Supersymmetry, β^+-Orthopositronium
and
Electroweak Interaction in the Theory of Everything. Phenomenology.

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On an experimental base – USA/1956, 1965; Russia/1967; USA/1975, England/1975, Canada/1975 and the Critical Experiment (Russia/1987) – it is possible to formulate the addition of supersymmetry ("β^+-*supersymmetry*") in the low-energy limit for products β^+-decay and orthopositronium formed in matter by β^+-decay positrons (β^+ - o - Ps).

β^+-supersymmetry is considered as a consequence of the Majorana fermion theory and the expansion of physical space-time "outside" the light cone (instead of the counterproductive phenomenology "tachyon"). This also makes it possible to complement in the low-energy limit the phenomenology of the electroweak interaction in the Theory of Everything.

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Positronium (*Ps*) by its physical nature is a *composite truly neutral vacuum system* of an electron (*e*) and a positron (e^+), since fluctuation of the physical vacuum allow the birth of "out of nothing" of virtual pair (e- e^+) during the time

$$\delta t_{e^+e} \cong \frac{\hbar}{2m_e c^2} \sim 10^{-21}\,\text{s}.$$

The time of the virtual pair of another stable ingredient of matter – proton (*p*) is

$$\delta t_{p^-p} \cong \frac{\hbar}{2m_p c^2} \sim 5\cdot 10^{-25}\,\text{s}.$$

The question is arises: what excludes the birth of a virtual pair (e- e^+) in a bound state – *Ps*?

Since all vacuum quantum numbers are identically zero, in the quantum electrodynamics/*QED* virtual positronium is excluded by hyperfine splitting of the *Ps* levels, which is characterized by an increase in the ground state energy (n = 1) of the triplet positronium (spin 1) on $\Delta^3 W = \frac{1}{3}\alpha^4 m_e c^2$ and a decrease in singlet positronium energy (spin 0) on $\Delta^1 W = -\frac{1}{4}\alpha^4 m_e c^2$.

As can be seen, the hyperfine splitting of the ground states of *Ps* (1^1Ps_0 и 1^3Ps_1) with an accuracy of to electrodynamic corrections is equal to:

$$\Delta W = {}^3W - {}^1W = \frac{7}{12}\alpha^4 m_e c^2 \cong 8.4\cdot 10^{-4}\,\text{eV}.$$

In *supersymmetric QED*/*SQED* the hyperfine splitting of the para- and ortho-states of the *Ps* is compensated – the precedent is formulated in [1]: "… *in the case of the supersymmetric N* = 2 *QED we find complete degeneracy for para- and ortho-superpositronium*".

Therefore, the ability to interpret and adopt supersymmetry in the low-energy limit [1] gives education of the β^+ - Ps in the final state of the β^+-decay – β^+ - o - $Ps \Leftrightarrow \beta^+$ - p - Ps', which substantiates the **Project of a New (Additional)** $G\hbar/ck$ **-Physics "Outside" the Light Cone** [2].

Searches for the effect of supersymmetry realization since the discovery of the mathematical formulation (1971), the subsequent rediscovery and recognition of it by the mid-1970s, were carried out and continue on giant accelerators. It is assumed that the superpartners of elementary particles and the effects due to them can be observed at ultrahigh energies. So far unsuccessfully.

The generally accepted representation of supersymmetry is formulated on **Wikipedia** (01.03.2019 – in Russian):

"*It is perfectly established* (!? – *B.L.*) *that our world is not supersymmetric in the sense of exact symmetry, since in any supersymmetric model, fermions and bosons associated with a supersymmetric transformation must have the same mass and charge and other quantum numbers* (*except for the spin*) – underlined, *B.L.* This requirement is not fulfilled for particles known in nature".

All *non-composite truly neutral particles are bosons*. Essentially, the supersymmetry formulation corresponding to the low-energy limit was presented by E. Majorana in the theory of *truly neutral fermions* [3], when yet there were no accelerators of elementary particle, and the coupled electron-positron system already was postulated (S. Mohorovicic, 1934), later called "positronium".

This addition of the problem of supersymmetry will be further represented as "β^+*-supersymmetry*" in accordance with previously reasonable "local" causality [4].

In the Project of the new (additional) $G\hbar/ck$ -physics "outside" the light cone a two-digit Planck mass $\pm M_{Pl} = \pm\sqrt{\frac{(\pm\hbar)\cdot(\pm c)}{G}}$ becomes real, due to the fact that in the final state of β^+-decay of nuclei of the type $\Delta J^{\pi} = 1^{\pi}$ (^{22}Na, ^{64}Cu, ^{68}Ga, etc.) each of the lattice nodes of the Hamiltonian graph filling limited volume of space-time "outside" the light cone – $U^{\pm}$ (in the development of the fundamental idea of E.B. Gliner [5] about *vacuum-like states of matter* – a positive/"+" ingredient of the *atom long-range action/ALRA-*$U^{\pm}$) contains a quasi-proton ($\overline{p}$) and quasi-electron ($\overline{e}$), and **the masses quasiparticles are equal to the masses of the corresponding stable matter particles**. It defines the nature of dark matter/dark energy [6].

