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The Mass Spectrum of Elementary Particles in Unitary Quantum Theory and Standard Model

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THEMASSSPECTRUMOFELEMENTARYPARTICLESINUNITARYQUANTUMTHEORYANDSTANDARDMODEL

Strictly as per the compliance and regulations of :

The Mass Spectrum of Elementary Particles in Unitary Quantum Theory and Standard Model

Leo G. Sapogin [α] & Yu. A. Ryabov [σ]

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In fact we have now to distinguish "the substance" and "fields" although we can hope that future generation will overcome this dualistic interpretation and will replace it by general idea as Field theory of our days has been vainly trying to do.
Albert Einstein (back translation).

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I. Introduction

In SM a particle is represented **as a point that is the source of a field, but cannot be reduced to the field itself** and nothing can be said about its "structure" except with these vague words. In the standard quantum theory, a micro particle is described with the help of a wave function with a probabilistic interpretation. This does not follow from the strict mathematical formalism of the nonrelativistic quantum theory, but is simply postulated. At the same time in UQT the probabilistic version of the wave function appears during the study of the process particle and macrodevice interaction.

This dualism is absolutely unsatisfactory as the two substances have been introduced, that is, both the points and the fields. The points are like the sources of a field, but they do not driven to the field. Presence of a both points and fields at the same time is not satisfactory from general philosophical positions - razors of Ockama. Besides that, the presence of the points leads to non-convergences, which are eliminated by various methods, including the introduction of a re-normalization group that is declined by many mathematicians and physicists.

We shall not criticize such normalized theories here; however, to quote P. A. M. Dirac*: *"…most physicists are completely satisfied with the existing situation. They consider relativistic quantum field theory and electrodynamics to be quite perfect theories and it is not necessary to be anxious about the situation. I should say that I do not like that at all, because according to such 'perfect' theory we have to neglect, without any reason, infinities that appear in the equations. It is just mathematical nonsense. Usually in mathematics the value can be rejected only in the case it were too small, but not because it is infinitely big and someone would like to get rid of it."*

Modern quantum field theory cannot even formulate the problem of a mass spectrum finding. The original idea of Schrödinger was to represent a particle as a wave packet of de Broglie waves. As he wrote in one of his letters, he "*was happy for three months*" before British mathematician Darwin showed that the packet quickly and steadily dissipates and disappears. So, it turns out that this beautiful and unique idea to represent a particle as a portion of a field is not realizable in the context of wave packets of de Broglie waves. It was proved [1] by V.E. Lyamov and L.G Sapogin in 1968 that every wave packet constructed from de Broglie waves with the spectrum $a(k)$ satisfying the condition of Viner-Pely (the condition for the existence of localized wave packets).

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$$\int_{-\infty}^{\infty} \frac{|\ln(a(k))|}{1+k^2} \geq 0$$

becomes blurred in every case. Later, de Broglie tried to save this idea by introducing nonlinearity for the rest of his life, but wasn't able to obtain significant results.

The trouble with the numerous previous field unification attempts was in trying to construct a particle model from classical de Broglie waves, whose dispersion is such that the wave packet becomes blurred and spreads out over the whole of space. The introduction of nonlinearity greatly complicated the task but did not lead to a proper solution of the problem.

II. Unitary Quantum Approach

There is a school in physics, going back to William Clifford, Albert Einstein, Erwin Schrödinger and Louis de Broglie, where a particle is represented as a cluster or packet of waves in a certain unified field. According to Max Jammer's classification, this is a "*unitary approach*". The essence of this paradigm is clearly expressed by Albert Einstein's own words:

"We could regard substance as those areas of space where a field is immense. From this point of view, a thrown stone is an area of immense field intensity moving at the stone's speed. In such new physics there would be no place for substance and field, since field would be the only reality . . . and the laws of movement would automatically ensue from the laws of field."

However, its realization appeared to be possible only in the context of the Unitary Quantum Theory (UQT) within last two decades. It is impressive, that the problem of mass spectrum has been reduced to exact analytical solution of a nonlinear integro-differential equation [2-8]. In UQT the quantization of particles on masses appears as a subtle consequence of a balance between dispersion and nonlinearity, and the particle represents something like a very small apple shape toroid, the contour of which is the density of energy.

The Unitary Quantum Theory (UQT) represents a particle as a bunched field (cluster) or a packet of partial waves with linear dispersion [4-11]. Dispersion is chosen in such a way that the wave packet would periodically disappear and appear in movement, and the envelope of the process would coincide with the wave function. Based on this idea, the relativistic-invariant model of such unitary quantum field theory was built.

The principal nonlinear relativistic invariant equation is following [4-7,15]:

$$i\lambda^{\mu}\frac{\partial\Phi}{\partial x^{\mu}} - \frac{c\Phi}{\hbar}\int\left(\bar{\Phi}\,\lambda_1 u^{\mu}\frac{\partial\Phi}{\partial x^{\mu}} - u^{\mu}\frac{\partial\bar{\Phi}}{\partial x^{\mu}}\lambda_1\Phi\right)\frac{dV}{\gamma} = 0, \qquad (1)$$

where $x^{\mu} = (ct, x)$,

$$u^{\mu} = \left(\frac{1}{\gamma}, \frac{v}{\gamma}\right)$$

is the four-velocity of the particle, matrices $\lambda^{\mu}(32\times 32)$ satisfy the commutation relations

$$\lambda^{\mu}\lambda^{\nu} + \lambda^{\nu}\lambda^{\mu} = 2g^{\mu\nu}I\,,\ \mu,\nu = 0,1,2,3,$$

and $g^{\mu\nu}$ is the metrical tensor. This fundamental equation of UQT describes, in our opinion, all properties of elementary particles and even of gravitation. It is possible to derive from (1) the Dirac equation and also the relativistic invariant Hamilton – Jacoby equation [4-7,12-14]. We have succeeded in solving only the simplified scalar variant of eq. (1). However, the obtained solution has allowed to determine theoretically the elementary electrical charge and the fine-structure constant α with high precision (our theoretical value $\alpha = 1/137.962$, the known experimental value $\alpha = 1/137.03552$). Probably the slight discrepancy between theory and experimental data are caused by screening of electric charge value by vacuum fluctuations [4-7, 11-14]. Our efforts to find more complete solution of eq.(1) were unsuccessful. Note, our approach based on Unitary Quantum Theory has nothing in common with Standard Model of Elementary Particles - SM.

