ELECTRON, PION and MUON: the RELATION of MASSES

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Masses of a pion m_p = 139.54 *MeV* and a muon m_μ= 105.58 *MeV* are calculated. As input quantity the mass of an electron serves only. The relevant tabulated values are equal 139.57 *MeV* and 105.66 *MeV*. The mass is understood as the module of a total energy of the particle consisting from electromagnetic and strong component. The role of a phase is analyzed during reform of particles. Segments *I* and (*mp* - *I*) form **a golden section** of a pion, where *I* - impulse energy of inverse transmutation of a muon in a pion.

1. A previous history. In transactions of the Larmor, Lorentz and Poincare for 1895-1905 y. [1] the concept according to which the electron is a field object consisting of electromagnetic fields and fields counterpoising them of other nature is submitted. The inertial mass is only a coupling coefficient of energy of a particle with its velocity, and over it there is no real or material mass.

In article [2] author inlets a complex charge with electrical and strong components which module, as against the elementary charge *e*, is a combination of physical constants *h* and *c*; the formula of quantization of masses of fundamental particles is offered also. In the monograph [3] (the bibliography contains 63 names) and paper [4] the author offers model of an electron which stability is stipulated by coexistence in it of the fields peculiar to electromagnetic and strong interactions. Energy of a particle represents the module of the vector possessing electromagnetic component (EC) and strong component (SC). Argument of a vector (phase) defines a relation a component, projections to abscissa axes and ordinates accordingly.

In rest the electron of the Compton size has an electric field with energy E_{0e}= $0{,}5E_0\alpha$, a magnetic field with energy E_{0m}= $0.5E_0\alpha$ so the complete EC is equal E_{0em}=$E_0\alpha$,where E_0 = 0.511 *MeV* - a total energy, and *a* is fine structure constant. Here the first part is stipulated by presence of a Coulomb charge, and second - presence of a natural interior motion with velocity of light *c*. Energy SC is equal $E_{0h} = (E_0^2 - E_{0em}^2)^{1/2} = E_0(1-\alpha^2)^{1/2}$, and the argument will be equal

$$\varphi_0 = \text{arc tan}\,(E_{0h}/E_{0em}) = (\alpha^{-2} - 1)^{1/2}.$$

From last publications, we shall mark F.R.Lipchenko's [5] report in which it is spoken about the key homogeneity of fields nuclear and electromagnetic.

2. An electron and a pion. The electron with mass m_e, moving with velocity *v*, has a momentum *p*, impulse energy *I=pc*, total energy $E = (E_0^2 + I^2)^{1/2}$, relativistic kinetic energy $T = E - E_0$ and kinetic energy $K = 0{,}5m_e v^2$. Then $E_0 = \beta E$, where $\beta = (1 - v^2/c^2)^{1/2}$ - known coefficient. The wavelength of an electron accepted for its size, is proportional β, therefore the electric-field energy density now will be equal E_e=$0{,}5E_0\cdot\alpha/\beta$. Energy of a magnetic field varies neglible a little, as the complete velocity of parts of an electron is always equal *c*. Therefore EC to energy of a propellant electron it will be equal $E_{em} = 0.5 E_0 \alpha (1 + \beta^{-1})$.

On fig 1 the part of a circle *B* has radius $ad = ab = E_0$, the part of circle *A* has the arbitrary radius $ag = ac = E$, a segment of the tangential *G* has length $bg = I$, the length of a segment $bc = T$.

