Atom of Long-Range Action Instead of Counter-Productive Tachyon Phenomenology. Decisive Experiment of the New (Additional) Phenomenology Outside of the Light Cone

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Limited, ultramicroscopic action radii of weak (~ 10^{-16} cm) and baryon (~ 10^{-13} cm) charges (interactions) against unlimited action radii of electrical and gravitational ones are the basis of phenomenology explaining the anomalies of positron annihilation in the "positron beta-decay Na-22 — neon (~9% Ne-22)" system established experimentally (1956–2003). A priori, it was impossible to imagine that the study of positron beta-decay positron annihilation (Na-22, Cu-64, and Ga-68) in noble gases would rise the issue of overcoming stagnation of fundamental physics (from mid-1970's) on the way to the expansion of the Standard Model and unification of physical interactions.

In noble (and any monoatomic) gases, slowing of positrons (e^+) under the positronium formation threshold (Ps; $E_{e^+} < E_0 = I - 6.8$ eV, where I is the atom ionization potential and 6.8 eV is the binding energy of Ps) is only possible through elastic collisions with atoms and may be observed, since: first, it is relatively long process (small parameter $\zeta = 2m_e/M$, where m_e is the positron mass and M is the atomic mass); and secondly, when the positron slows down to certain energy E_1 (determined by the inequalities $E_0 \gg E_1 \gg kT \cong 0.025$ eV) the positron annihilation rate rises more or less sharply, depending on the atomic number Z, as the positron polarize outermost electron shell of the atom. The combined effect of these two factors creates a non-exponential feature, the so-called *shoulder* in the time spectra of positron annihilation in inert gases (delayed $\gamma_n - \gamma_a$-coincidences; where γ_n is the nuclear gamma-quantum of the daughter nucleus after the β^+-decay of $^{22}\mathrm{Na} \xrightarrow{e^+_\beta+\nu} {}^{22*}\mathrm{Ne} \xrightarrow{E_{\gamma n}\cong 1.28\mathrm{MeV}} {}^{22}\mathrm{Ne}$)/"start", γ_a is one of the annihilation gamma-quanta/"stop"). The simplified theory of elastic slowing down says that the product of the shoulder length t_s and gas density (pressure, p) is the constant $t_s \times p$ for inert gas. In approximation of ideas gas, the constant is dependent on its parameters according to the following formula

$$(t_s \times p)_Z \cong \frac{\sqrt{2m_e}}{2.7 \times 10^{19}\,\sigma_e \zeta}\left(\frac{1}{\sqrt{E_1}} - \frac{1}{\sqrt{E_0}}\right),$$

where σ_e is the averaged cross section of elastic scattering of positrons [1].

When comparing lifetime charts of positrons of β^+-decay ^{22}Na for the entire range of noble gases, we cannot but notice the absence (or blurring) of the shoulder in neon [2]. Annihilation of *quasi-free positrons* after the shoulder with rate Λ depends on the number of electrons in the outermost shell of atom (Z_V). Value of Λ are shown in Table 1 [2]:

Table 1:

Noble gas	Λ, $\mu\mathrm{sec}^{-1} \times \mathrm{atm}^{-1}$	Z_V
Xenon (Xe)	26.3	8
Kripton (Kr)	5.78	8
Argon (Ar)	2.78	8
Neon (Ne)	0.661	8
Helium (He)	0.453	2

The chart $\Lambda/Z_V(Z)$ shown that neon falls out of the general monotonic dependence (Fig.1).

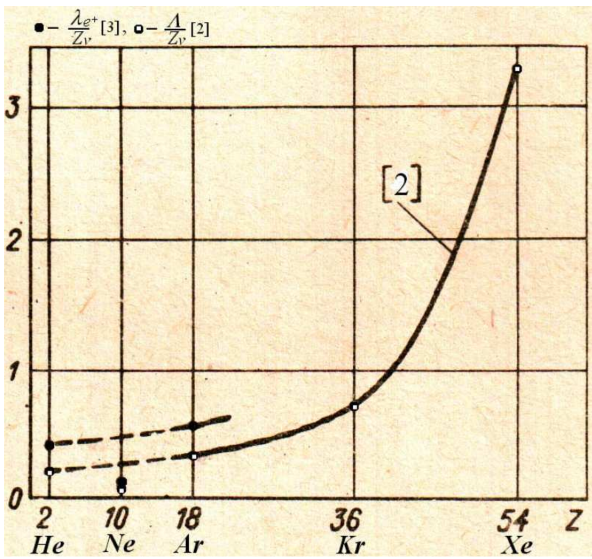

Fig. 1: Dependence of λ_{e^+}/Z_V [3] and Λ/Z_V [2] on Z (the atomic number of inert gas), where Z_V is the number of electrons in the outermost atomic shell.

