

The informational model – Nuclear Force

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Abstract This initial Planck scale model of nucleons interactions in nuclei (fundamental Nature Nuclear force) is developed in a framework of the whole Planck scale informational physical model that is based on the main postulate that everything in Matter exists, happens, interacts, and moves as some specific disturbances in Matter's ultimate base – the dense lattice of the [4+4+1]4D binary reversible fundamental logical elements [FLE], particles are some close-loop algorithms that run basing on the lattice FLE “hardware”, what was applied earlier at developing of the 2007 initial models of Gravity and Electric forces. It is shown, that in the case, when nucleons in nuclei interact on some distances, the action of Nuclear force is seems practically complete analog of action of Gravity and Electric forces, i.e. the Nuclear force mediators, in the model “circular mesons”, are in the main traits analogs of Gravity and Electric forces mediators “circular gravitons/photons”, also are propagating in the lattice as specific disturbances that are initiated by specific parts of particles' algorithms' FLEs “Forces charges”. In contrast to particles, at propagating in the lattice mediators, at least at statics, don't carry energy, but a mediator, if hits into “irradiated” particle, triggers in this particle own energy release that causes the particle's motion, etc. Only in this case the energy conservation law acts – in contrast to standard physical theories, where Forces mediators/fields contain energy. Also in contrast to the mediation of Forces in the theories, where mediators are virtual, all Forces mediators are completely real FLE structures in Matter. The developed model is in accordance with existent nuclear physics experimental data.

Key words: Planck scale physics; fundamental Nature forces; fundamental forces mediators; Standard particle Model; Nuclear force; nucleons; nuclei; π -mesons

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1 Introduction

In the 2007 “The Information as Absolute” concept [1 – 3] it was rigorously proven that Matter in our Universe – and Universe as a whole - are some informational systems (structures), which exist as uninterruptedly transforming [practically] infinitesimal subsets of the absolutely fundamental and absolutely infinite “Information” Set. This informational concept has enabled to propose the informational physical model (more see [4], [5]), which, basing, first of all, on the really outstanding C. F. von Weizsäcker’s 1950-54 years “UR” hypothesis [7, 8] and Fredkin-Toffoli finding [9], adequately to the reality and in complete accordance with all existent reliable experimental data depicts the motion and interactions of particles in Matter’s spacetime. In the model the ultimate of Matter’s base is the Matter’s “ether” – the dense lattice of at least [5]4D elementary logical gates – “fundamental logical elements” (FLE), which are some (essentially distinct, though) analogs of C. F. von Weizsäcker’s 1950-54 years “Urs”. The FLE’s sizes in the spacetime in both – in the space and in the time – dimensions are equal to Planck length, l_p , $l_p = \left(\frac{\hbar G}{c^3}\right)^{1/2}$, \hbar is the reduced Planck constant – the fundamental elementary physical action, G – gravitational constant, c – the speed of light in the vacuum; the time interval of the FLE’s state change – “FLE’s binary flip” is equal to Planck time, $t_p, t_p = \frac{l_p}{c}$. The lattice is placed in the corresponding Matter’s utmost fundamental and universal “kinematical” fundamentally absolute, fundamentally flat, and at least utmost universal [5]4D, Cartesian spacetime with the [5]4D metrics $(c\tau, X, Y, Z, ct)$, where 4 space dimensions correspond to the main FLE degrees of freedom at changing of its state – the space X, Y, Z dimensions correspond to “von Weizsäcker”, “binary flip”, the space $c\tau$ -dimension allows “Fredkin-Toffoli” reverse flips; and everything in Matter is/are some specific disturbances in the lattice that always move in the 4D space with 4D velocities that have identical absolute values be equal to the speed of light $c = \frac{l_p}{t_p}$, and, simultaneously in parallel in the time ct -dimension, it is convenient to postulate that with speed c as well. Note here that in physics now the really space $c\tau$ -dimension is used as the time dimension in 4D Euclidian and Minkowski spacetimes.

The model yet now solves and makes clearer near 30 fundamental problems in physics, see [4], [5]; including, enabled to put forward rather reasonable 2007 initial models of the fundamental Nature Gravity and Electric forces in statics [1]. where the Forces mediators are real – i.e. by no means virtual - disturbances in the lattice. In [6] more detailed and corrected version of the models, including first approximation description of free fall motion of gravitational test mass in Gravity field, and of motion of electric charges, are presented, where it is shown that at the motion of any these Forces charges (gravitational mass and electric charge) in the Forces fields no singularities are created. So rather probably it is possible to obtain at least first approximation description of motion of masses in extreme gravity fields, including below black holes’ event horizons, etc.

As well as it is rigorously shown that both – Gravity and Electric forces fields contain no energy (energy density) – in fundamental contrast to what is postulated, despite that evidently violates energy conservation law, in classical theories and quantum electrodynamics (QED); fields don’t interact specifically independently on charges with anything in Matter, so there is no “electromagnetic” masses, etc.; the

models explain what is gravitational mass and why the inertial and gravitational masses are equivalent, what are electric charge, e , and fine structure constant, α ; and why $\alpha\hbar c = e^2 / 4\pi\epsilon_0$ (in SI system. In more adequate to the reality CGS system $\alpha\hbar c = e^2$), etc. In this paper we apply the developed for Gravity and Electric forces approach at development of Planck scale initial model of fundamental Nuclear force that binds nucleons in nuclei.

1.1 Particles

In the model particles (more see [4]) are specific disturbances in the [5]4D FLE lattice (in this case it is enough to take into account only utmost general and universal spacetime above), which are created when some lattice's FLE is impacted by some 4D space momentum, \vec{P} .

If the momentum is practically infinitesimal, then in the lattice some straight line of sequentially “this-next” flipping lattice FLEs appears, when the “FLE-flipping point” moves in the lattice [and so in the 4D space with metrics $(c\tau, X, Y, Z)$] with 4D speed of light, and corresponding “particle” has zero energy, inertial mass and momentum – as for the case when FLE doesn't flip at all. But after some impact with non-zero momentum \vec{P} , since the flipping cannot be with a speed that is larger than c , that causes precessing of the flipping FLEs, the flipping point trajectory transforms into some 4D “helix”; and so the flipping transforms in some close-loop algorithm – which is just a created particle, which moves in the 4D space with the 4D speed of light (front of the “helix”. “Flipping point” moves along “helix trajectory” with speed $c\sqrt{2}$), having momentum $\vec{P} = m\vec{c}$, energy $E = Pc$, inertial mass, m , and the “radius” of the “helix” $\lambda = \frac{\hbar}{P}$, which is at small speeds the particle's Compton length $\lambda = \frac{\hbar}{m_0c}$, m_0 is

the particle's rest mass. The frequency the algorithm ticks with which is $\omega = \frac{E}{\hbar}$ (see Figure 1)

Really there exist two main types of particles: – “T-particles” that are created by 4D momentums' $c\tau$ - components, which, so, if are at absolute rest in the 3D XYZ space (i.e. the creating momentum has zero X, Y, Z components), move only in the $c\tau$ -dimension with the speed of light, and so have “rest masses” in the 3D space, that are most of particles; and “S-particles” that are created by momentums that are directed along some 3D XYZ space line, and so always move only in 3D space with the speed of light, having no “rest masses”, now that are for sure photons.