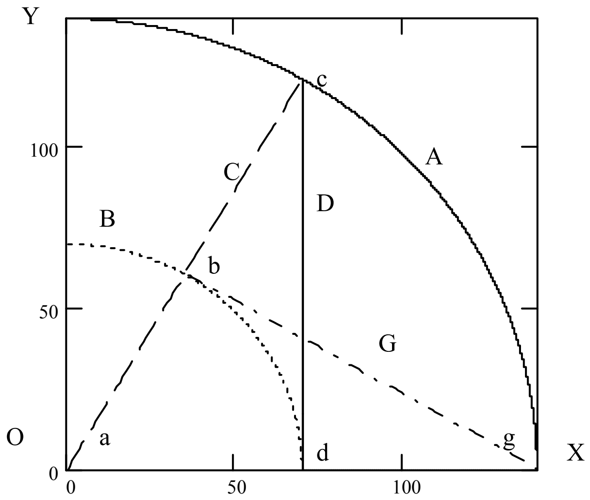


Fig. 1 Scheme of transformation of an electron in a pion

Rectangular triangles *acd* and *abg* are equal among themselves only if the phase $\varphi_1 = \angle cag$ is equal to a phase $\varphi_2 = \angle bag$. Really, in Δabg $\cos \varphi_2 = E_0/E$, that follows from a kinematics. On the other hand, in Δcad $\cos\varphi_1 = E_{em}/E$, that is stipulated by properties of a particle to change a phase at excitation.

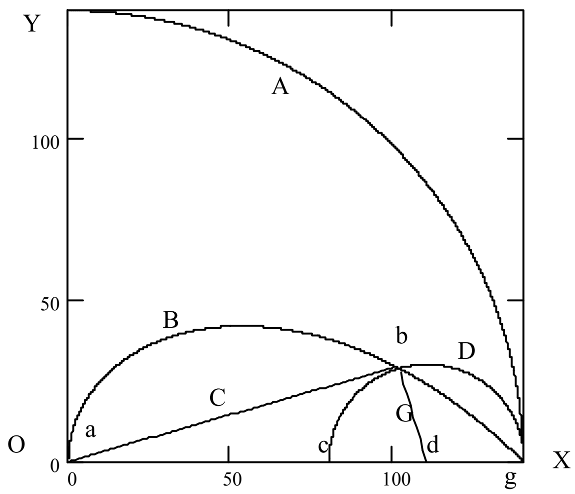
Hence, the requirement $\varphi_1 = \varphi_2$, $E_0 = E_{em}$, that is $\beta = \left(\frac{2}{\alpha} - 1\right)^{-1}$ should be satisfied and the mass of a pion m_p will be equal

$$m_p = m_e \left(\frac{2}{\alpha} - 1\right) = 139.54 \ MeV. \quad (1)$$

Tabulated values: $m_e = 0.511$ *MeV*, $m_p = 139.57$ *MeV*.

Thus, EC a pion *ad* in a standing *ac* it is equal to natural energy of electron E_0.

3. A pion and a muon. We shall consider a decomposition reaction of a pion π in a muon μ and a neutrino ν_μ: $\pi \rightarrow \mu\, \nu_\mu$. On fig 2 a curve *A* - a circle of radius $ag = m_p$ with the equation $y=(m_p^2 - x^2)^{1/2}$, curve *D* - a circle of radius



$p=cd=dg$ with centre in a point *d* and the equation $z=\{p^2-[x-(m_p-p)]^2\}^{1/2}$, a line *C* - a segment *ab* the tangential transiting through an origin of coordinates to curve *D*, line *G*-radius *db*, pairing centre *d* with a point of a tangency *b*.

Fig. 2 Decay scheme of a pion

In the given reaction the momentum *p* is defined by a known relation [6]:

$$p = \frac{m_p^2 - m_\mu^2}{2m_p}, \qquad (2)$$

where m_μ - mass of a muon, for example (factors c^2 at masses and *c* at momentums are dropped).