Blurring of the shoulder in neon has been confirmed in other laboratories [3–7]. All these experiments showed different degrees of blurring. It should be noted in this regard that the shape of the shoulder is influenced by the orthopositronium ($o-$Ps, ^{T}Ps) component of the lifetime spectrum (I_2), following the component of annihilation of quasi-free positrons (e^+_β) on the time axis. Special features of neon individuating it in terms of measurements in the range of inert gases also include the following:

1. There is a big difference (twofold) in the data on the portion of positrons forming Ps in neon, obtained by the lifetime method with ^{22}Na as the source of positrons ($f = (28 \pm 3)\%$ [3] and $f = 26\%$ [8]) and by another method, i.e. according the energy spectrum of annihilation γ_a-quanta with ^{64}Cu as the source of positrons ($f = (55 \pm 6)\%$ [9]). This discrepancy between the results of independent experiments was noted in [7]. However, it was not discussed because of the lack of any basis for its explanation.
   In note [10], we have drawn attention to the fact that the start in the lifetime method is marked by the detection of the nuclear γ_n-quantum from transition of the excited daughter nucleus of ^{22*}Ne to the ground state of ^{22}Ne ($E_{\gamma_n} \cong 1.28$ MeV). This method usually provides high-precision measurements of the time spectra, since the lifetime of the excited state ^{22*}Ne($E2$) $\tau^* \cong 4 \times 10^{-12}$ s is considerably less than the resolving time of a spectrometer $\tau \sim 10^{-9}$ s.
   Hence, the question suggested itself in respect of the measurements in neon – whether the destiny of marker γ_n-quantum accompanying β^+-decay of ^{22}Na could be affected to some extent by high concentration of atoms with non-excited identical nuclei (~ 9% ^{22}Ne)? In argon, where such a question is impossible, these different measurement methods provide consistent ($f = (30 \pm 3)\%$ [3] and $f = (36 \pm 6)\%$ [9]).
2. In contrast to helium and argon [7], there is large difference between experimental values of the constant characterizing the shoulder in neon $t_s \times p = 500 \div 900$ ns×atm [3] (see also [4, 7]), $t_s \times p = 2200 \pm 6\%$ ns×atm [5] and $t_s \times p = 1700 \pm 200$ ns×atm [6]. The discrepancy between shoulder lengths may be an indication of the difference between neon samples in impurities of polyatomic gases. Nevertheless, authors characterized neon as *high purity* gas in all measurements. On the other hand, almost double the difference in shoulder length in measurements with the same sample of neon [3] (see also [4, 7]) also shows another uncontrollable cause of such a big difference in $t_s \times p$ neon in all measurements with ^{22}Na as the source of positrons [2–6].
3. There is also a strong discrepancy between the data on the cross section of elastic scattering of positrons under the threshold of formation of Ps obtained with beams of slow positrons using the lifetime method (with ^{22}Na as the positron source). Even the greatest of the values of the constant $t_s \times p$ in neon, obtained in work [5], is almost three times less than the estimated one, if we use the cross section of elastic scattering of positrons in neon are in full compliance with the theory and with results of beam experiments [11, 12].

All the experimental results of special manifestations of annihilation in the "β^+-decay ^{22}Na – neon (~ 9% ^{22}Ne)" system were presented at the 7th Conference of Positron Annihilation (ICPA-7) [13].