That above is a first approximation scheme, more see [4], [5]

2 Mediation of the Forces in complex systems

2.1 Fundamental Nature forces and charges

Now four “fundamental” kinds of the fundamental interactions (four “fundamental Nature forces”) are known – Gravity, Weak, Electric (EM), Strong; which differ by the strength, e.g., for the proton as (approximately) $10^{-36}:10^{-11}:1:10^2$. In recent physics mediating of Forces at particles interactions proceeds as exchange by Forces' mediators,

which are “virtual” particles. In quantum electrodynamics that are virtual photons, Strong force in quantum chromodynamics (QCD) is mediated by virtual gluons inside hadrons, including nucleons; and outside, i.e. in systems of nucleons – atomic nuclei and N - N interactions, as the Nuclear force – by virtual mesons, though virtual π -mesons were postulated as Nuclear force mediators in its theory long before development of QCD.

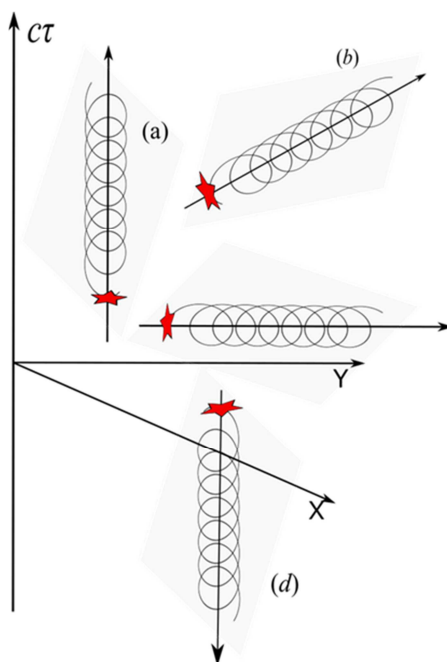


Figure 1. A few examples of particles creation (a) – a T-particle at 3D absolute rest moves along $c\tau$ -axis; (b) – a T-particle moves also in 3D space; (c) – a photon moves only in 3D space; (d) – a T-antiparticle moves along $c\tau$ -axis in negative direction. Stars point events when an ether FLE is impacted. Note that that is only some illustrative picture, in 4D space a 4D “helices” on Figure don’t exist, so that can be quite equally painted relatively to (X,Z) and (Y,Z) planes as well. From this it follows, including, that neutrinos for sure have non-zero rest masses; and – when a T-particle moves in 3D space, its “helix” is the sum of two “helices” – along $c\tau$ -axis and along the spatial direction.

Nonetheless it looks as completely scientifically rational to suggest that in Matter really all interactions are interactions of real particles and real mediators, whereas the “virtual particles” really is a mathematical trick in all quantum field theories (QFTs), which, for unknown now reason though, is – at least in QED – effective at elaboration of some physical tasks, Correspondingly that is postulated in the Forces models, including this model.

Besides in Standard Model it is postulated that the virtual mediators, if are “free” become to be real particles, and can be detected, so in SM corresponding real particles are indicated as real the Forces’ mediators (forces carriers), see Figure 2,

Standard Model of Elementary Particles

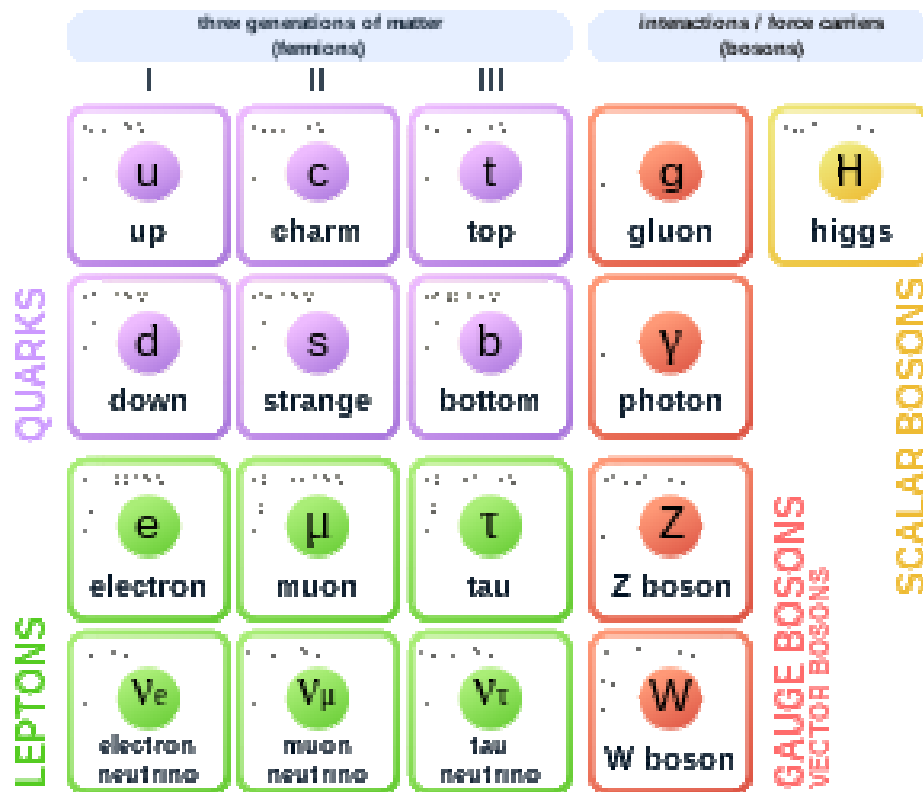


Figure 2. Elementary particles in Standard Model [10]

However, from experimental data it rather convincingly follows at least for Electric force, that the real interactions, at least in statics, are not caused by real “ordinary” photons – just which in QED are introduced as “virtual photons”, but in Standard Particle Model are indicated as real mediators. In this case there is no any experiment, where an exchange by ordinary photon was observed in a static system of charged bodies, nonetheless the charges at statics really do interact. That looks as is rather rationally strange, and it looks as quite rational to assume that the some real mediators that don’t exist in QFTs/SM] act at Electric and every other Forces interactions.