Nevertheless, our idea to consider a particle as some moving wave packet which periodically disappears and appears in movement, has allowed to arrive to the conclusion [4-7,16] that such particle may be described by the common telegraph – type equation of second order. In one-dimension case this equation is following:

$$\frac{1}{v^2}\frac{\partial^2 F(x,t)}{\partial t^2} - \frac{\partial^2 F(x,t)}{\partial x^2} - \frac{2imc^2\sqrt{1-\frac{v^2}{c^2}}}{\hbar v^2}\frac{\partial F(x,t)}{\partial t} - \frac{m^2c^4}{\hbar^2 v^2}\left(1-\frac{v^2}{c^2}\right)F(x,t) = 0 \qquad (2)$$

Note, this equation would be relativistic invariant if the root $\sqrt{1-v^2/c^2}$ would be placed in denominator. Equation (2) is satisfied exactly by relativistic invariant solutions in the form of a standard planar quantum-mechanical wave and also in the form of disappearing and appearing wave-packet, viz.,

$$F(x,t)=\exp\left(\frac{i}{\hbar}\frac{mc^2t-mvx}{\sqrt{1-\frac{v^2}{c^2}}}\right) \tag{3}$$

or

$$F(x,t)=\exp\left(\frac{i}{\hbar}\frac{mc^2t-mvx}{\sqrt{1-\frac{v^2}{c^2}}}\right)\varphi(x-vt)\,, \tag{4}$$

where φ is an arbitrary scalar function of its argument $x-vt$.

At terms v<<c Schrodinger equation [5-7,16] can be easily obtained from equation (2), by replacement of velocity via energy and potential, while the exact equation (2) can be deduced from Maxwell equations, and that was done by Heaviside.

III. Calculation of the Spectrum of Possible Wave Packets using Telegraph-Type Equation

We imagine the wave packet, while spreading in a media with dispersion and nonlinearity, should not only appear and disappear at the length de Broglier wave, but also keep its individuality. So, we are looking for exact class of solution for nonlinear integro-differential equation. Nonlinearity in equation will appear after replacement of mass by integral over the total volume of solution gradient square.

We will show that eq. (2) (considered in the case of 3-dimension coordinate space (r,θ,φ)) allows, namely, to determine theoretically the mass spectrum of elementary particles. Such equation for the function $u=u(r,\theta,\varphi)$ is following:

$$\frac{1}{v^2}\frac{\partial^2 u}{\partial t^2}-\frac{1}{r^2\sin\theta}\left(2r\sin\theta\frac{\partial u}{\partial r}+r^2\sin\theta\frac{\partial^2 u}{\partial r^2}+\cos\theta\frac{\partial u}{\partial\theta}+\sin\theta\frac{\partial^2 u}{\partial\theta^2}+\frac{1}{\sin\theta}\frac{\partial^2 u}{\partial\varphi^2}\right)-\frac{2iMc^2\sqrt{1-\frac{v^2}{c^2}}}{v^2\hbar}\frac{\partial u}{\partial t}-$$

$$-\frac{M^2c^4}{v^2\hbar^2}(1-\frac{v^2}{c^2})u=0\,, \tag{5}$$

(the symbol *m* is replaced by *M*). We will use the natural system of units and put $\hbar=1, c=1$, and will seek the solution of eq. (5) in the following form:

$$u=\frac{f}{r}\exp\left(\frac{iMt}{\sqrt{1-v^2}}-\frac{iMvr}{\sqrt{1-v^2}}\right)\,, \tag{6}$$

where $f=f(r,\theta,\varphi)$ is some function not depending on t. This function represents as hardened wave packet in coordinate space (r,θ,φ). Substituting (6) in eq. (5), we get

$$2iMvr^2\cos^2\theta\frac{\partial f}{\partial r}-2iMvr^2\frac{\partial f}{\partial r}+r^2\sqrt{1-v^2}\frac{\partial^2 f}{\partial r^2}\sin^2\theta+\sqrt{1-v^2}\frac{\partial^2 f}{\partial\theta^2}\sin^2\theta+$$

$$+\sqrt{1-v^2}\left(\frac{\partial^2 f}{\partial\varphi^2}+\sin\theta\cos\theta\frac{\partial f}{\partial\theta}\right)=0. \tag{7}$$

We will seek the solution of eq. (7) in form:

$$f = R(r)Y_{Lm}(\theta,\varphi), \tag{8}$$

where

$$Y_{Lm}(\theta,\varphi)=\frac{\sqrt{(2L+1)(L-m)!}}{2\sqrt{\pi(L+m)!}}P_L^m(\cos\theta)\exp(\pm im\varphi), \tag{8`}$$

$P_L^m(\cos\theta)$ is the Legendre function, $Y_{Lm}(\theta,\varphi)$ is the spherical harmonic and L,m are nonnegative integers L=0,1,2,3,…, $m=0\pm1\pm2\pm3..$ besides $m\le L.$ Substituting (8) in eq. (7), we come to the following equation with respect to the function $R(r)$:

$$\left(\frac{d^2R(r)}{dr^2}r^2\sqrt{1-v^2}-2i\frac{dR(r)}{dr}Mvr^2\right)-R(r)L^2\sqrt{1-v^2}-R(r)L\sqrt{1-v^2}=0 \tag{9}$$

The solution $R(r)=R_L(r)$ of this equation depends on parameter L and we obtain the family of solutions $u_{Lm}(r,\theta,\varphi,t)$ of equation (5) depending on parameters $L,m.$ It is natural to suppose that every solution u_{Lm} of our equation (5) describes the amplitude of the partial world unitary potential Φ_{Lm} determined by partial wave packet and the potential itself is represented by the quadrate of amplitude modulus, i.e.

$$\Phi_{Lm}=|u_{Lm}|^2=\left|\frac{R_L(r)}{r}Y_{Lm}(\theta,\varphi)\right|^2. \tag{10}$$

