β^+-Orthopositronium in the "resonance conditions" transforms a two-component Neutrino into true neutral Neutrino. Phenomenology

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The electroweak nature of a true neutral β^+-Orthopositronium with a Long-Range Atom transforms in the "resonance conditions" the two-component Dirac neutrino into true neutral Majorana neutrino. This process expands the Standard Model and, in contrast to the neutrinoless double β-decay, does not violate the law of the *electron* lepton number conservation. A decisive experiment proposed.

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The discovery of the neutrinos mass (Nobel Prize-2015) means the need to expand the Standard Model/*SM*, because in *SM* neutrino is a massless particle with spin ½. This requires a careful analysis of the known concepts of neutrinos in their connection with the experiment. The *SM* adopted the concept of a two-component neutrino with antiparticle (solutions of the relativistic, quantum equation of P. Dirac). In connection with the establishment of the neutrino mass, the concept of E. Majorana (1937), in which the neutrino, as a fermion, is a true neutral particle, is attracting more attention. This would mean expanding the *SM*.

Therefore for experimenters of the non-accelerators physics, the search a neutrinoless double β-decays of the nuclei became of particular interest. This means that in the final state of such decays

$$A(Z,N) \to A(Z \pm 2, N \mp 2) + 2e^{\mp}$$

charged leptons $e^{\mp}$ also carry away the energy of degenerate, true neutral neutrinos:

$$\bar{\nu}_e \equiv \nu_e .$$

More than three dozen even-even isotopes are known, for which double β^--decay is possible (with emission of two electrons and two antineutrinos), and as many even-even isotopes for which double β^+-decay is possible (with emission of two positrons and two neutrinos). The existence in nature of more than dozen Dirac double β^--decays – from $^{48}Ca \to {}^{48}Ti$ to $^{150}Nd \to {}^{150}Sm$ – has already been confirmed by experiment.

There are no generally accepted results for Majorana neutrino double β-decays.

Since neutrino energy must be transferred to charged leptons in neutrinoless double β-decays, the isotopes with the highest double β-decay energy are selected from this array. In these searches, the main problem is the background, so the double β^+-decays are excluded from the search base.

At present a number of facilities for observing neutrinoless double β^--decays are in operation, being construction and designed.

For a decade at depth of 1,5 km, an "ultra-clean" laboratory was built and put into operation (South Dakota, USA – Majorana Demonstrator/MJD Project [1]. The construction is completed, and the latest MJD results so far demonstrate only success in studying the "background" [2].

In this regard, let us again turn to the hypothesis of "vertical" neutrino oscillations (without changing the flavor) [3-5], in contrast to the "horizontal" neutrino oscillation established by the Nobeliates-2015 with changes in neutrino flavors $\nu_e \Leftrightarrow \nu_\mu, \nu_\tau$. This hypothesis was formulated [4] after observing the paradoxical realization of the Mössbauer effect in "resonance conditions"

$$^{22}Na(3^+) \xrightarrow{e^+_\beta + \nu_e + U^\pm} {}^{22*}Ne(2^+) \xrightarrow{\gamma_n} {}^{22}Ne(0^+)$$ – gaseous neon (8.86% ^{22}*Ne*).

The interpretation of “vertical” oscillations based on the idea of the metamorphoses of the Dirac neutrino into Majorana neutrino arose after reading of the letter in Progress in Physics [6]. This is possible when a complete degenerate β^+-ortho-parasuperpositronium [7], as a true neutral supersymmetric quantum system, substantively formalizes the status of a physical observer in the presence of Long-Range Atom/*LRA* (number of nodes/cells $N^{(3)} \cong 1.3\cdot 10^{19}$) with *LRA Core* ($\bar{n} \cong 5.3\cdot 10^{4}$), when open for neutrinos a limited macroscopic, two-digit/$\pm$ 4-volume of space-time “outside” the Light Cone.

The irony of the history of the β^+-orthopositronium anomalies is that the Michigan group of experimenters published fifteen years ago an article [8] in which they disavowed the results of their previous precision measurements (1982-1990) that came into conflict with theory (QED), and thus “closed” the problem for the scientific community.

An alternative to this ambiguous solution is presented in the preprint [9].

The proximity of the values of the nuclear γ_n-quant energy

$$E_{\gamma_n} = 1.274577\ \text{МэВ (Nuclear Data Sheets, 2005, v.106, №1, p.12)},$$

for registering the moment of β^+-decay (the emission of a positron e^+_β and neutrino ν_e) in the lifetime method of studying of the β^+-decay positrons annihilation, and of the mass difference between the neutron and proton

$$\Delta m_{np}c^2 = m_n c^2 - m_p c^2 = 1.2933317 \pm 0.0000005\ \text{MeV (W.-M.Yao et al., J. Phys. G 2006, v.33, p.1)},$$

in *SM* it seems random. This fact, with the inclusion of the *LRA* in the final state of topological quantum transitions, allows us to raise the question on the physical nature of the “resonance conditions”.

Comparison E_{γ_n} with $\Delta m_{np}c^2$ in the “resonance conditions” is assumes a twofold resonance.

Nevertheless, between energy E_{γ_n} and $\Delta m_{np}c^2$ there is a significant difference $\Delta m_{np}c^2 - E_{\gamma_n} = 18.7547\ \text{keV}$.

The question arises about the width of the prospective twofold resonance. The presence of protons (quasiparticles) in each of the nodes of the spatial lattice of the *LRD Core* and the binding ^{22}Ne nuclei of atoms from the gas medium [5[2018]] is the response of a unified field on the topological quantum transition, like a bias current in electrodynamics [9]. The difference is fundamentally, and consists in space-like structure of this response.