In the model the Forces are some logical marks, that can be, and are in Matter, assigned to, or, more correctly activated in, any the lattice FLE. So really FLE has more degrees of freedom at changing its state, than the 4+1 “kinematical” ones above, and Matter’ spacetime so has other than the ultimately common and universal [5]4D dimensions above. At least that relates to considered in [6] Gravity and Electric forces, and considered below Nuclear force. Thus the real Matter’s spacetime is fundamentally absolute, fundamentally flat, and at least [4+3+1]4D Cartesian spacetime with the metrics $(c\tau, X, Y, Z, g, e, s_n, ct)$, “g” and “e” are Gravity and Electric forces dimensions, “s_n” is the Nuclear force dimension. In principle there can exist the “s” dimension that corresponds to Strong force, which looks now as essentially differs in physics till now from the 3 Forces above in that these Forces act between rather distant particles, including nucleons in nuclei, while Strong force acts inside much more compact hadrons. So this [Nuclear force] model isn’t applicable now directly, say, for description and analysis of internal hadrons structures. Nonetheless we cannot exclude case Nuclear and Strong forces mediators are the same ones.

Really the presented here model reveals the physical sense of widely – and rather effectively - applied in nuclear physics Yukawa model of interactions inside nuclei, though the Yukawa potential is practically obligatory part of concrete potentials that are used in all corresponding physical tasks, e.g. at analysis of $N-N$ interactions..

In the models it is conjectured that if some FLE in some particle's algorithm FLE sequence has some Force's logical mark, then at constant cyclic running of whole algorithm, it precesses in the Force's dimension with some precession angle specifically additionally to the 4D universal "kinematical" ($c\tau, X, Y, Z$) precession of particles algorithms' FLEs (see section 1.1) above, and when this particle's FLE flips, it causes flipping of a neighbor the lattice FLE, at that:

- (i) - in the lattice FLEs corresponding "the radiated by the particle" Force mark becomes to be activated,
- (ii) – this lattice FLE becomes to flip, at least mostly, with (3+1)D space, i.e. in "kinematical" 3D XYZ, and the Force's, dimensions, precession, causing sequential flipping – and also "marked by the Force" – next lattice FLEs, and,
- (iii) - at every flip the flipping lattice FLE causes not only one a next lattice FLE flip – as that in first approximation happens at the particle algorithm's running, but so, that the flipping FLEs always compose in 3D space a dense circle "FLEs rim", the width of the rim is equal to FLE size, i.e. to Planck length.

However, the flipping and preceding FLEs in a rim differ from the flipping and precessing only in the 4D space particles algorithms FLEs, which compose close loop logical sequences and the FLE flipping point "helix" trajectories of their flips. The rim's FLEs don't compose close loop logical sequences and propagate always directly – along the rim radiuses orthogonally to the rim's circle; and, as that is pointed above relating to "kinematical" flipping after infinitesimal impact of the lattice FLEs along a straight line, when the Compton length of corresponding "particle" is infinite, and this "particle" contains zero energy, *the FLEs in rims also don't contain energy*.

However the FLEs in the rims, *which really are real Forces mediators*, have specific momentums, so, that when such FLE hits on an flipping FLE of "irradiated" particle that has the same Force mark, this particle obtains a "kinematical" 3D space momentum \vec{p} and, if is free, its kinetic energy increases. However, that happens in specific way – the impacted particle's "kinematical" FLE precession decreases (if the Force acts as attractive force), and further the particle's algorithm ticks slower; and its own intrinsic energy and inertial mass decrease.

As that is in [6] "a particle in a field moves spending own energy as, say, a human swims in water spending his energy". Just by this way the negative defect mass arises in coupled by attractive Forces systems of particles, bodies, etc.; and so the energy conservation law really acts:

- sum of energies in coupled by a Force closed system, if the energy isn't dissipated outside the system, at any interactions inside the system is always equal to sum of energies that particles had before composing the system; if a system's components were completely free, i.e. at rest in 3D absolute space on infinite distances, at any interactions inside system always $E = \sum_i m_{0i} c^2$

That solves one of the main problems in mainstream Forces physics – where, say, in the classical and quantum electrodynamicses the charged particles always constantly radiate either EM fields that contain energy, or “virtual photons”, that contain/carry energy, while, despite the constant radiating in outer space of the fields and virtual photons, the stable charged particles are stable billions of years.

Note also a couple of important points else. First of all, the Forces’ mediators propagate only in the 3D (XYZ) space - and so everything interact practically only in 3D space independently on – where a particle is in the $c\tau$ -dimension, that is observed, e.g. as moving bodies lengths contraction. Or, say, photons that are radiated by extremely distant cosmological objects interacts with anything on Earth without problems despite that are distant from Earth on the $c\tau$ -axis in billions of light years, and

- it looks as rather scientifically rational to conjecture, that if a Force rim is impacted by some way with transmission to the rim’s FLE a non-zero “kinematical” 3D momentum (e.g. at an acceleration of a charged particle), the rim with some probability transforms into some close-loop algorithm, i.e. into a specific particle. In the Electric force case that are ordinary photons, practically for sure that happens in the Gravity force case, and so the “ordinary gravitons” exist, and, at that, these rims transformations move, nonetheless in the 3D space also, with the speed of light and having zero rest masses.

This scheme (where “massless” mediators, if are impacted, transform into “rest massless” ordinary photons and gravitons) works in the similar Gravity and Electric forces, however can, on first glance, differ, though non-principally, but essentially, in other Forces cases – in nuclear physics Nuclear force acts, as that is postulated in physics now, as an exchange by virtual particles – π -mesons, while “ordinary” π -mesons are particles that have rest masses [that follows from Klein-Gordon equation in Yukawa theory]. However that is not essentially principal; that at 3D impact on a, say, nucleon, some lightest hadrons are created doesn’t look as some unphysical exotics.

So the charge of a Force is, first of all, a set – a part – of Force-marked FLEs in the particle’s algorithm. However, that is not complete, the Force strength – and so just “charge” also, depends quite naturally on the frequency at which this algorithm runs.

