Half-Century History of the Project of New (Additional) $G\hbar/ck$-Physics

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The origins of fundamental knowledge, which were mentioned by the genius of Pushkin, are closed in the history of science like in lens focus. This paper survey the 50-years history of studying the orthopositronium anomaly, where the author spent decades on the substantial experiments and further analysis among the experiments made by other experimental groups in different countries throughout the world.

Oh, how much of wondrous discoveries
Enlightenment Spirit preparing for us
And Experience the son of difficult errors
And genius, the paradoxes' friend,
And Case — the got of all inventions.

A. S. Pushkin, 1829

. . . Enlightenment spirit. . .

A single (as one might think) yet fundamental (!) phenomenon — **the annihilation of positrons emitted by a ^{22}Na isotope (and the like) in positron beta decay in inert gases** — combines all the types of physical interactions, such as: **strong/nuclear** interaction (transformation of a *proton* into a *neutron* in a *neutron-deficient atomic nucleus* with emission of a *positron* and a *neutrino*); **electromagnetic** interaction (electrically charged *proton* and *positron* with magnetic moments); **weak** interaction (emission of *neutrino*); and **gravity** interaction, since experiments have only been made in *ground-based* laboratories so far.

Therefore, if we come to think of it, we should not exclude the special role of the half-century *observations of anomalies in neon* (1956–2003) in making a *unified description of physical interactions* (*unified field theory*). Furthermore, these observations are only possible with *monoatomic* gases, which are the closest to the ideal gas status [1].

This idea is relevant against the backdrop of stagnation in fundamental physics (since mid-1970s), as Standard Model (SM) formulated in the same period has led to development of idea started by Einstein (with no final success through) and for the first time worded by Faraday (in respect of then known gravity and electromagnetism) [2]. The idea was given an official status in the XX century. It was the idea of all the fundamental interactions (the Theory of Everything).

The constructive idea presented by the new (additional) $G\hbar/ck$-physics Project could not emerge a priori. The signs of *new physics* in the experimental data on the beta-decay positron annihilation in inert gases were recorded for the first time by experimentalists involved in solving the issues of orthopositronium/parapositronium with a chemical-physical (or physical-chemical) "pedigree".

However, it would be impossible to implement the idea without the results achieved by fundamentalist theoreticians in their independent efforts on expanding SM [1]. It is clear why the phenomenology of the $G\hbar/ck$-physics Project finalized among experimenters a decade ago cannot get through to implementation of the *Decisive Experiment Project* [4], despite being based on the giant effect exceeding the SM estimate by 6–7 orders of magnitude [3].

Nevertheless, there is another reason, which the prominent ethologist Konrad Lorenz described as one of "*the civilised man's eight deadly sins*". It is *indoctrinability of the "Big Science"* (susceptibility to fashion and stereotypes).

"...never before have the manipulators had at their disposal such clever advertising techniques or such impressive mass media as today. [...]

However, the worst effect of fashion ... can be observed in the realm of science. It is mistake to suppose that all professional scientists are free from the cultural diseases that are the subject of this treatise. [...] "Big Science" in no way implies a science concerned with the most important things on our planet, nor is it the science of the human psyche and intellect: it is exclusively that science which promises money, energy, or power... [...] The special danger of fashionably indoctrination in the field of science lies in the fact that it leads too many, though fortunately not all modern scientists, in a directions exactly opposite to that of the real aim of all human striving for truth — the aim for the better self-knowledge" [5].

In 1970s, K. Lorenz still retained hope for overcoming the "*mortal*" contradictions. In another essay of this, we can feel the spirit of the Rome Club ("*sustainable development*") founded in those years:

"I believe that we can see the true sings that self-consciousness begins to awaken in the cultural humanity, based on scientific knowledge. [...] **Until now, there has never been a rational self-study of human culture on our planet**, just like there was no objective, in our opinion, natural science before Galileo' s times. [...]

Of course, the position of mankind is now more dangerous than it has ever been in the past. However, thinking found by our culture due to its natural science potentially gives it a

change to escape death that befell all the high cultures in the past. This is the first time in world history" [6].