A critical experiment (*falsification* by Karl Popper) was performed a decade after the publication of a proposal for experimental verification of the paradoxical idea of nuclear gamma-resonance in *gaseous* neon of natural isotopic compositions [10]. The successful experiment [14], which confirmed the paradoxical implementation of the Mössbauer Effect in gas in final state of β^+-decay $^{22}\mathrm{Na}(3^+) \xrightarrow{e^+_\beta + \nu} {}^{22*}\mathrm{Ne}(2^+)$ opened the prospect of building a phenomenology of extension of the Standard Model [15] in the suggestion that the limited four-dimensional space-time of the final state of β^+-decay of this type ($\Delta J^\pi = 1^\pi$) is topologically non-equivalent to the initial state (the *topological quantum transition*). With this in mind, let us denote the orthopositronium formed in the gas by the β^+-decay positron as β^+-orthopositronium: $^3(e^+_\beta e^-)_1$.

Since there is an *isolated virtual photon* $\widetilde{\gamma}$ in $o-$Ps dynamics, there is a possibility that the β^+-orthopositronium may overcome the *light barrier* due to quantum-mechanical oscillations. Hence we have sensing of four-dimensional space-time "on the outside" of the light cone and, consequently, an additional (single quantum) mode of annihilation involving a double-valued (±) space-like structure. The existence of the Planck mass $\pm M_{Pl} = \pm(\hbar c/G)^{1/2}$ opens a unique opportunity to represent a macroscopic space-like structure.

The phenomenology of physical nature of "resonance conditions" in the "β^+-decay ^{22}Na — neon (~ 9% ^{22}Ne)" system formulated in [15]* leads to the conclusion that the uncontrollable factor in all neon measurements is the gas temperature (laboratory temperature). This means that deciding experiment aiming to confirm double resonance I_2 within the range ±30°C (see below) is out of the question in Standard Model.

Theorists have been independently (for their own reasons) probing the possibility of going beyond the Standard Model:

*The Michigan group have renounced their results in the β^+-o-Ps self-annihilation rate by $(0.19 \pm 0.02 \div 0.14 \pm 0.023)$ percent over the theoretical value (*QED*) [16]. The findings of this work are most likely to be erroneous, since they were obtained by introducing an auxiliary electric field into the space of the measuring chamber. The field might "obscure" the effect. Fairly speaking, the work-2003 by the Michigan group has also played a constructive role. It destructive conclusions made it possible to detect and substantiate the fundamental link between gravity and electricity [17] — the cause of the erroneous nature of the conclusion made by the Michigan group, who did not have all the experimental data available by the time [14]. *A decisive experiment is needed.*

1. **Lev Landau** at the International Conference on High Energy Physics (Kiev, 1959) spoke about the limited perspective of the *Hamiltonian method* for strong interactions (the text of the presentation was included in the collection of articles in memory of **Wolfgang Pauli**, 1962) [18].
   Although quantum chromodynamics (QCD) was formulated in the framework of the *Hamiltonian method* in the 1960s–1970s, it did not solve the problem of strong interactions (the absence of fundamental justification of *confinement*), and the problem of the fundamental interactions unification (*Theory of Everything*) was complicated by mysterious nature of *dark matter* and *dark energy* ($\sim$ 95% of the Universe);

2. **R. F. Feynman [19]:** "At the suggestion of Gell-Mann I looked at the theory Yang-Mills with zero mass [...] it should been noticed by meson physicists who had been fooling around the Yang-Mills theory. They had not noticed it because they're practical, and the Yang-Mills theory with zero mass obviously does not exist, because a zero mass field would be obvious; it would come out of nuclei right away. So they didn't take the case of zero mass and no investigate it carefully";

3. **F. Hoyle and J. V. Narlikar** considered discrete scalar C-field with negative mass density [20]. This allowed presenting the final state of the topological quantum transition in β^+-decay of ^{22}Na (and the like) as a vacuum structure $U^\pm$, in which the space-like negative mass is balanced by the vacuum-like state of matter (an *atom of long-range action with a nucleus*). That is β^+-decay of $^{22}\mathrm{Na}(3^+) \xrightarrow{e^+_\beta+\nu} {}^{22}\mathrm{Ne}(2^+)$ under expansion of the Standard Model will be $^{22}\mathrm{Na}(3^+) \xrightarrow{e^+_\beta+\nu+U^\pm} {}^{22*}\mathrm{Ne}(2^+)$;