In the Gravity and Electric forces’ models [1], [4], [6] some non-existent in physics now as real the Forces’ mediators are historically titled “circular gravitons” and “circular photons” (the “rims” above), in this Nuclear force model the mediators are titled analogously historically “circular mesons”.

Remaining in this concept it is possible to put forward [1] also rather reasonable conjecture: that particles interact exchanging by mediators that the strength of interactions is proportional to the *accidental coincidence rate* of random hits of a Force mediators’ FLEs on the other particle flipping marked this Force FLEs. Such coincidences always exist since the FLE’s flip-time [Planck time] is not equal zero, the rims have non-zero widths, and that happens in the 3D (XYZ) space, besides the three conditions above, in accordance with that:

- the frequency at which a particle’s algorithm runs if particle is at rest (in statics), is

$$\omega = E / \hbar = m_0 c^2 / \hbar. \text{ Logical length of algorithm, } N_0 = \frac{\hbar}{m c l_p};$$

– every concrete particle’s algorithm has concrete number ΔN_F of the marked by concrete Forces FLEs in the whole N_0 .

Since the Forces-marked FLEs flip independently in both particles, and particles practically are not oriented specifically in the space [what happens at Gravity and Electric forces at least on macro scale], or that is at Nuclear force interactions, though since in this case this Force acts fundamentally only on the QM scale, that is true at least in first approximation, the elementary interactions above are random.

As that was assumed above, the FLE’s sizes are equal to Planck’s length, l_p . Besides, as that is pointed above, assume that:

(i)- because of that all Forces above have potentials that are proportional $1/r$, at every “tick” of a “radiating” particle’s algorithm the “rims” of a Force-marked FLEs flips starts to expand in the lattice in the 3D space with radial speed that is equal to the speed of light, c , the rim’s area is equal $2\pi r l_p$, see Figure 3,

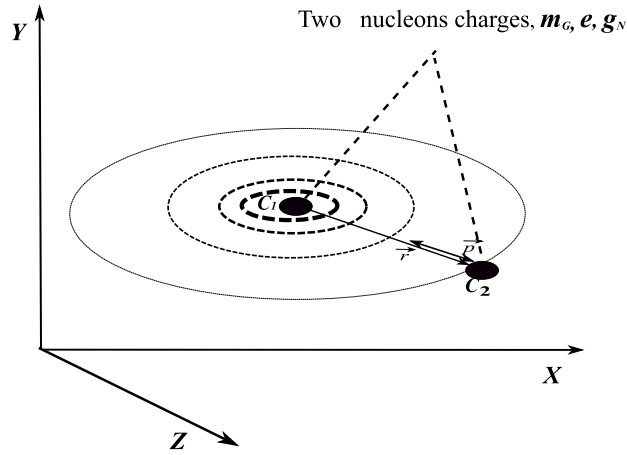


Figure 3. A sketch of a spreading in 3D space of a Force-marked FLEs flips rims (of Forces mediators) in the space between two nucleons. C_1 and C_2 are Forces charges: m_G is Gravity force charge (“gravitational mass”), e is Electric force charge (elementary charge), g_N is Nuclear force charge.

(ii) – the time intervals of the “radiating” particle’s Force-marked FLEs, of the corresponding rim’s the lattice Force-marked FLEs, and “irradiated” particle’s Force-marked FLE, flips are the same and are equal to Planck time; and

(iii) – at the interaction of a rim’s flipping Force-marked FLE and a particle’s flipping Force-marked FLE, the “irradiated” particle is impacted – by the *specific way* above - with the specific transmission to it the elementary momentum $p = \pm \frac{\hbar \vec{r}}{r^2}$, “+” if the Force

is repulsive, “-” if the Force is attractive; r is the radius-vector from the radiating to the impacted particle (the rim’s radius).

The interactions of rims’ and irradiated particles algorithms’ FLEs happen in any time moment when the both Plank times intervals overlap (Figure 4).

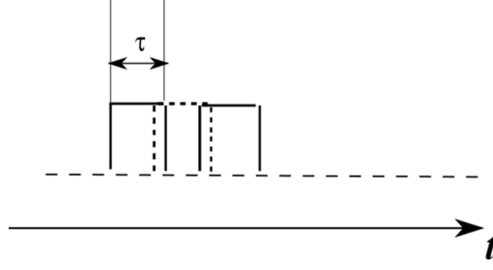


Figure 4. Overlapping of a Force's rim's the Force-marked the lattice FLE and the Force-marked FLE in the algorithm of the "irradiated" particle.

It is evident, that interactions of the mediators and particles' Force-marked FLEs are accidental events – coincidences of independent processes of "radiation" and spreading of the mediators of "radiating" particle and of the Force-marked FLE flipping of "irradiated" one. Both – the rate n_1 of mediators FLEs in a point, where an irradiated particle's Force-marked FLE flips, and the rate n_2 of these Force-marked FLE flips, are random; and, if both [average] rates of coincidences inside Plank time interval, τ , (note that isn't, of course, " τ " in the spacetime metrics above) aren't too large, then it is well known that the coincidence rate is equal

$$N_c \approx 2n_1n_2\tau \quad \tau \sim t_p \quad (1)$$

- and the momentum that is transmitted to [released in] "irradiated" particle in one second, $\frac{d\vec{P}}{dt}$ is the force that acts on the particle

$$\vec{F} = \frac{d\vec{P}}{dt} = \pm N_c \frac{\hbar\vec{r}}{r^2} \quad (2)$$

Note though, that Eq.(1) is true only if both – radiating and irradiated particles algorithms have only one marked FLE – as that is if Gravity force acts. In other cases the rate of a Force mediators' hits, n_1 , and the rate of the Force-marked FLE flips Force n_2 , depend, again, on both particles two parameters – the rate of the particles algorithms ticks, i.e. frequencies ω , and on the number of the Force-marked FLEs in the whole logical algorithm's length, ΔN_F , $\Delta N_F = kN_0$, k are some specific Force s that determines a Force strength.

Correspondingly the coincidences in irritated happen in the time interval $\Delta N_F \tau$, and, if we consider interactions between particles, then at given distance between particles so the force F is proportional to both these parameters, $\vec{F} \sim \omega_1 \Delta N_{F1} \omega_2 \Delta N_{F2}$ and the value ωn_F is the component of a "Force charge".