Further, we consider the gradient of this potential as the tension of corresponding field (it is the custom in electrodynamics) of the partial wave packet and consider the quadrate of the tension as the density W_{Lm} of the energy or of the wave packet's mass distributed continuously in space. If we consider eq. (9) in some fixed spherical zone Q_r with radius r, where the corresponding part of our hardened wave packet is placed, then it is natural to consider $M=M_{Lm}$ as the mass of this part of the partial wave packet, i.e. as the integral of density W_{Lm} over given spherical zone. Such approach allows to replace the mass M in (9) by integral

$$M=\iiint\limits_{Q_r}W_{Lm}r^2\sin(\theta)drd\theta d\varphi, \tag{11}$$

where $W_{Lm}=|\mathrm{grad}\,\Phi_{Lm}|^2.$ So, we will consider eq. (9) as the integro-differential equation with respect to the function $R(r)=R_L(r)$. For the sake of simplicity; we will use the following expression for M (after discarding the members which depend on θ,φ and omitting index L):

$$M=\int_0^r\left|\frac{d}{dr}\left(\frac{R(r)^2}{r^2}\right)\right|^2r^2dr. \tag{12}$$

We will use the following way to solve our integro-differential eq. (9). Viz., at first, we rewrite this equation in form

$$2ivM=\frac{1}{r^2R'(r)}(R''(r)r^2-L(L+1)R(r))\sqrt{1-v^2},\ \ ('=\frac{d}{dr}). \tag{13}$$

At second, we substitute integral (12) for M and differentiate left- and right-hand sides with respect to $r.$ We obtain

$$2iv[\frac{d}{dr}(\frac{R^2}{r^2})]^2r^2=\frac{d}{dr}[\frac{1}{r^2R'}(R''r^2-L(L+1)R)]\sqrt{1-v^2}. \tag{13'}$$

At the third step, we set $v=0$ in (13'). The grounds are following. The solution of this equation depends on parameter v (the velocity of our particle). It is natural to suppose that the potential Φ describe processes which are continuous with respect to v (in any case, if v is less, than light velocity c), i.e. $\lim R(r,v)=R(r,v^*)$ if $v\to v^*$ and it is valid if $v^*=0.$ Besides, we want to determine the inner (proper) characteristic of our wave packet not depending on the velocity of its movement. We consider the mass of the wave packet as its inner (proper) characteristic not depending on the velocity of its movement. Now, suppose $v=0$ and after integration obtain the following differential equation for $R(r)$:

$$R''-\frac{L(L+1)}{r^2}R=CR',$$

where *C* is some constant. This equation possesses the analytical general solution:

$$R=C_1\exp(\frac{C}{2}r)\sqrt{r}\,\mathrm{J}(L+\frac{1}{2},\frac{1}{2}\sqrt{-C^2}r)+C_2\exp(\frac{C}{2}r)\sqrt{r}\,\mathrm{Y}(L+\frac{1}{2},\frac{1}{2}\sqrt{-C^2}r) \qquad (14)$$

where C, C_1, C_2 arbitrary constants and J and Y are are the Bessel functions. Since we seek the finite solution R for $r\to 0, r\to\infty$ and tending to zero for, $r\to\infty$ we set $C_2=0$ and can set some positive value for C_1 and some negative value for the constant *C* in eq. (13). The calculations show the choice of these constants has influence only on the absolute value of the masses calculated below but the ratios of these masses remain the same. We have chosen the simplest values

$$C_1=1, C=-2$$

and have obtained following solution

$$R(r)=\sqrt{r}\exp(-r)\,\mathrm{J}(L+\frac{1}{2},ir)), \qquad (15)$$

where $\mathrm{J}(L+\frac{1}{2},ir)$ is the Bessel function of the first kind with imaginary argument, or

$$R(r)=i^{L+\frac{1}{2}}\sqrt{r}\exp(-r)\,\mathrm{I}(L+\frac{1}{2},r), \qquad (16)$$

where $\mathrm{I}(L+\frac{1}{2},r)$ is the modified Bessel function of the first kind.

Radial part of amplitude of world potential for any integral positive *L* is a complex value.

So, we obtain the following expression for the partial world unitary potential Φ_{Lm} (taking into consideration (6, 8, 8', 10) :

$$\Phi_{Lm}=\frac{e^{-2r}}{4\pi r}\left|\frac{(2L+1)(L-m)!\,\mathrm{I}(L+\frac{1}{2},r)^2\,\mathrm{P}_L^m(\cos\theta)^2}{(L+m)!}\right| \qquad (17)$$

Now, we form $\operatorname{grad}\Phi_{Lm}$ considered as the tension of the world unitary field and form also the quadrate of its modulus considered as the mass density W_{Lm}. We obtain:

$$W_{Lm}=2e^{-4r}\left(\frac{(L-m)!^2\,\mathrm{I}(L+\frac{1}{2},r)^2\left((L+r+1)\,\mathrm{I}(L+\frac{1}{2},r)-r\,\mathrm{I}(L-\frac{1}{2},r)\right)^2\mathrm{P}_\mathrm{L}^\mathrm{m}(\cos\theta)^4(L+\frac{1}{2})^2}{\pi^2r^4(L+m)!^2}+\right.$$

$$\left.+\frac{(L+\frac{1}{2})^2\,\mathrm{I}(L+\frac{1}{2},r)^4(L-m)!^2\,\mathrm{P}_\mathrm{L}^\mathrm{m}(\cos\theta)^2\left((m-L-1)\,\mathrm{P}_{L+1}^\mathrm{m}(\cos\theta)+(L+1)\cos\theta\,\mathrm{P}_\mathrm{L}^\mathrm{m}(\cos\theta)\right)^2}{\pi^2r^4(L+m)!^2\sin^2\theta}\right) \qquad (18)$$

The integrals of W_{Lm} overall spherical space (r,θ,φ) for different $L=0,1,2,...$ and $m=0,\pm1,\pm2,...,m\le L$ is equal to required different masses M_{Lm} of elementary particles, i.e.

$$M_{Lm} = \int_0^\infty \int_0^\pi \int_0^{2\pi} W_{Lm} r^2 \sin(\theta) dr d\theta d\varphi \tag{19}$$