When bonding due to the exchange of proton-proton interaction at the $\bar{n}$ nodes of the space-like lattice of the *LRA Core* ^{22}Ne nuclei of neon atoms from a gas at laboratory temperature, the energy

$$\bar{n}\cdot\frac{3}{2}kT \cong 2\ \text{keV (the gas temperature } T \cong 300\,\text{K)} \qquad (1)$$

is frozen for a lifetime of β^+-*o-Ps*.

There is prospect of associating the difference $\Delta m_{np}c^2 - E_{\gamma_n}$ with the resonance of the response energy, since the neutrino in the final state of the transition

$$^{22}Na(3^+) \to {}^{22*}Ne(2^+) + e^+_\beta + \nu_e$$

as well as β^+-*o-Ps* (through a solitary virtual photon) during its time of life also participates in oscillations “inside-outside” of the Light Cone $\nu_e \Leftrightarrow \nu_e^{/}$ [10, 11].

In these oscillation the neutrino retains its flavor (positron neutrino), but acquires an effective (topological) mass, as is characteristic of the transformations of the “left-right particles” in topological quantum transitions [12]. Then the excess mass difference can be represented as

$$\Delta m_{np}c^2 - E_{\gamma_n} = \bar{n}\cdot\frac{3}{2}kT + m^{eff}_{\nu_e} \cong 18.7547\ \text{keV} \qquad (2).$$

From (1) and (2) we find $m^{eff}_{\nu_e} \cong 16.75\ \text{keV}$.

Interestingly, that the effective mass $m^{eff}_{\nu_e}$ is close to the mass of a heavy 17 keV neutrino (a brief overview problem in [13]). An experimental study of this issue, initially very encouraging (1985-1991), was interrupted after a series of works with alternative methods and negative results (1991-1993). The dramatic history of the experimental study of the 17 keV neutrino is similar to the history of the problem of orthopositronium [8, 13].

The closeness of the values E_{γ_n} and $\Delta m_{np}c^2$ led to a new proposal of the experiment, which is called upon to confirm (or refute) the alleged physical nature of the "resonance conditions" as a *twofold delayed resonance*. The point is that in the energy response (2) there is a term depending on the gas temperature. Consequently, the uncertainty of the temperature of the measuring chamber of the order $\Delta T \cong 10^{\circ}$, quite probable under laboratory conditions, can testify to a different degree nearness of temperature of the measuring chamber in the works [14-18] around of a source of positrons in the radius

$$r_{\bar{n}} = \Delta \cdot \sqrt[3]{\frac{3\bar{n}}{4\pi}} \cong 1{,}3 \text{ cm}$$

to the temperature peak *of the twofold resonance*.

It can cause of the uncertainty in the visualization of the shoulder (its "blurring" [19]) and the extremely wide scatter of its quantitative characteristics $t_S \cdot p$ ns·atm. Thus, the expected width of the twofold resonance is $\delta_T \cong 10^{-3}$ eV.

The statement of a decisive experiment is obvious: it is necessary to compare the lifetime spectra of positron annihilation from ^{22}Na in high-purity neon gas in an enough wide intervals of temperature with accuracy ~ 3°.

The observation by the method $\gamma_n - \gamma_a$ delayed coincidence high intensity of the lifetime spectra of orthopositronium component (***I***$_2$) and (after its subtraction) more and more precise visualization of a shoulder at removal from "peak" temperature on tails of a temperature range is expected, i.e. normalization by this criterion of the neon position in the set of the inert gases (see Ref. [14]). As the peak of a temperature resonance is approached, decrease ***I***$_2$ is supposed (up to 2 times; see [3]) and, accordingly, blurring of a shoulder, as takes place according the works [14-18], in which the temperature of the measuring chamber was not fixed. This effect is most pronounced on a positive branch of a temperature resonance, as with decrease the temperature the role of the van der Waals molecules $Ne \cdots Ne$ grows, and the mechanism of the shoulder formation varies, because non-elastic scattering of the e^{+}_{β} increased.

The expected result would mean the existence of an additional mode of β^{+}-orthopositronium annihilation formed by β^{+}-decay positrons

$$\beta^{+}\text{-}^{T}Ps \rightarrow \gamma^{\circ}/2\gamma^{\prime} \cdot U^{\pm},$$

where *LRA* ($U^{\pm}$) could claim the role of the ninth massless pseudoGoldstone boson with all the consequences of this restoration of chirality in a limited 4-volume space-time of final state β^{+}-decay of type $\Delta J^{\pi} = 1^{\pi}$:

"*Physically, non-conservation of chirality in quantum chromodynamics is manifest in the absence in nature of a ninth light pseudoscalar boson, analogous to the octet* $\pi^{\pm}, \pi^{0}, K^{\pm}, K^{0}, \overline{K}^{0}, \eta$. <...> *If the symmetry group were the group* $SU(3)_L \times SU(3)_R \times U(1)_L \times U(1)_R$ *then there have to be a ninth pseudo-Goldstone boson. Its absence is direct experimental proof of the non-conservation of chirality* (*non-invariance under* $U(1)_{L-R}$) *in quantum chromodynamics*" [20].

The Project of a New (Additional) *Għ/ck* -Physics "Outside" the Light Cone by including in theory the *LRA* with the *LRA Core* as massless and space-like quasiparticles, means the extension of *SM*.

As R. Feynman remarked long ago ("… *following the proposal of Gell-Mann*") "… *Yang-Mills theory is clearly not engaged in a massless field that would have to leave the nucleus and be noticeable. Therefore, theorists have not carefully studied the massless case*" [21].

Of course, such an expansion of *QCD* does not violate the "color" confinement; however, it retains the functional status of a strong (nuclear) interaction, when its carrier is a quasiparticles-proton ($\overline{p}$) at the nodes of the $U^{\pm}$.

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