Gravity Force (more about Gravity and Electric forces see [6]) has extremely small charge, since in this case all particles have only one G -marked FLE and so $\Delta N_G = 1$; in any particle; and so different particles, algorithms of which tick with different rates ω in both cases, if a particle radiates the Gravity marked rims "circular gravitons", or is irradiated with larger rate, it impacts / is impacted by larger force than a particle with

lesser ω . An example – gravitational force of proton is larger than gravitational force of electron in ≈ 1835 times.

Electric force number of E-marked FLEs is **relative**, $\Delta N_E = \alpha^{1/2} \frac{\hbar}{mcl_p} = \alpha^{1/2} N_0$, α is

the fine structure constant, and so the value $\omega \Delta N_E = \frac{mc^2}{\hbar} \alpha^{1/2} \frac{\hbar}{mcl_p} = \frac{\alpha^{1/2} c}{l_p}$ is the same

for all particles (we don't say here about quarks) and so electron and proton electrically interact equally.

Thus the ratio of the Forces charges values, R_{cF} , for equal masses, for identical particles, or practically equal in this cases proton and neutron, is determined only by n_F . Gravity and Electric charges ratio for electron $R_{cF}(G:E) = \alpha^{-1/2} \frac{m_e c l_p}{\hbar} \approx 4.9 \times 10^{-22}$; and these Forces' strengths between two electrons so differ in $R_{cF}^2 \approx 2.4 \times 10^{-43}$.

These quantities are in complete accordance with experimental data, and *so this is strong confirmation of the validity of one of main postulates in the whole model – that FLE size and FLE flip time are equal to Planck length and \Planck time*. If that would be not so, the calculated above the charges and strengths ratios would have other – and unreal - values.

The forces, the particles interact with which, besides the values of ω and ΔN_F , depends also on the |geometrical" probability of interactions that is equal at a given radius, r , to the ratio of the rims' widths, W , to the corresponding sphere surface $\frac{2\pi r W}{4\pi r^2}$, $W_G = l_p$ for Gravity force, $W_E = \alpha^{1/2} \frac{\hbar}{mc}$; the coincidence resolution time intervals are equal $\tau_{G,E} = \frac{W_{G,E}}{c}$,

Thus the coincidence rate in an irradiated electrically charged particle so is

$$N_{cE} = \frac{mc^2 \cdot 2\pi r W_E}{\hbar 4\pi r^2} P_E \frac{mc^2}{\hbar} 2\tau_E, \quad (3)$$

where P_E – the probability of the elementary momentum transmission at a coincidence. If $P_E = 1$ the Electric force that acts on the both interacting particles since Eq. (3) is symmetrical, is

$$F_E = N_{cE} \vec{p} = \pm \frac{\alpha \hbar c \vec{r}}{r^3} = \pm \frac{e^2 \vec{r}}{r^3} \quad (4)$$

2.2 Initial model of Nuclear Force

As that is assumed in this model, all Forces at interactions of different particles act in accordance with the same scheme: exchange by mediators, mediators act only in 3D space as propagating 2D rims of flipping a Force-marked the FLE-lattice FLEs, and so the Forces' potentials are $\sim 1/r$ potentials; and the relative strengths of a Forces really

depends practically first of all on what fraction of the whole logical length of a particle's algorithm a concrete Force-marked FLEs occupy. Correspondingly that should be true in the case of Nuclear force, which acts between different nucleons in atomic nuclei.

The potential for this Force was proposed by Yukawa yet in 1935 [11], when he suggested that Nuclear force is the action of some scalar field U that has the potential $\sim 1/r$ - as that is in the Gravity and Electric forces cases, however, unlike the Electric force, it acts as exchange by some U quanta of energy, that are equivalent ≈ 200 electron's rest mass. Besides, using also the Heisenberg finding that the solution of Klein-Gordon equation for a field with additional term is that the field's potential exponentially decreases, he obtained the equation for nuclear potential

$$\varphi = -g_N \frac{\exp(-r/\lambda)}{r} \quad (5)$$

- where $\lambda \approx 2\pi\lambda_p$, λ_p is \approx proton's Compton length, g_N is the Nuclear force charge, nucleons in nuclei interact exchanging by these quanta. In 1930s in physics there was known no any rational mechanism how that can happen, including, e.g., the physics had (and has till now) no any understanding - how nucleons extremely intensively radiate energy quanta $\approx 15\%$ of nucleon mass without any changes in their masses, why these quanta' impacts decrease exponentially, etc., however after at high enough energy accelerators experiments π -mesons were detected, these real particles were, and are till now, adopted in physics as real versions of "virtual" Nuclear force mediators.

However that, first of all the radiating energy problem, isn't unique problem, and in only this case. That - see above - eventually happens at consideration of a lot of other, practically equally transcendent, postulates in all/every, classical and quantum, physical theories, so in physics attempts to solve concrete problems what really are fundamental Forces and mediators, which [attempts], of course are based on whole physics, really till now logically inevitably correspondingly failed.

An example of recent analog of Yukawa derivation of the Nuclear force potential equation is given, e.g., in [12]:

- squared energy equation of a free particle that has a rest mass, m , and moves in 3D space with 3D momentum p is

$$E^2 = m^2c^4 + p^2c^2, \quad (6)$$

- the corresponding Klein-Gordon equation for the potential of the meson field, φ , is

$$\nabla^2\varphi - \frac{1}{c^2} \frac{\partial^2\varphi}{\partial t^2} - \frac{m^2c^2}{\hbar^2}\varphi = 4\pi g_N, \quad (7)$$

- where g_N is the density of the "meson charge". The solution of Eq.(7) in statics case ($\frac{\partial\varphi}{\partial t} = 0$) is

$$\varphi = -g_N \frac{\exp(-r/\lambda_m)}{r}, \quad (8)$$

- where $\lambda_m = \frac{\hbar}{mc}$ is the Compton length of the meson.

It is evident that all in the QM approach above really can be correct only if in Eq. (6) –(8) the mass m of “virtual” mesons really exists, i.e. in this case again really rather strange process of intensively and constantly escaping from parental nucleons mesons is supposed, when the mesons constantly form virtual “mesonic fur coats” around nucleons. The fur coats aren’t observable by any real physical instruments. Besides, as that is postulated in recent nuclear physics, the mesons above are π -mesons, which are unstable particles and decay with creation e^\pm , μ^\pm , gammas, neutrinos, so around nucleons corresponding fur coats of the decay products above also should exist, which also aren’t observable, either since the products are also virtual, or virtual π -mesons don’t decay as that real π -mesons do. Etc., all that looks as rather strange, however, again, that is typical situation if some virtual, but really existing and interacting by the Forces particles, are introduced in standard physics as the Forces real mediators at description and analysis of what exists and happens in Matter.