Since W_{Lm} do not depend on φ and the Legendre functions in expressions of W_{Lm} may be integrated analytically, we calculated, at first, analytically (with help of *Mathematica-9*) the integrals

$$U_{Lm} = \int_0^\pi W r^2 \sin(\theta) d\theta \int_0^{2\pi} d\varphi = 2\pi \int_0^\pi W r^2 \sin(\theta) d\theta \tag{20}$$

and then calculated numerically (with the help of *Mathematica-9*) the integrals

$$M_{Lm} = \int_0^\infty U_{Lm} dr \tag{21}$$

For example, we have obtained for $L=0$ и $m=0$ (with help of *Mathematica*-9):

$$U_{00} = \frac{8e^{-4r}\sinh(r)^2}{\pi^3 r^4}\left\{(r^2+\frac{1}{2}+r)\cosh(r)^2 - r(1+r)\sinh(r)\cosh(r) - \frac{(1+r)^2}{2}\right\}$$

and

$$M_{00} = \int_0^\infty U_{00} dr = 0.003944364169$$

For $L=1, m=1$, we have obtained (with help of *Mathematica-9*)

$$\begin{aligned} U_{11} = \frac{8e^{-4r}}{\pi^3 r^8}\Bigg[&\left(r^6+5r^5+\frac{93}{8}r^4+13r^3+\frac{61}{4}r^2+2r+\frac{17}{8}\right)\cosh^4 r - \\ &- r\sinh r\cosh^3\left(r^5+5r^4+11r^3+\frac{33}{2}r^2+8r+\frac{17}{2}\right) - \\ &- \cosh^2 r\left(\frac{1}{2}r^6+3r^5+10r^4+14r^3+\frac{71}{4}r^2+4r+\frac{17}{4}\right) + \\ &+ r\sinh r\cosh r\left(r^4+3r^3+8r^2+8r+\frac{17}{2}\right) + \frac{1}{2}r^4+r^3+\frac{5}{2}r^2+2r+\frac{17}{8}\Bigg] \end{aligned}$$

and

$$M_{11} = 0.00006798678730.$$

The calculations for small values of L are sufficiently simple. But for large L, the quantities U_{Lm} are represented by long polynomials in r and $\cosh(r), \sinh(r)$ with enormous numerical coefficients and the integration of these polynomials meets serious technical difficulties. The same computations have been made with the help of *Maple-18* program, it's faster than *Mathematica-9* integrates with the respect to angle, but slower integrates in number with respect to radius. The results totally coincide. It's amazing but for the difficult non-linear integro-differential equation UQT managed to obtain the exact analytical solution. It can be considered as a gift of Fortune. The Standard Quantum Theory has only one similar gift – analytical solution for the atom of Hydrogen.

We consider the ensemble $L+1$ particles (masses) with given L and $m = 0 \ldots \pm L$ to be one family and we will use the notations

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$M_{L,0}, M_{L,1},..., M_{L,L}$ for particles (masses) of the family with given L. We have calculated and analyzed in full the masses of 49 families ($L = 0,...,48$), i.e. of 1225 particles. Our PC with $3GHz, RAM = 32GB$ has required for these calculations nearly 3 weeks of computing time.

We have compared our theoretical spectrum for 1225 masses with known experimental spectrum for elementary particles measured in *MeV*. The zero-point for the matching of both spectra was required. We have taken for such matching the quotient of the muon mass to the electron mass. As we know, this quotient for observed muons and electrons is measured straight experimentally [17] with the most precision and is equal 206.768283(10). Each our calculated mass was divided consecutively by all other 1224 masses and the resulting quotients were compared with the mentioned number. It turned out that the quotient of our masses $M_{16,10} / M_{48,45}$ is equal to 206.7607796 (with relative divergence 0.0039%) and we have taken our mass $M_{48,45}$ equal to $0.2894982442536304 \cdot 10^{-10}$ for zero-point, i.e. for our electron mass. Then we have divided all other 1224 masses $M_{L,m}$ by $M_{48,45}$ and we have obtained our theoretical spectrum in electron masses which may be compared (after expressing in *MeV*) with known experimental masses. Here is the table 1 with our masses M_{Lm} for 38 cases of the well coincidence with well known experimental values (relative errors are less than 1% in 35 cases and between 1.3% and 1.8% in three cases):

Among these calculated masses all of known leptons and quarks are presented. Note, the ratio of our proton mass $M_{12,1}$ and our electron mass $M_{48,45}$ is equal 1832.355 with relative error 0.207% in comparison with well known experimental ratio 1836.152167. Our calculated spectrum containing 169 masses from muon to the heaviest mass approximates also others well known particles and, although the coincidences with experimental data are worse but quite acceptable (with relative divergences not more than several per cent). The mass values for negative m coincides with the mass valued for positive m (antiparticles?).

We do not analyze mass spectrum for neutrino because of numerous experimental mistakes. On the whole, this table shows the striking coincidence of our theoretical values with essential quantity of the known experimental masses and, by no means, such coincidence may be called occasional. The probability of such occasional coincidence is less 10^{-60}.Note, the choice of the nominee for the electron's mass is not unique and may be further calculations of families with $L = 60....100$ would allow to obtain the better result. Our calculated theoretical spectrum contains also the values near to the masses of quarks. In UQT there is no firm belief that quarks exist at all and this question will be discussed further. The experimental data for quarks are not so precise and are determined in an indirect way. We give the separate table 2 with the calculated and experimental quark masses (*MeV*).

We have carried out also the series of calculation M_{Lm} for L exceeding 48 including $L = 60$. The ratio of maximal $M_{00} = 0.00394443641689$ to minimal $M_{60,60} = 0.3909395521 \cdot 10^{-11}$ is of order 10^9. The ratio of maximal M_{00} to the mass $M_{12,1} = 0.5304640719 \cdot 10^{-7}$ of proton is equal 74400. This number does not contradict the known the experimental data.

Note, the radial function $U_{Lm}(r)$ being the density mass as function of r, is equal zero always for r=0 and for all L, m, and, at first, increases very swiftly on the right from for r=0 and then very swiftly decreases. The plot of $U_{Lm}(r)$ reminds for large L quasi delta-function approaching to coordinates origin as L increases (very simplified analogy is shown on Fig.1.