The first (and only so far) constructive response by theorists to the unique information on the positron (orthopositronium) annihilation anomalies, received by "quiet physics" (without accelerators of ultrahigh-energy particles) after they created the mathematical theory of the existence of the *third form of matter* [7], is that the experimental data was understood by the authors as subject for application of their fundamental theory [8]. Through paradoxical expansion of the general relativity, they "... studied the possibility of coexistence of short-range and long-range actions", using the method of chronometric invariants (physical observable values, A. L. Zelmanov, 1956). The theoretical (mathematical) prediction of the existence of the third form of matter (*zero-particles*) in the *zero-space* became an additional incentive for building the phenomenology of new (additional) $G\hbar/ck$-physics on the way to justifying the anomalies in neon.

And experience the son of difficult errors...

The start (1964) of assumption of a new range of time spectrometry (up to 200 ns) at the Department of Matter Structure of the Institute of Chemical Physics Academy of Sciences USSR/DMS IChP in Moscow (led by Professor V. I. Goldanskii) to study the annihilation of beta-decay positrons in physical media with the large void volume (gases or porous solids) coincided with the publication of a work by P. E. Osmon from Columbia University, New York, presenting comparative data on annihilation of quasi-free positrons (from the Na-22 isotope) in all inert gases at pressures of several atmospheres and room temperature [9].

Here is the abstract of this work:

"Positron lifetime spectra have been measured in helium, neon, argon, krypton, and xenon at pressures of a few atmospheres. The annihilation rates of the free positrons are found to be time-dependent. Physical reasons, based on the strong correlation between energy and age of a positron, are suggested for this time dependence. Three parameters describing the main features of the free-positron spectrum are separated from the data, for each gas, and tabulated".

Neither the abstract, nor the article itself contains any reference to the characteristic feature of *neon* lifetime diagrams. Lifetime diagrams show a nonexponential feature of this area of the lifetime spectra — the so-called *shoulder*. Its manifestation is generally enhancing from helium to xenon along with the increasing atomic number of gas Z. However, *neon* stands out — the shoulder in its diagrams is blurred or nonexistent at all.

It was decided to repeat the observation in the *helium-neon-argon* area to verify the said distinctive feature of neon. The blurring effect in the shoulder of neon was confirmed. The result were published (1967) in the departmental Newsletter of the Institute of Instrument Engineering, which provided time range converter into digital vernier type code up to 200 ns for lifetime spectrometer, and in Tables [10].

V.I.Goldanskii discussed the results at international meetings. Later on, several laboratories took up measurements with neon and confirmed the neon shoulder blur [11–14].

As we known, polyatomic impurities in inert gas influence the dynamics of positron moderation under the positronium formation threshold due to inelastic energy losses on the background of elastic moderation in inert (monoatomic) gas. Therefore, the difference in shoulder parameters between experimental data obtained in different laboratories could be attributed to differences in residual polyatomic impurities in neon samples used in the experiments [9–14], despite the fact that neon had the *ultra-high purity* grade in all the experiments.

However, an analysis of all the experimental data showed that this cannot explain the observed differences in shoulder parameters in neon. In our measurements, using *the same sample of neon* in a wide pressure range (16 atm to 32 atm), the product of the shoulder length t_s and the gas pressure p (the constant for ideal gas [1]) differ almost twofold (from 500 ns atm to 900 ns atm); in [10] these results are only represented by upper limit of 900 ns atm). The true result (500÷900) ns atm was reported by V. I. Goldanskii (see [11]*, [14]†). At the same time, according to our measurements, the shoulder lengths in helium and argon remain constant (with in the experimental errors) [10].

A decade after the shoulder blur in neon had been confirmed, a hypothesis was published that the marker gamma-quantum of lifetime spectrometer is collectivized under special conditions of the system described as "**beta-decay of a Na-22 isotope** $\xrightarrow{\text{positron+neutrino}}$ **excited Ne-22** (the source of the marker gamma-quantum of the lifetime spectrometer/ "start") **in gaseous neon with natural isotope composition (~9% of the Ne-22 isotope)**" [15].

Two decades later, a comparative critical experiment was made on separated neon isotopes [3]. The experiment confirmed the hypothesis and opened up the prospects for expanding SM and building the phenomenology of $G\hbar/ck$-physics.