Really that the following from the equations above g_N value is consistent with experiments, including from the experiments at N - N interactions it is obtained that the Nuclear force strength in ≈ 100 times is larger than Electric force strength on equal distances, it is obtained only by fitting the main parameter in Eq.(7), the mass m ; while, say, Heisenberg’s attempt to derive equation for Nuclear force potential assuming that the mediators are virtual electrons failed only because electrons have inappropriate mass, etc. but really this unique “mass criterion” by no means determinates any other specific properties/parameters of something for it to be just mediator of just Nuclear force.

So really Yukawa theory isn’t a theory of Nuclear force, though really that is concrete formulation of real interesting physical problem “why and how the lightest particles that are created at NN interactions at action of Strong force [which with a well rationally non-zero probability is mediated by the same as Nuclear force mediators], i.e. π -mesons, have masses that fit Klein-Gordon equation for this Force potential with experiment?

The initial Forces scheme in section 2.1 above is without problems applicable in the Gravity and Electric forces cases, where different distant enough gravitational and electric charges interact. Since in nuclei different nucleons interact on rather large distances as well, the scheme is applicable to Nuclear Force interactions as well, using practically only two rational specific conjectures:

– (i) - Nuclear force differs, in that is essentially stronger comparing with other Forces, only because of that the number of Nuclear-marked FLEs section ΔN_N in the nucleons’ algorithms logical lengths is larger than that is in other Forces cases; and

- (ii) the Force mediators – “circular mesons”, unlike circular gravitons and circular photons, are unstable, and decay with decay constant $\lambda_{decaym}, \lambda_{decaym} = \frac{c}{r_0}$, while the

rest in the model is the same – circular mesons rims propagate in the 3D space only, only with the speed of light, and every flipping the lattice N -marked FLE causes in “irradiated” particle releasing of the elementary momentum $\vec{p} = -\frac{\hbar\vec{r}}{r^2}$

In proton’s logical length Gravity- and Electric-marked FLEs occupy (one Gravity-marked FLE in the algorithm is quite negligible) $\Delta N_E = \sqrt{\alpha}$ part of whole length N_0 . If we assume that the remained part in proton’s algorithm is marked by Nuclear force, so $\Delta N_{Np} = (1 - \sqrt{\alpha})N_{0p} \approx 10.7\Delta N_{Ep}$, i.e. is as that is the experimental ratio of nuclear and electric charges $g_N / e \approx 10$ above.

However here is a nuance, real electric charge in proton, which, as that seems rather rationally is postulated in the Standard Model, is a composition of charged u -quarks that has electric charge $+2/3e$, and d -quark that has electric charge $-1/3e$, (\bar{u} and \bar{d} are antiquarks), $p = uud$. So its “whole” charge is $5/3e$, and so real ratio, R_{NEP} of the electric and nuclear charges sections of N_0 is

$$R_{NEP} = \frac{\Delta N_{Np}}{\Delta N_{Ep}} = \frac{1 - \frac{5}{3}\sqrt{\alpha}}{\frac{5}{3}\sqrt{\alpha}} \approx 6.04.$$

Nonetheless, since the quarks positive and negative electric charges compensate action of each other, and so only 1e interaction is really experimentally observed, thus

the ratio of the real strengths of these Forces is $R_{NES} = \frac{1 - \frac{5}{3}\sqrt{\alpha}}{\sqrt{\alpha}} \approx 10.03$, i.e. in

accordance with the experiment. Neutron is the quarks composition $n = udd$, and, though so has zero “active” charge, nonetheless while proton’s experimentally measured electric charge .radius is $\approx 0,871\text{fm}$ [13], the neutron’s measured one is $\approx 0.751\text{fm}$ [14], i.e. differs only in $\approx 16\%$, Thus the Nuclear force part in neutron N_0

can, in principle, be not equal to the proton’s part, but $\Delta N_{Nn} = (1 - \frac{4}{3}\sqrt{\alpha})N_{0n}$, i.e.

neutron’s Nuclear force charge can be, in principle, slightly larger than the proton’s charge. However, in the neutron’s algorithm there exist also at least some non-zero FLE-section that acts as the Weak force algorithm’s defect, which causes the decay of neutron, so the proton and neutron N -charges can be identical. That should be studied additionally, but in this initial Nuclear force model it looks as inessential.

Correspondingly Eq. (3) for Nuclear force is as

$$N_{cN} = \frac{mc^2 \cdot 2\pi r W_N}{\hbar 4\pi r^2} P_N \frac{mc^2}{\hbar} 2\tau_N \quad (9)$$

- where W_N and τ_N are circular meson rims’ width, $W_N = \left(1 - \frac{5}{3}\sqrt{\alpha}\right) \frac{\hbar}{mc}$, and the

coincidence resolution time interval is equal $\tau_N = \frac{W_N}{c}$ (note, though, that all

“elementary” rims in W_N (and W_E) have only Planck length widths); m is the (equal in

this model) mass of nucleon, and the equation (4) for the forces that act between two nucleons on short distances is

$$F_N = N_{cN} \vec{p} = - \left(1 - \frac{5}{3} \sqrt{\alpha} \right)^2 \frac{\hbar c \vec{r}}{r^3} \equiv - \frac{g_N^2 \vec{r}}{r^3} \quad (10)$$

- on arbitrary distances this force is

$$F_N = N_{cN}(r) \vec{p} = - \left(1 - \frac{5}{3} \sqrt{\alpha} \right)^2 \frac{\hbar c \vec{r}}{r^3} \exp(-r/r_0) = - \frac{g_N^2 \vec{r}}{r^3} \exp(-r/r_0) \quad (10a)$$

- where $r_0 \approx c / \lambda_{decaycm}$;

- and

$$g_N = \left(1 - \frac{5}{3} \sqrt{\alpha} \right) (\hbar c)^{1/2} = \left(1 - \frac{5}{3} \sqrt{\alpha} \right) \left(\hbar \frac{l_p}{t_p} \right)^{1/2} \quad (10b)$$

- is the Nuclear force charge of nucleon (“meson charge” in [12]) – Nuclear force interaction constant.