All particles look like bubbles cut by spherical harmonic but button wall itself at other values of L and m has numerous oscillations. Curious, such model, namely, was considered by A. Poincare [18]. And that mass spectrum was very identical to experimental data. It was so because all components of tensor fields contributed to energy in the process of scalar equation solution and to get more precise details of the particles' structure the integro-differential equation (1) should be solved, but the authors failed to do it because the mathematical trick used earlier has not work more. The particles' masses decrease with the growth of L and m and in theory the foot of the spectrum is infinite and gradually after mass of electron approaches to the quasi-continuous vacuum fluctuations.

Certainly, we do not intend to assert that our results are adequate in full to the known experimental mass spectrum of elementary particles. The divergences are present. Our theoretical spectrum contains the large quantity (1053) of masses between electron mass and muon mass but such real particles have not been observed till now. Our spectrum contains many light particles $M_{L,m}(L > 48)$ with masses differing extremely little one from another. Somebody may suppose the existence of quasi-continuous distribution of lightest particles not affirmed till now by experiments. We suppose that this region of our calculated spectrum contains also the values corresponding to masses of all 6 neutrinos, and it will be possible to discover their theoretical masses after sufficiently precise experimental determination of their masses.

Our spectrum contains 169 particles from the muon to the heaviest particle $M_{0,0}$ but we can see the large quantity of particles in this interval with short “life-time” (so called “resonances”) of order 10^{-22} sec. These divergences require the further researches. With respect to light particles, it may be supposed the existence of some selection principles (not discovered till now theoretically) for such particles and these principles lead to essential decreasing of particles quantity between muons and electrons. We suppose that such principles arise theoretically from some relations between the tensors of different valences (ranks) and spherical functions for different *L, m* and leave this complicate problem for future researches. May be these light particles constitute the "dark energy".

Now arise the question with respect to the particles with short “life-time”: how about to take all these particles for elementary? Our Unitary Quantum Theory allows formulating the following criterion: **If the way which the particle (which we identify with appearing and disappearing wave packet) passes from the moment of its appearing to the moment of its destruction is much longer than de Broglie wave, then such particle may be called elementary.** Have we reason to call “elementary” the particle with life-time of order 10^{-22} sec ?

IV. Calculation of Spectrums of Possible Wave Packets for Schrödinger and Klein-Gordon Equations

Let us point to following essential circumstance. Viz., if we will use the Schrödinger equation in spherical coordinates (relativistic-noninvariant) or Klein—Gordon equation (relativistic-invariant) instead our initial equation (5), then we will come to the same theoretical mass spectrum. Really, the above mentioned Schrödinger equation is following:

$$\frac{\hbar^2}{2}\frac{\left(2r\sin\theta\frac{\partial u}{\partial r}+r^2\sin\theta\frac{\partial^2 u}{\partial r^2}+\cos\theta\frac{\partial u}{\partial\theta}+\sin\theta\frac{\partial^2 u}{\partial\theta^2}+\frac{1}{\sin\theta}\frac{\partial^2 u}{\partial\varphi^2}\right)}{Mr^2\sin\theta}+i\hbar\frac{\partial u}{\partial t}=0\ , \tag{22}$$

where *M* is the particle’s mass. We will seek the solution of this equation in form of unitary wave packet f :

$$u=\frac{f}{r}\exp(-i\frac{Mv^2}{2\hbar}t+i\frac{Mv}{\hbar}r) \tag{23}$$

where $f=f(r,\theta,\varphi)$ is the function of coordinates and does not depend on the time. The function u is considered as the amplitude of the world unitary potential Φ. Substituting (23) in (22), we obtain (after simplification) the following equation

$$\hbar r^2\sin^2\theta\frac{\partial^2 f}{\partial r^2}-2iMvr^2\sin^2\theta\frac{\partial f}{\partial r}+\frac{\hbar}{2}\sin 2\theta\frac{\partial f}{\partial\theta}+\hbar\sin^2\theta\frac{\partial^2 f}{\partial\theta^2}+\hbar\frac{\partial^2 f}{\partial\varphi^2}=0\,. \tag{24}$$

This equation coincides with our equation (7) if we put $\sqrt{1-v^2}$ instead $\hbar$. The further study described above remains unchanged.

Let us consider Klein—Gordon equation in spherical coordinates and in natural units system $c=1$, $\hbar=1$

$$\frac{\left(2r\sin\theta\frac{\partial u}{\partial r}+r^2\sin\theta\frac{\partial^2 u}{\partial r^2}+\cos\theta\frac{\partial u}{\partial\theta}+\sin\theta\frac{\partial^2 u}{\partial\theta^2}+\frac{1}{\sin\theta}\frac{\partial^2 u}{\partial\varphi^2}\right)}{r^2\sin\theta}-\frac{\partial^2 u}{\partial t^2}-M^2u=0\,, \tag{25}$$

where *M* is the particle’s mass. We will seek the solution

$$u=\frac{f}{r}\exp\left(\frac{iMt}{\sqrt{1-v^2}}-\frac{iMvr}{\sqrt{1-v^2}}\right)\ , \tag{26}$$

where $f=f(r,\theta,\varphi)$ is the function of coordinates not depending explicitly on *t*. Substituting (26) in (25), we obtain following equation after simplification:

$$r^2\sin^2\theta\sqrt{1-v^2}\frac{\partial^2 f}{\partial r^2}-2ivr^2M\sin^2\theta\frac{\partial f}{\partial r}+\sin^2\theta\sqrt{1-v^2}\frac{\partial^2 f}{\partial\theta^2}+\sqrt{1-v^2}\frac{\partial^2 f}{\partial\varphi^2}+\frac{\sqrt{1-v^2}}{2}\sin 2\theta\frac{\partial f}{\partial\theta}=0 \quad (27)$$

This equation coincides in full with our equation (7) and we will come to the same results.

So, different initial equations (5), (22), (25) (the last is relativistic invariant and the other two are relativistic non-invariant) lead to the same theoretical mass spectrum. Note the following remarkable fact: the standard theory allowed to detect spectra by using always the quantum equations with outer potential and as corollaries to geometric relations between de Broglie wave length and characteristic dimension of potential function. **The quantum equation of our theory does not contain the outer potential and describes a particle in empty free space; the mass quantization arises owing to the delicate balance of dispersion and non-linearity which provides the stability of some wave packets number**. It is the first case when spectra are detected by using the quantum equations without outer potential.