Energy $gd=p$ carries away a neutrino, and energy $m=ad=m_p-p = ag-dg$ will have a generator muon with a momentum *p*. The natural mass of a muon m_μ after breaking up to a stopping will be equal

$$m_\mu = ab = (ad^2 - bd^2)^{1/2} = (m^2 - p^2)^{1/2} = [m_p(2m - m_p)]^{1/2}. \qquad (3)$$

Then the equation of a curve *B* decay of a pion, defining a standing of a point *b*, will look like:

$$y2 = (m_p - x)\left(\frac{2m_p}{x} - 1\right)^{-1/2}. \qquad (4)$$

On fig. 3 build-up is carried out in actual gauge. Half-rounds *y*1 and *y*11 with radius 0,5 m_p here are added:

$y1 = [(0.5m_p)^2 - (x-0.5m_p)^2]^{1/2} = [(m_p - x)x]^{1/2}$,

$y11 = 0.5m_p + [(0.5m_p)^2 - x^2]^{1/2}$.

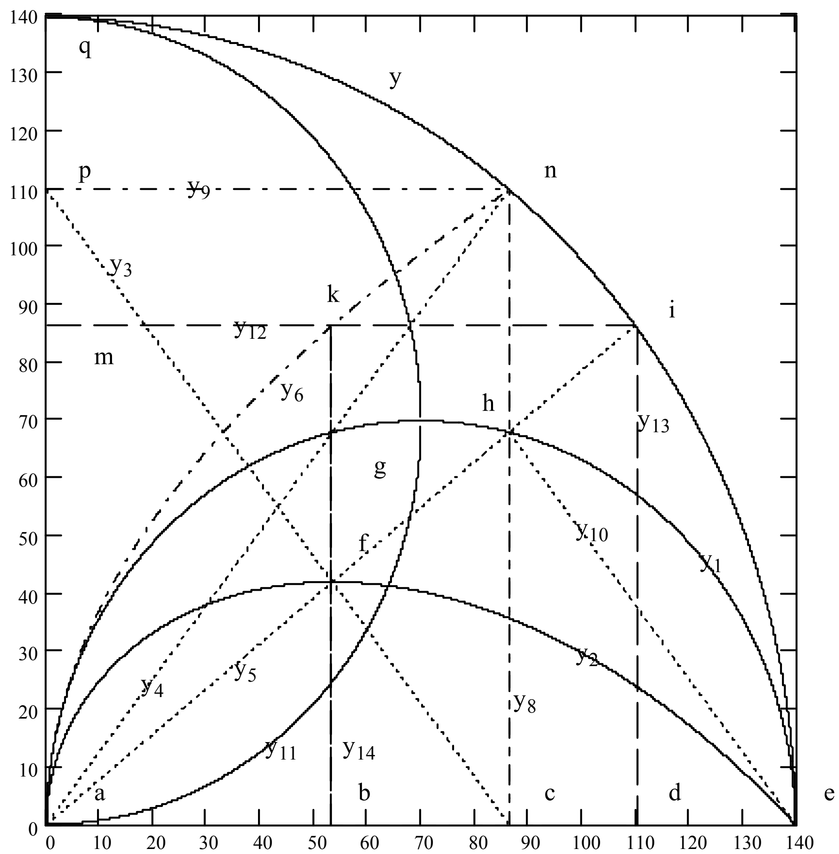


Fig. 3 Scheme of formation of a muon

Function $y1$ defines a standing of vertexes h rectangular triangles ahe, where $ah = m$ mass of a certain initial particle, $he=I$ - its impulse energy, and $m_p=(m^2+I^2)^{1/2}$, if a terminating phase of a pion zero. The curve $y11$ is constructed for a case when this phase is equal 0.5π. Function $y6 = m$ defines on current coordinates a point h ($ac = x$, $hc = y1$).

Values of required mass m:

$$y6=(hc^2+ac^2)^{1/2}=(m_p x)^{1/2} . \qquad (5)$$

On fig 3 quantity *ac* is an abscissa of a point *n*, to blanket functions *y* and *y6*, it is the solution of the equation *y (ac)* = *y6 (ac)*, that is $ac = m_p\Phi$, and required $m = cn = ah = y\ (ac) = m_p\Phi^{½}$, where Φ=0.618… is number of Phydeo.
Let's enter a label $\psi = \angle hac$. Then $\cos\psi = ac/ah = \Phi^{½}$= 0,786151 and ψ =0,6662394. The mass of a muon (3) will be equal these requirements

$$m_\mu = m_p(2\cos\psi - 1)^{1/2} = 105.5856\ MeV, \qquad (6)$$

where m_p=139.56995 *MeV* tabulated value of mass of a pion. Value m_μ given by the formula (6), is close to the experimental quantity 105.6583 *MeV* (the relative diversion equally $7\cdot10^{-4}$).