The project of new $G\hbar/ck$-physics was surprisingly supported by the results of the Michigan group (University of Michigan, Ann Arbor) for absolute measurement of the lifetime (the reciprocal of the self-annihilation rate) of an orthopositronium (1982–1990). Two methods (with buffer gases and in vacuum) revealed that the self-annihilation rate of an orthopositronium is exceeded by ($0.19 \pm 0.02 \div 0.14 \pm$

*"Aside from the presence of the prompt component, it is very difficult to discern any nonexponential region of the spectrum. Goldanskii claims to see a shoulder in his room-temperature spectra, (ρt_s = 500–900 nsec amagat), but he states that it is considerably weaker than that which occurs in helium and is difficult to locate".

†"The only other evidence for the shoulder comes from the work Goldanskii and Levin reported by Hogg et al. [10] to have a width in the range 500–900 ns amagats".

0.023) percent compared with the calculated value (quantum electrodynamics/QED), which has reached the accuracy of $1.6 \times 10^{-4}\%$ by now. As we see, the deviation of the experimental data from the theory was recorded at the level of 10σ (standard deviation)!

These groups of H.M. Randal Laboratory at the University of Michigan led by Professor A. Rich (1937–1990) were the world leaders in the orthopositronium lifetime absolute precision measurements. The irony is that the article titled "*Resolution of the Orthopositronium-Lifetime Puzzle*" [16], published by the Michigan group in Phys. Rev. Lett., and disavowed the results of the group's previous measurements (1982–1990), which were in conflict with the theory, and thus "closed" the problem for the scientific community.

In the modified method, an auxiliary electric field was introduced *vertically* in the measurement chamber [16]. A sequential analysis, taking into account all the information available, showed that previously found discrepancy between the theory and the experiment would be preserved with a *horizontal* direction of the auxiliary electric field [17].

In all fairness, Work-2003 had a constructive role too. Its destructive conclusions made it possible to find and substantiate the manifestation of the fundamental connection between *gravity* and *electricity*, which was the cause of the wrong conclusion by the Michigan group, who did not have all the experimental data available by the time.

The shoulder shape is influenced by intensity of the orthopositronium component I_2, since the **orthopositronium component follows the component of annihilation of quasi-free positrons on the time axis** in lifetime spectra. This can cause the shoulder blurring and problems with anomalies of beta-decay positrons (from Na-22) annihilation in neon [3,9–13], because the **laboratory temperature was not taken into account in all of this measurements**.

It is also worth nothing that there is an abnormally high share of positrons forming a positronium in gaseous neon — $(55 \pm 6)\%$ — obtained on the energy spectrum of the annihilation gamma-quanta with Cu-64 as the source of positrons [18] in contrast to half the value — $(28 \pm 3)\%$ — obtained by a lifetime method with Na-22 as the source of positrons.

And genius, the paradoxes' friend...

The blatant paradox in the perspective of justification on the hypothesis of collectivization of Ne-22 nuclear excitation ($\cong$ 1.28 MeV) by nuclei of Ne-22 atoms with natural isotopic composition ($\sim$ 9%) in the macroscopic volume of the measuring chamber at the final stage of the beta-decay of Na-22 nucleus was confirmed by comparing the lifetime spectra of neon samples — a natural one and a sample depleted by Ne-22 isotope [15]. As said above, the effect of changing I_2 was 6–7 orders of magnitude higher than the estimate of SM.

Now we can exclude the general suggested version of the determining role of the residual polyatomic gas impurities.

The paradox is that, in experimental conditions [3], the Mössbauer effect (nuclear gamma-resonance) takes place for a sufficiently hard gamma-quantum ($\cong$ 1.28 MeV) of the excited daughter Ne-22 nucleus, located on the solid positron source, and nuclei of Ne-22 atoms staying in gas at room temperature. As we known, the Mössbauer Effect is possible in condensed media (solids: crystalline, amorphous, or powder one).

Most likely, this paradoxical formulation of the issue was due to the fact that two group of experimenters were working alongside at DMS IChP in Moscow (from beginning 1960s) led by V.I. Goldanskii — "positron group" (the group of Chemistry of New Atoms) and "Mössbauer group" (the Mössbauer Effect laboratory). The groups met at general workshops, making presentations and passively sharing information and ideas.

The concept of zero-space (zero-particles) as an extension of the *general relativity* [7] has set a framework for overcoming the paradox through introduction of the four-dimensional space-time on the *outside* of the light cone into fundamental physics.