The circular mesons since are a Force mediators, aren't particles and don't carry energy, but, since all Forces in systems of interacting distant charges act by the same way, at impact of some external particle on a circular meson that is radiated by some nucleon it seems some “ordinary” particle can be created – as that happens, say, when a circular photon that is radiated by some nucleus is impacted by a photon with energy more 1.022 MeV; and the system “circular photon+ ordinary photon” transforms into the system “ e^\pm pair”. The pair, since both, ordinary and circular photons have only 3D space momentums, despite that electron and positron have rest masses, since they move in the opposite directions in $c\tau$ – dimension, has whole momentum's zero $c\tau$ – component.

So it looks as rather natural to suggest that analogously an impact on a circular meson transforms it into observed at $N-N$ interactions π^\pm mesons, $\pi^+ = u\bar{d}$, $\pi^- = \bar{u}d$, pairs, the pairs whole momentums' have zero $c\tau$ – component, and π^0 mesons, $\pi^0 = \frac{u\bar{u} - d\bar{d}}{\sqrt{2}}$, where the quarks and the antiquarks also have identical opposite momentums in $c\tau$ – dimension, so π^0 mesons have zero $c\tau$ – components as well. Moreover, π^0 mesons as a whole don't move in $c\tau$ – dimension at all. Correspondingly all these “ordinary” mesons decay so that the sums of their decays products, i.e. e^\pm , μ^\pm , gammas, neutrinos and antineutrinos, momentums have in every concrete decay zero whole momentum $c\tau$ – component as well.

Note, also, that nuclei are principally QM systems, and so in nuclei the other universal Forces act – “spin”, “spin-orbital”, “exchange”, etc., Forces. So, e.g. in the system ${}^2H = n + p$ the binding energy of the proton and neutron is rather small – 2.22 MeV, i.e. the p and n are on distance ≈ 20.06 the nucleons' Compton lengths, and on ≈ 3 π -mesons' Compton lengths – or ~ 3 the circular mesons' average decay lengths.

When number of nucleons in nuclei increases, the binding energy sharply increases as well, and yet in ${}^4\text{He}$ it is equal $E=7.18$ MeV, and further with increasing of nuclei mass is near this value – in nuclei the “binding energy saturation” effect is observed, what looks as can have rather interesting application at considering of extremely large Gravity and Electric charges interactions problems [5], [6]

3 Discussion and conclusion

This initial Nuclear force model is in accordance with existent experimental data, and so with a large enough probability is completely scientific model. From the consideration above it follows that at least 3 fundamental Nature Gravity, Electric, and Nuclear, forces at interactions in systems of distant enough particles (macro bodies and charges in Gravity, and particles, atoms, molecules, and “more macro” material structures, in Electric, forces cases), i.e. when the distances are larger than the particles’ Compton lengths, *act by the same one universal scheme*:

- the Forces charges are Forces-specific sequences of Forces-marked FLEs in the particles’ algorithms, the strengths of the interactions are determined, besides, by the frequency the algorithms tick with which,

- these FLE-sequences cause the propagating in the Matter’s ultimate base – “everyferous aether” – the (at least) [4+3+1]D dense FLE lattice that is placed in the corresponding Matter’s fundamentally absolute, fundamentally continuous, fundamentally flat, and at least [4+3+1]4D Cartesian, spacetime with the metrics $(c\tau, X, Y, Z, g, e, s_n, ct)$, “g” and “e” are Gravity and Electric Forces dimensions, “s_n” is the nuclear force dimension, of rims of flipping Forces-marked the lattice’s FLEs, which propagate in the lattice, so in the space, with the speed of light; and at interactions with particles’ flipping marked by the same Force marked FLE, cause a change of the “kinematical” precession angle, so that the article “works out” for itself the fundamentally universal for all, Forces elementary 4D “kinematical” momentum $p = \pm \frac{\hbar\vec{r}}{r^2}$ so, that, if the “irradiated” particle is at rest in the 3D X,Y,Z space, this momentum is \pm directed to the “radiating Force rims” particle. If the “irradiated” particle is free, it starts to move/accelerates in \pm direction to the radiating particle. Correspondingly the Forces particles charges are rather similar:

- Gravity charge $g_G = \frac{m(\hbar c)^{1/2}}{M_p}$, $M_p = \frac{\hbar}{l_p^2} t_p$ is Planck mass, m is the particle mass,
- Electric charge $e = (\alpha\hbar c)^{1/2}$,
- Nuclear charge $g_N = \left(1 - \frac{5}{3}\sqrt{\alpha}\right)(\hbar c)^{1/2}$.

At that the Forces mediators don’t carry some energy, and so the radiating particles don’t lose their energy, if are free; but if are irradiated and move, the moving particles kinetic energy is provided by spending this particle’s intrinsic energy E . If a particle is free and at rest $E_0 = m_0c^2$, if it interacts with other particles composing a coupled by a Force system, including the system of nucleons “a nucleus”, the interacting particles’

intrinsic energies are lesser than E_0 on the binding energy/particle's mass defect - just by this way the energy conservation law in this case works.

The flows of the mediators are observed in physics as the Forces' fields, in mainstream physics some really strange properties for which are postulated. First of all that in classical theories the fields contain energy; that is also in quantum fields theories, where the radiated mediators, though are "virtual", nonetheless carry/transmit to irradiated particle quite real energies/momentums. Besides in QFTs, it is postulated that all fields of all possible Forces in Matter always really constantly exists in some "virtual" states, composing rather so strange "physical vacuum", where always and all particles constantly in virtual states are creating/annihilating as "excitations of the virtual fields", while real particles are excitations of real fields as well. Really indeed – everything in Matter, including particles and fields, really always constantly exists – but only *potentially*, as that all particles and fields "are written" completely in every FLE. Correspondingly any specific impact on any/every FLE in the lattice can result in creation of any real particle or mediator, however only after this in 3D space real fields, which are radiated by the created real particles, appear.

All Forces' mediators are fundamentally real, and by no means "virtual", disturbances in the FLE lattice, and, at that, the real Forces' mediators can be impacted by some ways, so some rather specific for every Force real particles are created. In this case that are gravitons, photons and π -mesons, which in Standard Model are postulated as real Forces mediators, but these real particles have no relations to the Forces mediations in concrete coupled systems. Photons have no electric charges and so don't radiate Electric field, despite that all photon algorithm seems is composed by Electric force marked FLEs – so the charges aren't reduced only to sequences of Force marked FLEs, as that is in these initial models till now; and this, rather probably important for all Forces, point should be clarified at development, basing on these initial models, of the completed Forces theories.