4. **E. B. Gliner [21]:** "The physical interpretation of some algebraic structures of the energy-momentum tensor allows us to suppose that there is a possible form of matter, called the μ-vacuum, which macroscopically possesses the properties of vacuum. [...] Because of the multiplicity of the comoving reference systems we cannot introduce the concept of localization of an element of μ-vacuum matter, and consequently cannot introduce the concepts of particle and of the number of particles of the μ-vacuum in a given volume, if we understand by a particle an object singled out in a classical sense relative to the remaining "part" of the matter. Similarly, one cannot introduce the classical concept of a photon".
   Views on β^+-decay of the type $\Delta J^\pi = 1^\pi$, $^{22}\mathrm{Na}(3^+) \rightarrow {}^{22}\mathrm{Ne}(2^+)$, $^{64}\mathrm{Cu}(1^+) \rightarrow {}^{64}\mathrm{Ni}(0^+)$, $^{64}\mathrm{Ga}(1^+) \rightarrow {}^{68}\mathrm{Zn}(0^+)$ in the Standard Model's expansion $^{22}\mathrm{Na}(3^+) \xrightarrow{e^+_\beta+\nu+U^\pm} {}^{22*}\mathrm{Ne}(2^+)$ (see item 3 above) was based on Gliner's cosmological ideas;

5. **V. I. Ogievetskii and I. V. Polubarinov** discussed the *notoph* in [22]: "... a massless particle with zero helicity, additional on the properties to photon. In interactions notoph, as well as photon, transfers spin 1".
   This makes possible to postulate an additional mode of annihilation of β^+-*o*-Ps by one notoph (γ°) $\beta^+ - {}^{\mathrm{T}}\mathrm{Ps} \rightarrow \gamma^\circ U^\pm$ (see items 3 and 4 above). Annihilation of *o*-Ps by one photon is prohibited in *QED* by the law of conservation of momentum;

6. **G. J. Iverson and G. Mack [23]** on the possibility of the space-like nature of some types of neutrinos;

7. **V. L. Lyuboshits and M. I. Podgoretskii** about the identity of elementary particles; the mirror world outside context of the P and CP violation [24].
   This opened the possibility of consideration of β^+-*o*-Ps oscillations in the mirror world, as Ps *initially is object of quantum electrodynamics* (electromagnetic interactions) preserving the P and CP symmetries, while the mirror was considered in the context of their violation under weak interactions;

8. **Yu. A. Golfand and E. P. Likhtman** discovered the mathematical structure of supersymmetry [25].
   Since the mid-1970s no common physical realization of supersymmetry has been found;

9. **S. W. Hawking and C. F. R. Ellis [26]:** "... the simultaneous creation of quanta of positive energy fields and of the negative energy C-field".
   This justifies the postulation of $U^\pm$ on an experimental basis [2–6, 9, 14, 15] (see item 3 above);

10. **J. L. Synge [27]:** "Anti-Compton scattering" — the idea that was not seen by the author as a physical concept — was developed in [28] to justify additional realization of supersymmetry (*superantipodal symmetry*) manifested in lifetime anomalies of β^+(^{22}Na)-*o*-Ps in neon;

11. **A. F. Andreev:** "Gravitational Interaction of Zero-Mass Particles", "Macroscopic Bodies with Zero Rest Mass" [29]; complete relativity, i.e. equivalence of "... all speeds (but speed of light)" [30].
    This was the first quantum-field justification of space-like fundamental structures previously postulated on the basis of general theory of relativity (the μ-vacuum concept, see item 4 above);

12. **P. Fayet and M. Mezard [31]:** Calculation of the probability of *o*-Ps annihilation by a single γ_a-quantum and a neutral supersymmetric gauge boson U with spin 1: $B(^{\mathrm{T}}\mathrm{Ps}) \rightarrow \gamma_a U = 3.5 \times 10^{-8}(1 - x^4)$, where $x = m_U/m_e \rightarrow 0$, m_e standing for the electron (positron) mass;