But how shall we implement this program on a quantitative level, when compared with the experimental data?

The collective genius of famous and prominent theorists, who independently sought (each for their own reasons) to go beyond SM, determined the development of a phenomenology of new (additional) $G\hbar/ck$-physics [1]. The search for unique and rarely-cited works of theorists with high index of citing continued for two with half decades (1987–2012) following publication of the critical experiment results [3].

An analysis of the paradoxical experimental situation has led to the conclusion that the macroscopic volume of the double-valued ($\pm$) four-dimensional space-time of the final state of positron beta-decay of $\Delta J^{\pi} = 1^{\pi}$ type is filled with bonded Hamiltonian chains/cycles of the *nucleus* of the atom of long-range action (with a number of nodes $\bar{n} \cong 5.2790 \times 10^4$) and the *atom of long-range action* as a whole ($N^{(3)} = 1.302 \times 10^{19}$) [1].

Summing up this phenomenology, we can say that two fundamental (mathematical) abstractions — the *material point* (*inside* the light cone) and *absolutely rigid body* (*outside* the light cone) — will determine the relevant expansion of SM (the *unified quantum field theory*).

A decisive experiment in the study of the supposed temperature resonance I_2 in the range $-30^{\circ}\mathrm{C} < T < +30^{\circ}\mathrm{C}$ (see [4], Appendix) will finally clarify the issue of anomalies of positron (Na-22) annihilation in gaseous neon.

And case — the God of all inventions

One might think that the sacral line by Pushkin is a poetic paraphrase of a revelation from the New Testament, the Apostle Paul to the Romans 11:33, "*Oh, the depth of the riches and wisdom and knowledge of God! How unsearchable are*

His judgments and His ways!" The deep thought received a lapidary form — "*The ways of God are inscrutable*".

Fundamental physics is the search for Truth, for understanding of the basic of Existence — the space-time (quantitative criteria of cause-and-effect relationship, *experiment and theory*).

However, since the mid-1970s, physics suffers a profound crisis. At no time in history there was such a long stagnation of fundamental knowledge, when the issue was formulated (e.g. *How does the supersymmetry manifest itself? What is the nature of dark matter/dark energy? What is the mainstay of consciousness? And others???*), but they had no solutions. This breaks the formation of fundamentally new technologies. That cannot not have globally destructive social consequences.

There is a high measure of confidence, that crisis could be overcome for a long time. A decade before the physicists understood the heuristic importance of supersymmetry, there was made an experiment [9, 10], which laid the foundation for the study of anomalies in the system described as "**beta-decay of a Na-22 isotope $\xrightarrow{\text{positron+neutrino}}$ excited state of Ne-22 isotope (the source of the marker gamma-quantum of the lifetime spectrometer/"start") in gaseous neon with natural isotopic composition (~9% of Ne-22 isotope)** — "resonance conditions" [15]". Later on, this anomaly was linked to the anomaly of the positronium share in neon (55 ± 6)% under nonresonance conditions (with Cu-64 as the source of positrons) [16].

All of this have prepared the ground for the introduction of space-like object physics (i.e., on the outside of the light cone) in the fundamental context.

Physics is one, but the now prevailing stereotype — the increased interest in ultra-high energies as a prospect for overcoming stagnation — and neglect of the unique data received by "quiet physics", does not promise to overcome stagnation. The existence of the quantum-field resonance as a consequence of the existence of a *nucleus of the atom of long-range action* is possible, if energy $m_p \times \bar{n} \cong 50$ TeV (where m_p is proton mass), which is half order of magnitude greater than the energy of the colliding proton beams of the Large Hadron Collider. It is very distant, if not illusory prospect...

The core of the Project of New (Additional) $G\hbar/ck$-physics was the critical experiment [3]. It was the result of previous work in many laboratories [9–13], an independent breakthrough by theorists to the double-valued ($\pm$) four-dimensional space-time [7], which virtually legalized the results of independent theoretical searches for the way to go beyond Standard Model by the methods of the *general relativity* [19] and the *quantum field theory* ([20] and [21]).

Setting a decisive experiment promises a breakthrough to the *unified field theory* based on expansion of the Hamiltonian method by including the Hamiltonian chain/cycle [1].

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