In the nodes of the compensating lattice $U^{\pm}$/«–» there are, respectively, a *quasi-antiproton* ($\overline{p}^{\,-}$) and a *quasi-positron* ($\overline{e}^{\,+}$). In a gravitational field of sufficient force, baryon charges are released at the nodes of the core of the *ALRA* ($\overline{p}\setminus\overline{p}^{-} : \overline{n} \cong 5.278\cdot 10^4$) – dark matter [2] and the interaction of ordinary matter with dark matter become possible due to compensation of the Coulomb barrier by the $U^{\pm}_{-}$-lattice [7] and through exchange $p(^{22}Ne)$ - $p(U^{\pm}_{+})$-interaction.

Obviously, the lifetime of the *ALRA* vacuum structure in the final state of the β^+-decay of nuclei of type $\Delta J^{\pi} = 1^{\pi}$ (dark matter/dark energy) is unlimited:

$$t_{\pm M_{Pl}} \sim \frac{\hbar}{(\pm M_{Pl})c^2} \to \infty,$$

and the quasiparticles in the *ALRA* nodes should recognize Majorana fermions, respectively, $\overline{p}_M$, $\overline{e}_M$ and $\overline{p}^{-}_M$, $\overline{e}^{+}_M$.

It turns out that, due to the two-valued Planck mass, the energy of ~ 10^{28}eV is realized in corresponding β^+-decays. Such energy cannot be achieved by accelerators of elementary particles. This means that the generally accepted, emphasized above categorical judgment from **Wikipedia** may turn out to be false. This is evidenced by critical experiment with $\beta^+ - \mathrm{o} - Ps$ [8], which confirmed the paradoxical realization of the Mössbauer effect in the "^{22}*Na*-gaseous neon of natural isotopic composition (~9% ^{22}*Ne*)" system in "resonance conditions".

The incompleteness of the modern Standard Model/*SM* (in stagnation since the mid-1970s) is also visible in the state of the theory electro-weak interaction:

Wikipedia (08.03.2018 – in Russian): "*In elementary particle physics electroweak interaction is a general description of two of the four fundamental interactions*: *the weak and electromagnetic interaction. Although these two interactions are very different at ordinary low energies*, *in theory they appear as two different manifestations of the same interaction. At energies above the unification energy* (*of the order of* 100 GeV), *they unite into a single electroweak interaction*".

It follows that in the low-energy limit the electromagnetic interactions is not associated with weak interaction, and only $\beta^+ - \mathrm{o} - Ps$ as a model of a physical observer can justify the restoration of their unified nature (due to the presence of virtual single-photon annihilation in its dynamics). Observation of this is possible by the lifetime method (γ_n - γ_a -delayed coincidence) [8] through compensating half energy of the annihilation γ_a-quantum ($\cong 1.022$ MeV) by a quasi-positron $\bar{e}_M^+$ in the node of the compensating lattice/"–" of the *ALRA*.

The initial positron $e_{D\Rightarrow M}^+$ and neutrino $\nu_{D\Rightarrow M}$ are born as Dirac fermions, but they accompany oscillation β^+ - o - *Ps* "through the looking glass" and transfers to Majorana fermions (truly neutral fermions), and the electron e_D in the composition β^+ - o - *Ps* is Dirac fermion

$$^{22}Na\,(3^+)\xrightarrow{e_{D\Rightarrow M}^+ + \nu_{D\Rightarrow M}(m_{\nu_M}\sim 17\,\mathrm{KeV}) + U_M^{\pm}} {}^{22*}Ne(2^+)$$

$$\gamma_n\,(\cong 1.274\mathrm{MeV})\ 8.86\%\,{}^{22}Ne(0^+)\,\lrcorner$$

$$e_{D\Rightarrow M}^+ + e_D \rightarrow \beta^+ - o - Ps \xrightarrow{\gamma_a(\cong 1.022\,\mathrm{MeV})} \bar{e}_M^+ \rightarrow \gamma_a(\cong 0.511\mathrm{MeV}).$$

It is not known how P. Dirac reacted to the alternative proposed by E. Majorana [3], but in the headings of the works list of P.A.M. Dirac (from 1937 to 1984) name of E. Majorana is absent [9].

In the presented phenomenology of the Theory of Everything, truly neutral Majorana fermions do not require the abandonment of the law of conservation of the lepton number, as is necessary when setting up experiments to search for neutrinoless double decay and neutrino-antineutrino oscillations.

All this means that in the Project of the new (additional) $G\hbar/ck$ -physics "outside" the light cone P. Dirac and E. Majorana are presented "on an equal footing".

Everything will determined by the implementation of the Program Decisive Experiment [10].

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