13. **P. Di Vecchia and V. Schuchhardt [32]:** complete degeneration of $N = 2$ para- and orthosuperpositronium.
    This has set a precedent of complete degeneration of para- and orthopositronium while maintaining superantipodal symmetry in the final state of β^+-decay ^{22}Na

and others. We know that conservation of full spin Ps is unequivocal law, not related to approximation. It follows from the CP-invariance of electromagnetic interactions, while the annihilation modes (the even number of γ_a-quanta for parapositronium ^{S}Ps and the odd number for ^{T}Ps) are determined by conservation of the charge parity (C) and the total angular momentum (the spin, as the ground states of Ps have no orbital angular momentum). Hence, the possibility in principle to justify the complete degeneration of the ground spin states of a superpositronium, taking into account the oscillations in the mirror world, may be associated with the relativistic transformation of the angular momentum. Indeed, if we postulate random mirror-world wandering in the three-dimensional space with velocity $|V| \sim c$ relative to the ground laboratory (observer) and if the relation between the walk step Δ (and the time Δ/c) and the ^{T}Ps$|^{T}$Ps$'$ (stroke indicates belonging to the mirror world) lifetime is favorable, the averaged (over this time interval) value of spin seen by the observer is $\langle(S = 0)\rangle = (S = 1)'(|V|^2/c^2)^{1/2}$ [33];

14. S. L. Glashow due to the presence of the isolated virtual photon $\widetilde{\gamma}$ in the dynamics of the orthopositronium, postulated (outside the context of the violation of P- and CP-symmetries) the possibility of o-Ps oscillations in the mirror world. The difference in understanding the nature of the mirror world discussed herein as past a new (additional) $G\hbar/ck$-physics and the *mirror Universe* by Glashow (the "mirror world"), rejected by himself in comparing the alleged consequences with the experimental data available at the time [34], is that the *energy* and *action* in the $G\hbar/ck$-mirror world of a new (additional) $G\hbar/ck$-physics have *negative sings*. In addition, the mirror world of $G\hbar/ck$-physics (with the negative sign) is realized *locally* (in the atom of long-range action) through the double-valued (±) Planck mass $M_\mu = M_{U^\pm} = \pm M_{Pl} = \pm(\hbar c/G)^{1/2}$ (development of Gliner's ideas);

15. A. D. Linde [35] earlier proposed an independent concept of antipodal symmetry of energy and action in the mirror world relative to the observable Universe. The $G\hbar/ck$-physics is substantiated by this concept. Expansion of the Standard Model includes the double-valued nature of the Planck's constant $\pm\hbar$;

16. L. B. Okun considered the possibility of "...the existence of many-particle states with anomalous permutation symmetry [...] in the relativistic case, it leads to non-positive energy or non-locality" (ferbons/parastatistic) [36];

17. G. A. Kotelnikov [37]: "It was shown that equations of electrodynamics are invariant with respect to the operation of changing the value the speed of light".
The double-valued nature of the speed of light $\pm c$ was realized in $G\hbar/ck$-physics. Two of the three superconstants of physics are double-valued G, $\pm\hbar$, $\pm c$.
We have noted the fact that $\pm\hbar$ and $\pm c$ are included in the structure of all quantum-relativistic physical constants with odd exponents, i.e. in the form of the positive-definite product of $(\pm\hbar)^{2k+1} \otimes (\pm c)^{2\kappa+1}$ (where k and κ are equal to 0 or an integer) as a phenomenon of the *antipodal cosmological invariance* (*ACI phenomenon*) *of the fundamental physical constants*: dimensionless constants of physical interaction — $\alpha = e^2/\hbar c$ (electromagnetic), $\alpha_g = Gm^2/\hbar c$ (gravitat.), $\alpha_W = G_F m^2/\hbar c$ (weak), Planck values — mass $M_{Pl} = (\hbar c/G)^{1/2}$, length $l_{Pl} = (\hbar G/c^3)^{1/2}$, time $t_{Pl} = (\hbar G/c^5)^{1/2}$ and all the rest. This means that mirror-world physics ("on the outside of the light cone") may be regarded as an extension of the Standard Model;