The proposed initial models of the 3 Forces above are developed provided that the mediators are isotropically radiated and spins of particles are isotropically directed as well, what happens always if a special spin ordering isn't applied. Nonetheless it looks in this case rather naturally to assume that radiation of circular mediators and spin orientation are somehow linked, the case when circular rims planes are orthogonal to spin direction look as rather probable. This point should be clarified since that can be a critical point at studying of particles internal structures. The assumption above seems can be experimentally tested at least in Electric force case: if the assumption is true, then a having parallel spins electrons cloud should expand orthogonally to spins faster than in parallel to spins direction. If that will be true in this case, then, since Forces act by the same scheme, with a well non-zero probability that will be true also for Gravity and Nuclear forces; and rather probably, for Strong force that acts inside hadrons, while it looks as rather reasonable to assume that the Nuclear force "circular mesons" above really are gluons.

Another critical point that should be clarified at development of the completed Forces theories is – the Forces mediators don't contain energy at statics, but what does happen when a radiating particle moves in 3D space? In principle, e.g., in this case circular mediators' FLEs can obtain at their radiation additional "kinematical" precessions and momentums, and so some energy and inertial mass, from the parent particle; though that looks as violates the energy conservation law, and it seems as more probable that this motion impact results only in change of the released in irradiated

particle elementary momentums directions, as that is observable at Electric force action at least as the magnetic force [and so it looks as would be rather natural if gravimagnetic and “gluonmagnetic” forces would exist as well]. Note also, that from independence of electric charge value on the charge speed seems it follows that the point in [4], where it is conjectured that at motion in 3D space particles algorithms become to be longer in Lorentz factor since are diluted by blank space FLEs isn't correct. Really it looks as more probable that at a particle motion its marked by a Force FLEs precession in Force dimension slows in Lorentz factor [here can some other effects act, of course], and ΔN_F sections so correspondingly increase. so charges values remain be constant despite that the algorithm ticks' frequency decreases, and unstable particle lives longer. At that unstable particles decay probability on some whole algorithm's tick doesn't change, and moving particles live longer at any Force decay, what looks as would be more natural provided the “blank FLE dilution”

However besides the frequency “kinematical” decreasing above the algorithm ticks' frequency in coupled by a Force particles is decreased also because of negative binding energy effect. Though if particles in the rest in the system are free, and so the binding energy really is transformed into positive kinetic energy and corresponding motion in 3D space, the problem of constancy of charges values now exists. Elaboration of these points seems would be especially important in cases when in coupled systems the Forces interactions are essentially strong.

Finally note here, that particles [including that compose complex particles, say, quarks in hadrons] fundamentally interact as QM objects, and so interactions are essentially determined also by spin-spin, spin-orbital, etc., interactions, while really “angular momentums” of particles are at least 4D objects. Though 4D cross-product doesn't exist in 4D mathematical space as a 4D vector, and so, say, there cannot be a “4D gyroscope” that has definite rotation axis, that is completely, true only in mathematical “static” case, while in the particle case, which exists as “FLE flipping point” that constantly moves along 4D helix trajectory, really the “dynamic angular momentum” \vec{M} of this point has value \hbar and exists as at least something that is like 4D vector, which is directed along the particle's 4D momentum \vec{P} vector. However when \vec{P} can have arbitrary 3D space component/projection, 3D projection of \vec{M} , as that follows from experiments is equal to $\frac{1}{2}\hbar$. At large Lorentz factor 3D projection of \vec{M} is observed as the particle's “helicity” be equal to \hbar . So at development of complete quantum theories of the Forces the problem “what is 4D momentum” should be substantively enough clarified principally basing on at least [5]4D spacetime with metrics $(c\tau, X, Y, Z, ct)$, not in 4D Minkowski space that is the base in physics now. Though that, of course isn't a unique problem in this case, more see above and [5].

References

[1] S.V. Shevchenko, V.V Tokarevsky, “The Information and the Matter.” e-print <https://doi.org/10.48550/arXiv.physics/0703043> (2007-2008)

[2] S.V. Shevchenko, V.V Tokarevsky, “Inform Physics do is possible?” Poster report on the conference XIXèmes Rencontres de Blois Matter and Energy in the

- Universe. Blois, Loire Valley, France May 20th – May 26th, <http://confs.obspm.fr/Blois2007/AllAbstracts.html> (2007)
- [3] S.V. Shevchenko, V.V Tokarevsky, “The Information as Absolute” - 2022 ed.” e-print <https://doi.org/10.48550/arXiv.1004.3712> (2022)
- [4] S.V. Shevchenko, V.V Tokarevsky, “The Informational Conception and Basic Physics”, e-print <https://doi.org/10.48550/arXiv.0707.4657> (2021)
- [5] S.V. Shevchenko, V.V Tokarevsky, “The Informational Physical Model and Fundamental Problems in Physics”. Preprints 2021, 2021100453 (doi: 10.20944/preprints202110.0453.v4) <https://www.preprints.org/manuscript/202110.0453/v4> (2023)
- [6] S.V. Shevchenko, V.V Tokarevsky, “The informational model -Gravity and Electric Forces” (Version v2), GPA22-07 conference paper, Cairo, 4-9 of December , <https://indico.cern.ch/event/1109513> (2022)
- [7] C .F. von Weizsäcker, “Eine Frage Über die Rolle der quadratischen Metrik in der Physik Zeitschrift für Naturforschung”, 7 a: 141, (1952).
- [8] C.F. von Weizsäcker, “Komplementarität und Logik. Die Naturwissenschaften”, 42: 521–529, 545–555, (1955.)
- [9] E. Fredkin, “Digital Philosophy”, http://www.digitalphilosophy.org/digital_philosophy/toc.htm (2000)
- [10] https://en.wikipedia.org/wiki/Elementary_particles
- [11] H. Yukawa, “On the Interaction of Elementary Particles” Proc. Phys-Math Soc. Jpn (PTP), 17, p 48 (1935)
- [12] К. Н Мухин, “Экспериментальная ядерная физика” Книга 2 “Физика элементарных частиц” (in Russian) М. Энергоиздат (1993)
- [13] H. Gao and M. Vanderhaeghen, “The proton charge radius”, Rev. Mod. Phys. 94, 015002 DOI: 10.1103/RevModPhys.94.015002 (2022)
- [14] H. Atac, M. Constantinou, Z.-E. Meziani, M. Paolone, N. Sparveris, “Charge radii of the nucleon from its avor dependent dirac form factors,” The European Physical Journal A 57 (2), 65. (2021)