Here is the table 1 with all our theoretical masses from the muon to the heaviest $M_{0,0}$ (*MeV*). We should note that data from Table 3 was calculated in 2007 [2,3,6-8] and remained unchanged, and Higgs boson and three pentaquarks were insert in the table 1 after their discovery. We should also note that both elementary electric charge and mass spectrum appear in the result of complex space geometry, while time in UQT becomes Newtonian again.

In view of all above-mentioned we, nevertheless, make bold to say that our results represent the substantial advancement on the way of solution for the extremely complicated theoretical problem of the mass spectrum for elementary particles and to underline that this advancement is owing to our Unitary Quantum Theory. We hope that further analysis with the help of exact equation (1) of our theory will allow to obtain more precise results.

We would like to propose the name "**Dzhan—particle**"- 69.62274 *TeV* for our heaviest particle $M_{0,0}$ in honor of the kosmonaut V.A. Dzhanibekov, general of RF Air Force. As we know, particles with mass of such order are observed in cosmic rays.

The UQT allows to explain both "dark matter" and "dark energy". The heaviest **Dzhan-particle** should be neutral and pure scalar. As the result it will poorly react with the surrounding particles also due to minimum quantum numbers, and probably this state will be filled as much as possible and is responsible for existence of "dark matter". At the same time numerous light particles with masses less than electron may create vacuum fluctuations with negative pressure – "dark energy".

V. Standard Model, Supersymmetry and Strings

Conventional quantum theory has concepts of the field dualism and the matter, where particle is considered as s point – a source of a field, but UQT was the first to presented it as a field. There is a concept of a standard model (SM) of particle physics, it is often called by mass media as *"theory of nearly everything"*. This modern theory of structure and interaction of elementary particles repeatedly confirmed by experiments allows to predict the properties of different processes of scattering and transformation in the world of elementary particles. Physicists working in the frame of this model stipulate that all their predictions are experimentally confirmed. But this perfect (for lack of something better) model cannot predict even the masses of elementary particles. For example, both Higgs boson mass and recently opened pentaquarks has not been predicted, SM had only rough estimation of the orders of their values, that is why the SM cannot be considered as a final theory of elementary particles.

According to Einstein words used as epigraph to this article the next theory should decrease the number of matters, but SM builds the matter from 12 fundamental "bricks" – six grades of leptons and six grades of quarks. The number of possible combinations made from these bricks is limited, therefore SM leaves no space for the great number of weakly interacting particles that make up 95 % of the University general mass. In addition SM left in deep rear some fundamental quantum questions like corpuscular-wave dualism and uniform explanations of numerous phenomena of chemical catalysis [5-7, 23, 24]. In UQT quantum entanglement of photon and quantum teleportation does not arise as a problem at all [7]. In UQT the possibility to consider the interaction between entangled particles for data communication (seriously discussed by modern science) does not occur at all and even Einstein called this "*interaction illusory*".

Now UQT explains the existents of the low energy nuclear reactions, of other exceptional phenomena and the possibility to create new sources of energy, for example E-cat Andrea Rossi [5-7]. Appearance of quarks with charges of 2/3 and 1/3 is a striking example of a beautiful mathematical fairy tale. As far quarks had not been found it was stipulated aiming the rescue of SM that quarks could not been extracted from "quark bag" in general, even the origin of this "bag" was mysterious also. From UQT point of view the possibility of arising of the particles with charges of 2/3 and 1/3 is beyond understanding because nothing except π and e in calculation of fine-structure constant are used.

To our regret today this theory cannot compute correctly the masses of elementary particles including the mass of "Higgs boson". More worse that SM contains from 20 to 60 adjust in arbitrary! - parameters (there are different versions of SM). SM does not have theoretically proved algorithm for spectrum mass computation and no ideas how to do it! All these bear strong resemblance to the situation with Ptolemaic models of Solar system before appearance of Kepler`s laws and Newton s mechanics. These earth-centered models of the planets movement in Solar system had required at first introduction of so called epicycles specially selected for the coordination of theoretical forecasts and observations. Its description of planets positions was quite good; but later to increase the forecasts accuracy it had required another bunch of additional epicycles. Good mathematicians know that epicycles are in fact analogues of Fourier coefficients in moment decomposition in accordance with Kepler`s laws; so by adding epicycles the accuracy of the Ptolemaic model can be increased too. However that does not mean that the Ptolemaic model is adequately describing the reality. Quite the contrary... More over SM does not take into account in the computations the gravity and it's beyond the understanding how it can be used at all.

One of the main unsolved problems of SM remains the impossibility to compute the fine-structure constant value $\alpha =$ 1/137 (non-dimensional electric charge in system $\hbar = 1$, c=1). The value $\alpha =$ 1/137 is dimensionless and each extraterrestrial civilization with the highly developed level of science will know tree great constants π, e, α. In UQT it was computed for the first time [7,12-14]. This result is very important. There are some opinions:

"The mystery about α is actually a double mystery. The first mystery – the origin of its numerical value $\alpha \approx$ 1/137 has been recognized and discussed for decades. The second mystery –the range of its domain – is generally unrecognized." —M. H. MacGregor (2007). The Power of Alpha. World Scientific.

"If alpha were bigger than it really is, we should not be able to distinguish matter from ether and our task to disentangle the natural laws would be hopelessly difficult. The fact however that alpha has just its value 1/137 is certainly no chance but itself a law of nature. It is clear that the explanation of this number must be the central problem of natural philosophy". — Max Born, A.I. Miller (2009). Deciphering the Cosmic Number: The Strange Friendship of Wolfgang Pauli and Carl Jung. W. W. Norton & Co.

"There is a most profound and beautiful question associated with the observed coupling constant, e – the amplitude for a real electron to emit or absorb a real photon. It is a simple number that has been experimentally determined to be close to 0.08542455. (My physicist friends won't recognize this number, because they like to remember it as the inverse of its square: about 137.03597 with about an uncertainty of about 2 in the last decimal place. It has been a mystery ever since it was discovered more than fifty years ago, and all good theoretical physicists put this number up on their wall and worry about it.) Immediately you would like to know where this number for a coupling comes from: is it related to π or perhaps to the base of natural logarithms? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man. You might say the "hand of God" wrote that number, and "we don't know how He pushed his pencil." We know what kind of a dance to do experimentally to measure this number very accurately, but we don't know what kind of dance to do on the computer to make this number come out, without putting it in secretly!" Richard P. Feynman (1985). "QED: The Strange Theory of Light and Matter", p. 129.