18. A. Yu. Andreev and D. A. Kirzhnits [38]: "Not quite simple and rather obscure relations between the concept of 'instability' and 'tachyons' are discussed".
This work has defined the physical status of the double-valued ± four-dimensional space-time "on the outside" of the light cone. At the time of publication, the authors could not give up the phenomenology and the term *tachyon*. The key word is *instability*. The only realization is the β^+-orthopositronium oscillating in the mirror world. In the final state of the topological quantum transition under the β^+-decay of ^{22}Na, β^+-o-Ps breaks the light barrier due to presence of the isolated virtual photon $\widetilde{\gamma}$ in its dynamics. An *atom of long-range action with a nucleus* takes over from the counterproductive phenomenology "tachyon".
The β^+-decay of $p \to n + e^+_\beta + \nu$ (in the atomic nucleus) in the earth laboratory (g = 981 cm/s^2) involves physical interactions of all types: *strong* — $p \to n$, *electromagnetic* — p, e^+_β, *weak* — ν (*electroweak*) and *gravitational* one. That is why "instability" in the context of the β^+-decay (of the $\Delta J^\pi = 1^\pi$ type) must be accompanied by a unified field reaction (generalized displacement current) ad modum the displacement current in electrodynamics.
The space-like structure of the unified field displacement current (an atom of long-range action with a nucleus) was postulated instead of the counterproductive phenomenology "tachyon";

19. L. B. Borissova and D. D. Rabounski [39]: Using the method of chronometric invariants (physical observable values, A.L. Zelmanov, 1956), "...the possibility of co-existence of short-range and long-range action has be studied" as an extension of GR.
Mathematical prediction of the existence of the third form of matter in the zero-space (zero particles) has given rise to construction of the phenomenology of the additional one notoph mode of β^+-o-Ps annihilation

(see items 5,7,10 above);

20. J. M. Fröhlich ("Planck's Hypercube" [40]): following the logic and intuition of **Max Planck** (1900/1906), re-attributes Boltzmann's constant k to the status of the fundamental constants $c, G, \hbar$, which determined the *cube of physical theories* (G. Gamov, D. Ivanenko, L. Landau, M. P. Bronstein/1928, and A. Zelmanov/ 1967–1969), thus opening the opportunity of the *four-dimensional generalization of the cube*.
The formulation of the double resonance concept (Appendix in [15]) predicts dependence of intensity of β^+-o-Ps (I_2) on temperature in the "β^+-decay ^{22}Na — neon ($\sim$ 9% ^{22}Ne)" system to be studied in the range — 30°C < T < +30°C.
This remind on lecture [40]. If there was destructive criticism of the Planck's Hypercube concept in [41], lecture [40] would hardly be noticed, as it was published in a non-peer-reviewed journal (it is absent in the Science Citation Index);

21. A. D. Sukhanov and O. N. Golubeva [42]: "We show that the quantum statistical mechanics (QSM) describing quantum and thermal properties of objects has only the sense of particular semiclassical approximation. We propose a more general (than QSM) microdescription of objects in a heat bath taking into account a vacuum as an object environment; we call it $\hbar$-k-dynamics";

22. L. V. Prokhorov [43]: "On Planck Distances Physics. Universe as a Net", "On Physics at the Planck Distance. Strings and Symmetries".

These ideas and results obtained by theoreticians (items 1 to 22) were included in the wording of the Standard Model extension phenomenology, as the isotope effect in neon (the increased β^+-orthopositronium component I_2 in the sample depleted by an isotope of ^{22}Ne [14]; 1.85 ± 0.1 factor) is on 6-7 order of magnitude greater than estimated in the Standard Model (by isotopic shift of atomic energy levels).

The main motives for extending the Standard Model to explain the anomalies in the "β^+-decay ^{22}Na – neon ($\sim$ 9% ^{22}Ne)" system [2–6, 9, 14, 15] are determined by three concepts — vacuum-like state of matter (see item 4 [19] above), complete relativity (see item 11 [29, 30] above) and development of the idea of β^+-o-Ps oscillations in the mirror world [15] ([34]).

It is surprising that, in the XIX century, the genius of Sir W. R. Hamilton (1806-1865) linked the Standard Model of physics of XX century (the Hamiltonian method) and its alleged expansion in XXI century, since quantitative harmonization of lifetime anomaly β^+-o-Ps in the "β^+-decay ^{22}Na — neon ($\sim$ 9% ^{22}Ne)" system is based on the phenomenology of the *atom of long-range action with nucleus*. This space-like structure in the final state of β^+-decay is represented by bound Hamiltonian chains/cycles (paths contain each node of the graph once).