Why more than 99.98 % of decays of pions fall to reaction of formation of muons? To answer this problem, it is necessary to analyze features of the given build-up.
They are those:

1. For given ψ the equality $\cos^2\psi = tg^2\psi = \sin\psi$ is fulfilled. Therefore the pion from a standing *ia* c a phase ψ has EC $ad=ah=m=m_p\cos\psi$ and SC $id=he=I=m_p\cos^2\psi=ac$, where *ac* is EC particles *m*, and *I* - its impulse energy.

2. The curve *y2* has a maximum a point *f* such, that points *a*, *f*, *h*, *i* lay on one line. The particle with mass $af = m_p\cos^3\psi$ has EC $ab = m_p\cos^4\psi = fc = ce = nd$, equal to a momentum of a neutrino at decay of a pion from a state *ae* with a zero phase, and the momentum *ce* is equal EC to energy *I=he*. Feature of this particle consists also that it has peak SC $fb=m_p\cos^5\psi = nh$. In turn *af=hc*, being blanket SC for particles *m* and *I*.

3. Through a generic point of curves *y*1 and *y*11 the bisector serving as a symmetry axis so for decay of a pion from a standing *na* upwards are interchanged the position EC and SC, therefore $\Delta ahe = \Delta adi = \Delta anc = \Delta apc$, *ag* = *he*, *bk* = *id* transits only at the found phase ψ.

4. The momentum *p=hi=de* is equal to the relativistic kinetic energy *p=T*, therefore the particle with mass *ha* may reach mass *mp* or acceleration on a line *he*, or uptake of a neutrino or a photon on a line *hi*, that is direct transition.

5. The kinetic energy of a particle with mass $ah=m=m_p\cos\psi$ is equal $K = 0{,}5m_pc^2\cos^5\psi$, where $v^2/c^2=1-\beta^2$, and $\beta = \frac{m}{m_p} = \cos\psi$. From here we shall receive $K = 0{,}5m_pc^2\cos^5\psi$, that makes half of quantity found above *fb*, that is SC particles with mass $fa = m_p\cos^3\psi$ = = 67.81 *MeV*, approximately equal half of mass neutral π^0 mesons (67.48 *MeV*).

As $\cos^{s+2}\psi + \cos^{s+4}\psi = \cos^s\psi$ where *s* - the integer, $\cos\psi$ defines corners of triangles, and *s* serves as gauge of their similarity. Similar triangles *ahe*, *ahc*, *hce*, *afb*, *fbc* have s = 0, 1, 2, 3, 4 accordingly, and this series of masses of particles has prolongation in both sides.

4. The inference. The vector representation of energy of elementary particles and introduction of concept of a phase allows viewing processes of reform of particles as well from a position of redistribution of energy between their component fields.

In the given article the requirements oozing a pion from a spectrum of particles which may be born by excitation of an electron are spotted. The analysis of a kinematics of reaction of two-particle decay of a pion enables to justify a dominance of muons among yields of decay. Namely:

1. Quantity m is a mean geometrical mass of a pion and impulse energy

$$m=(m_p \cdot I)^{0.5} = m_p \cdot \cos\psi$$

2. Quantities I and $(m_p - I)$ form **a golden section** of mass of pion

$$I = \sqrt{m_p(m_p - I)} = m_p \sin\psi ,$$

where $\sin\psi = \cos^2\psi = 0{,}618\ldots$ there is number Phideo.