The researches of supersymmetry and strings exist by themselves and look like next beautiful mathematical fairy tales without any experimental confirmation. More over the modern science is based on special and general theory of relativity and relativistic conception of space-time, the UQT has a lot of complaints to [19-22]. In UQT the relativistic correlations between impulse and energy is strictly maintained but the reason of their appearance is absolutely different. The time is Newtonian again, and with the change of gravitational potential (equivalently to acceleration effect) the speeds of all processes change too, at the same time the lines reduction is absent at all [19-22]. The authors realize in full the panic their investigations can create among scientists working in the field of high energy physics. And of course the position of modern science is quite evident: to keep the financing of future projects the UQT should not be noticed at all.

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Table 1 (*MeV*)

$M_{L,m}$	Theory	Experiment	Notation	Error %
$M_{48,45}$	0.51099906	0.51099906	e	--
$M_{16,10}$	105.6545640	105.658387	μ	0.0036
$M_{18,4}$	135.8958708	134.9739	π^0	0.683
$M_{23,0}$	137.2902541	139.5675	π^+, π^-	1.62
$M_{14,1}$	541.7587460	548.86	η	1.29
$M_{7,7}$	894.0806293	891.8	K^{*+}, K^{*0}	0.25
$M_{12,1}$	936.3325942	938.2723	p	0.206
$M_{10,4}$	957.1290490	957.2	ω	0.0083
$M_{9,5}$	1110.473414	1115.63	Λ	0.462
$M_{8,6}$	1224.151552	1233	b_1^0	0.71
$M_{11,1}$	1271.916682	1270	K^*	0.14
$M_{9,4}$	1331.705434	1321.32	Ξ^-	0.78
$M_{10,2}$	1378,127355	1382.8	$\sum^0$	0.33
$M_{12,0}$	1524.617683	1522$\pm$ 3	θ^+barion	0.29
$M_{8,5}$	1549.444919	1540 ± 5	F_1	0.28
$M_{7,6}$	1595.510637	1594	ω_1	0.094
$M_{9,3}$	1601.282953	1600	ρ'	0.08
$M_{6,6}$	1718.917400	1720	N_0^3	0.06
$M_{10,1}$	1774.917815	1774	K_3^{*+}	0.051
$M_{8,4}$	1906.842877	1905	Δ_5^+	0.096
$M_{9,2}$	1965.115639	1950	Δ_4	0.77
$M_{11,0}$	2092.497779	2100	Λ_4	0.35
$M_{7.5}$	2195.695293	2190	N(2190)	0.25
$M_{7,4}$	2818.645188	2820	η_c	0.048
$M_{10,0}$	2954.549810	2980	η	0.85
$M_{6,5}$	3082.979571	3096	J/ψ	0.42
$M_{7,3}$	3543.664516	3556.3	χ	0.35
$M_{5,5}$	3687.679612	3686.0	ψ'	0.04
$M_{9,0}$	4315.87	4380$\pm$86	pentaquark	
$M_{7,2}$	4436.65	4449.8$\pm$19	pentaquark	
$M_{7,2}$	4496.650298	4415	ψ'''	1.84
$M_{6,4}$	5642.230394	5629.6	Ξ_b	0.8
$M_{5,3}$	9499.927309	9460.32	$\Re$`	0.41
$M_{6,1}$	10075.78271	10023.3	$\Re$``	0.523
$M_{7,0}$	10533.15222	10580	$\Re$```	0.442
$M_{2,2}$	131517.11	125000-140000	Higgs	
$M_{0,0}$	6962274	?	Dzhan	?

(e – electron, μ - muon, π^0 - π -meson, p – proton etc.)

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Таблица 2. (*MeV*)

$M_{L,m}$	Theory	Experiment	Notation
$M_{13,3}$	4.722547634	4,79±0,07	down
$M_{30,25}$	2.75072130	1.5-3.0	up
$M_{20,4}$	94.4251568	95 ± 25	strange
$M_{11,1}$	1271.9166	1250 ± 90	charm
$M_{6,4}$	4300.86662	4200 ± 70	beaty
$M_{3,0}$	179100	174 200 ± 3300	truth

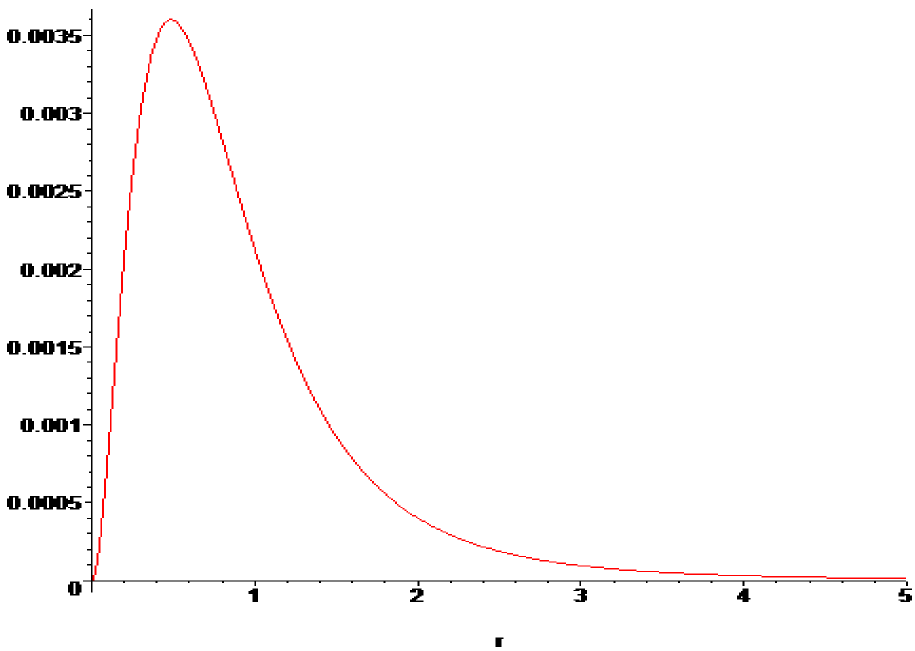

Fig.1 : The plot for $U_{00}(r)$

Table 3 (*MeV*)