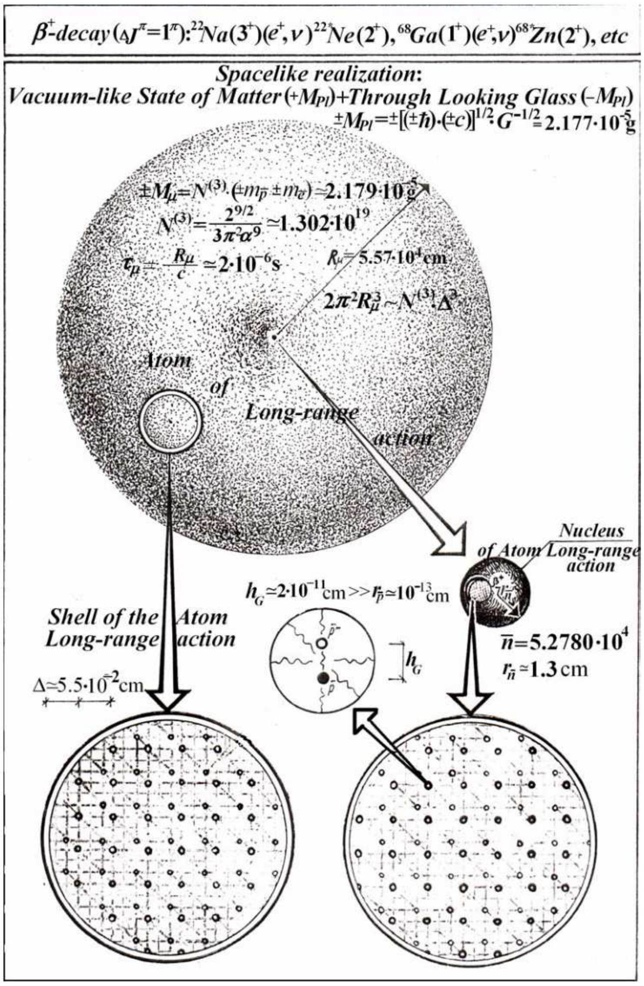

Fig. 2: "Microstructure" of the vacuum-like state of matter (*VSM/mirror world*); h_G is vertical displacement of double-valued sublattices $U^\pm$ in the gravitational field of the Earth.

The Planck mass $M_\mu = M_{U^\pm} = \pm M_{Pl} = \pm(\hbar c/G)^{1/2}$ g is regarded as a space-like structure (the number of nodes in *atom of long-range action* and radii is $N^{(3)} \cong 1.302 \times 10^{19}$, $R_\mu \cong 5.57 \times 10^4$ cm, in the nucleus $\bar n \cong 5.2780 \times 10^4$, $r_{\bar n} \cong$ 1.3 cm). It is assumed that each node contains elementary charges of all physical interactions ($\bar p^+$, $\bar p^-$, $\bar e^-/\bar e^+$, $\bar\nu/\bar{\bar\nu}$ with their double-valued ± masses). In these assumptions, the Planck mass is calculated with high accuracy using the fine structure constant α [15].

Unlike the *gravitational* (G) and *electromagnetic* (α) *interactions* with infinitive ranges ($r_G, r_\alpha = \infty$), the ranges of the *weak* ($r_W = 10^{-16}$ cm) and *baryon* ($r_{str} = r_{\bar p} \sim 10^{-13}$ cm) *interactions* are *ultramicroscopically* small. Since $+M_{Pl}$ and $-M_{Pl}$ move in the gravitational field vertically and in opposite directions and diverge to a distance of $h_G = 2g\tau^2_{0-Ps}/2 = 2 \times 10^{-11}$ cm over the lifetime of β^+-o-Ps (up to 142 ns), the weak and baryon charges are decompensated (opened) in the nodes of *vacuum-like state of matter/VSM* ($+M_{Pl}$) as $h_G \gg r_W, r_{\bar p}$ (Fig. 2).