Here I is length of the side of the decagon entered in a circle of radius m_p to that there corresponds a corner 0.2π. A series of phases φ_n it is defined by the formula

$$\sin(0.5\varphi_{n+1})=0.5\sin(\varphi_n), \qquad (7)$$

where n=1,2,3,…, φ_1=1.21243…, $\varphi_6 = \psi$, $\varphi_7=0.2\pi$ and so on. The mass of a kaon is equal

$$m_k=m_p(2\cos(\varphi_6)-1)^{0.5}(1-\cos(\varphi_6))^{-1}=m_p\cos(\varphi_5)(1-\cos(\varphi_6))^{-1} =493.74 \ MeV.$$

The following design values of masses of stable baryons concern only to the indicated channels of decays:

$\Lambda(1115.642)\rightarrow n\gamma$, $\Delta(1231.828)\rightarrow\Lambda\gamma$, $\Sigma^0(1193.718)\rightarrow\Lambda\gamma$, $\Sigma(1195.146)\rightarrow n\pi^-$, $\Xi^0(1316.74) \rightarrow\Sigma^0\gamma$, $\Xi^-(1322.045) \rightarrow\Sigma^-\gamma$, $\Omega^-(1672.579) \rightarrow\Xi^0\pi^-$.

Also in one channel there is a series of the modes relevant to corners φ_n. For example, the meson $f_1(1285) \rightarrow\phi\gamma$ has masses 1211, 1233, 1261, 1297 *MeV* at n=*9*, 8, 7, 6 of what it is easy to be convinced at the analysis of experimental data's.

On fig. 4 build-up of a polygonal spiral with the sides lengths and which diagonals are equal to the mentioned series of cosines, and an equiangular spiral transiting through all salient points and featured by the equation is given

$$R(\phi)=\Phi^{\tau} , \ \tau = \phi - \psi - 0.5\pi . \qquad (8)$$

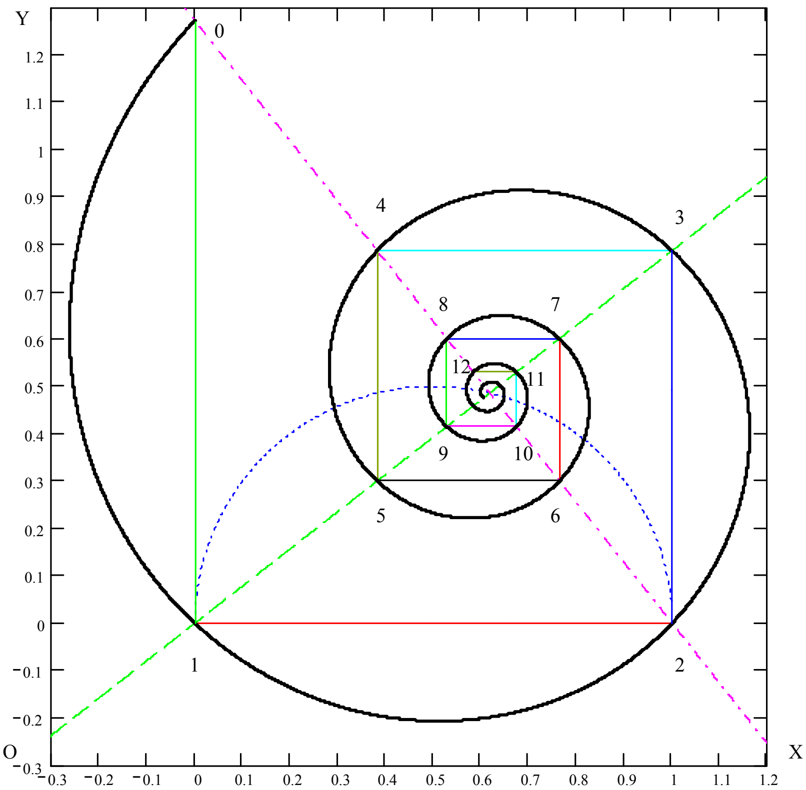


Fig. 4 Standing of points, distances up to which
make the whole degrees cos(φ_6).

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