$

we get

$$N_A = 92 \qquad \Delta N_A = u\ N_A = 61.333 \tag{27}$$

$$N_B = 181 \qquad \Delta N_B = d\ N_B = -60.333 \tag{28}$$

$$\Delta N_A + \Delta N_B = 61.333 - 60.333 = 1 \tag{29}$$

The **rest masses** of the quarks are

$$m_A = N_A\ m_e = 8.3806 \cdot 10^{-29}\ kg \qquad m_B = N_B\ m_e = 1.6488 \cdot 10^{-28}\ kg \tag{30}$$

For the **neutron** we have that $n^+ = 919$ and $n^- = 919$ and that it is a *udd* particle. We get

$$T = N_A + N_B + N_C = n^+ + n^- = 1838 \tag{31}$$

$$u\ -\ d\ -\ d = \frac{2}{3} - \frac{1}{3} - \frac{1}{3} = 0 \tag{32}$$

For the Σ^+ **particle** we have that $n^+ = 1164$ and $n^- = 1163$ and that it is an *uus* particle.

$$T = N_A + N_B + N_C = n^+ + n^- = 2327 \tag{33}$$

$$u\ +\ u\ +\ s = \frac{2}{3} + \frac{2}{3} - \frac{1}{3} = 1 \tag{34}$$

The distribution of electrons and positrons on the different quarks must not be necessarilly static.

Conclusion: The Q values for the electric charge at quarks refere to the relative charge of the quarks. There is no need to introduce fractional charges which were never directly measured. All charges are integer multiples of the charge of an electron, which constitutes the unit of the charge.

Note: No strong forces or gluons are necessary to hold quarks together, because for the distance tending to zero electrons and positrons neither attract nor repel each other. The distribution of electrons and positrons on the quarks is not a constant. The number N_i of the u quarks of one hadron may be different because u gives only the relative charge of a quark.

6 Positronium, Charmonium and Bottonium

Positronium is a bound state of an electron and a positron. For the approximation to the spectrum of the positronium the Coulomb interaction is used, what means, that the electron must move in the external zone 5 of the potential well of Fig. 4 and the positron at the central zone 0. This behaviour is characteristic for the hydrogen atom where the mass of the nucleus is much bigger than the mass of the electron and its movement can be neglected. This is not the case for the positronium where the masses of the electron and positron are equal and they move around a mass centre which is equidistant to them. The movement of the positronium must be located in the zones 0 and 1 of Fig. 4. In these zones the force is proportional to d^2, what gives a potential energy proportional to $|d^3|$ for the Schroedinger equation.

The **Charmonium** and **Bottonium** are bound states of two quarks at the distance of fm where the force between them is also given by the zones 0 and 1 of Fig. 4. In these zones the force is proportional to d^2, what gives a potential energy proportional to $|d^3|$ for the Schroedinger. As the two bound quarks can have different masses, the centre of mass is not necessarily equidistant to the quarks.

7 Conclusions.

The present work is based on findings of the model "Emission & Regeneration" Unified Field Theory. The model represents subatomic particles as focal points of rays of Fundamental Particles (FPs) that move from infinite to infinite. FPs are emitted by the focal point and at the same time regenerate it. Interactions between subatomic particles are the product of the interactions of the angular momenta of the FPs. The interaction between two charged subatomic particles tend to zero for the distance between them tending to zero, allowing to place the zero of the potential energy at the distance zero between the particles. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. This allows a completely new interpretation of the interactions between quarks and the corresponding energy states. No strong forces or gluons are necessary to hold quarks together, because for the distance tending to zero electrons and positrons neither attract nor repel each other.

The Q values for the electric charge at quarks refer to the relative charge of the quarks. There is no need to introduce fractional charges which were never directly measured. All charges are integer multiples of the charge of an electron, which constitutes the unit of the charge.

The potential energies used for the calculations of the spectra of the positronium, charmonium and bottonium must be proportional to $|d^3|$, where d is the distance between the two bound particles.

8 Bibliography.

Note: The present work is based on a completely new approach for the representation of subatomic particles and correspondingly no reference papers exist.

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