The rate of self-annihilation of β^+-o-Ps (in non-resonant conditions) is exceeded by (0.19 ± 0.02 ÷ 0.14 ± 0.023) % (see footnote in Page 12) due to the amplification factor as result of β^+-o-Ps oscillations on $\bar{n} \cong 5.2780 \times 10^4$ nodes of the space-time structure of the *nucleus of atom of long-range action* [15] (parallel acts of annihilation)

$$B\left(\beta^+ - {}^{\mathrm{T}}\mathrm{Ps}\right)\bar{n} \rightarrow \gamma^\circ U^+ = 3.5 \times 10^{-8} \times 5.2780 \times 10^4 \cong 1.9 \times 10^{-3} (0.19)\%$$

(see item 12 above).

In the fourth dimension of space-time outside the light cone, the $+M_{Pl}$ lattice has the properties of an *absolutely rigid body*. Electrical charges in the nodes of $\bar{p}^+/\bar{p}^-$, $\bar{e}^-/\bar{e}^+$ lattices are balanced as a result of the infinite range (the Coulomb barrier is absent in the VSM nodes). Exchange of *quasiprotons* in the nodes of the *VSM* lattice with protons of the atomic nuclei of the gas surrounding the source of positrons becomes possible. In the case of neon, nuclear gamma-resonance (the Mössbauer Effect) is realized in the "β^+-decay ^{22}Na — neon (∼ 9% ^{22}Ne)" system.

Appearance of protons (quasi-particles $\bar{p}$) in each node of the $+M_{Pl}$ lattice and bonding of atoms with ^{22}Ne nuclei in the "β^+-decay ^{22}Na — neon (∼ 9% ^{22}Ne)" system is the response to β^+-decay ^{22}Na. This is similar to the displacement current, but having the space-like structure.

The difference between the masses of the neutron and proton $\Delta m_{np}c^2 = m_n c^2 – m_p c^2 = 1.2933317 \pm 0.0000005$ MeV is exceeding energy of the marker γ_n-quantum ("start": $^{22*}\mathrm{Ne} \xrightarrow{E_{\gamma_n} = 1.274577\,\mathrm{MeV}} {}^{22}\mathrm{Ne}$; $\Delta m_{np}c^2 – E_{\gamma_n} = 18.7547$ keV).

There was an idea to link the difference $\Delta m_{np}c^2 – E_{\gamma_n} = 18.7547$ keV with response energy resonance in the topological quantum transition under β^+-decay ^{22}Na, because the kinetic energy of neon atoms from gaseous phase "freeze" on the $+M_{Pl}$ lattice during the β^+-o-Ps lifetime, and the final-state neutrino also participates in "vertical" (↕) oscillations and gains the additional (topological) mass ($m^{\mathrm{eff}}_{\nu_e}$)

$$^{22}\mathrm{Na}(3^+) \rightarrow {}^{22*}\mathrm{Ne}(2^+) + e^+_\beta + \nu_e + U^\pm.$$

Then $\Delta m_{np}c^2$ exceeding E_{γ_n} may be presented as follows

$$\Delta m_{np}c^2 – E_{\gamma_n} = \frac{3}{2}\, kT\bar{n} + m^{\mathrm{eff}}_{\nu_e} = 18.7547 \text{ keV},$$

where $\frac{3}{2}kT\bar{n} = 0.038 \times 5.2780 \times 10^4 \cong 2$ keV, $m^{\mathrm{eff}}_{\nu_e} \cong 16.75$ keV.

The effective mass of the neutrino $m^{\mathrm{eff}}_{\nu_e}$ is equal to the mass heavy 17-keV neutrino as a possible result of mixing "horizontal" generation of neutrinos (a brief review of the 17-keV neutrino problem is described in monograph [44]). The dramatic history of experimental studies of 17-keV neutrinos is similar to the history of the β^+-orthopositronium problem [44, 45].

All the anomalies in the "β^+-decay ^{22}Na — neon (∼ 9% ^{22}Ne)" system — blurred shoulder and variability of the observed β^+-orthopositronium intensity (I_2) (up to factor 2) [9, 14] — are explained by the assumption of existence of the temperature-dependent resonance I_2. The inert gas temperature (the laboratory temperature) was not monitored in lifetime spectra measurements [2–6, 14].

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