105.655, 105.94, 106.241, 108.291, 108.997, 109.597, 110.133, 112.784, 117.054, 118.136, 120.31, 121.826, 122.664, 125.522, 125.71, 127.187, 127.237, 127.306, 131.445, 133.013, 135.896, 137.29, 142.287, 144.326, 145.96, 147.309, 147.698, 149.62, 149.905, 153.765, 153.827, 159.796, 162.135, 162.192, 165.33, 172.249, 177.091, 178.559, 178.758, 180.585, 180.895, 187.69, 192.661, 192.917, 195.832, 199.852, 203.297, 205.588, 209.097, 218.681, 219.639, 221.135, 224.061, 225.089, 231.432, 231.656, 241.805, 249.092, 252.972, 253.184, 269.993, 270.91, 276.443, 280.151, 281.016, 289.488, 300.299, 301.848, 304.024, 314.364, 318.997, 335.848, 339.955, 341.136, 342.52, 349.235, 357.381, 366.838, 373.402, 402.126, 408.316, 423.36, 423.429, 432.83, 445.413, 459.388, 461.593, 472.253, 504.945, 521.772, 529.951, 531.566, 539.326, 541.759, 560.236, 571.51, 606.559, 619.012, 672.537, 686.757, 705.247, 705.477, 730.141, 738.98, 812.354, 828.374, 866.997, 894.081, 897.982, 915.038, 936.333, 957.129, 996.316, 1110.47, 1135.57, 1137.9, 1224.15, 1271.92, 1331.71, 1378.13, 1524.62, 1549.43, 1595.51, 1601.28, 1718.92, 1774.92, 1906.84, 1965.1, 2092.5, 2195.7, 2334.9, 2557.69, 2818.65, 2906.6, 2954.55, 3082.98, 3543.66, 3687.68, 3832.21, 4300.87, 4315.87, 4496.65, 5642.23, 6026.01, 6570.85, 6666.64, 7358.75, 9219.36, 9499.93, 10075.8, 10533.2, 12941.1, 16897., 18035.6, 18261.3, 25000.7, 28935.4, 33698.9, 36955.4, 54518.8, 71060.4, 87704.5, 131517., 179100., 266419., 601983., 1.20005e6 3.4545e6, 6.96227e7.

UQT - Table of the Mass Spectrum of Elementary Particles

MeV	$M_{L,m}$	MeV	$M_{L,m}$	MeV	$M_{L,m}$	MeV	$M_{L,m}$	MeV	$M_{L,m}$	MeV	$M_{L,m}$
0.51099906 electron	48,45 e	2.751 up	30,25	4.722 down	13,3	94.425 strange	20,4	105.655 μ	16,10	105.94	-
106.241	-	108.291	-	108.997	-	109.597	-	110.133	-	112.784	-
117.054	-	118.136	-	120.31	-	121.826	-	122.664	-	125.522	-
125.71	-	127.187	-	127.237	-	127.306	-	131.445	-	133.013	-
135.896 π^0	18,4	137.29 $\pi^+\pi^-$	23,0	142.287	-	144.326	-	145.96	-	147.309	-
147.698	-	149.62	-	149.905	-	153.765	-	153.827	-	159.796	-
162.135	-	162.192	-	165.33	-	172.249	-	177.091	-	178.559	-
178.758	-	180.585	-	180.895	-	187.69	-	192.661	-	192.917	-
195.832	-	199.852	-	203.297	-	205.588	-	209.097	-	218.681	-
219.639	-	221.135	-	224.061	-	225.089	-	231.432	-	231.656	-
241.805	-	249.092	-	252.972	-	253.184	-	269.993	-	270.91	-
276.443	-	280.151	-	281.016	-	289.488	-	300.299	-	301.848	-
304.024	-	314.364	-	318.997	-	335.848	-	339.955	-	341.136	-
342.52	-	349.235	-	357.381	-	366.838	-	373.402	-	402.126	-
408.316	-	423.36	-	423.429	-	432.83	-	445.413	-	459.388	-
461.593	-	472.253	-	504.945	-	521.772	-	529.951	-	531.566	-
539.326	-	541.759 η	14,1	560.236	-	571.51	-	606.559	-	619.012	-
672.537	-	686.757	-	705.247	-	705.477	-	730.141	-	738.98	-
812.354	-	828.374	-	866.997	-	894.081 K^{*+}, K^{*0}	7.7	897.982	-	915.038	-
936.333 p	12,1	957.129 ω	10,4	996.316	-	1110.47 Λ	9,5	1135.57	-	1137.9	-
1224.15 b_1^0	8,6	1271.92 sharm K^*	11,1	1331.71 Ξ^-	9,4	1378.13 Σ^0	10,2	1524.62 barion	12,0	1549.43 F_1	8,5
1595.51 ω_1	7,6	1601.28 ρ'	9,3	1718.92 N_0^3	6,6	1774.92 K_3^{*+}	10,1	1906.84 Δ_5^+	8,4	1965.1 Δ_4	9,2
2092.5 Λ_4	11,0	2195.7 N(2190)	7,5	2334.9	-	2557.69	-	2818.65 η_c	7,4	2906.6	-
2954.55 η	10,0	3082.98 J/ψ	6,5	3543.66 χ	7,3	3687.68 ψ'	5,5	3832.21	-	4300.87 beauty	6,4
4315.87 pentaquark	9,0	4436.65 pentaquark	7,2	4496.65 ψ'''	7,2	5642.23 Ξ_b	6,4	6026.01	-	6570.85	-
6666.64	-	7358.75	-	9219.36	-	9499.93 $\mathfrak{R}`$	5,3	10075.8 $\mathfrak{R}``$	6,1	10533.2 $\mathfrak{R}```$	7,0
12941.1	-	16897	-	18035.6	-	18261.3	-	25000.7	-	28935.4	-
33698.9	-	36955.4	-	54518.8	-	71060.4	-	87704.5	-	131517 Higgs	2,2
179100 truth	3,0	266419	-	601983	-	1.20005e6	-	3.4545e6	-	6.96227e7 Dzhan	0,0