О пространстве волновых функций хронометрического протона: поиск его новых элементов на основе скейлинга

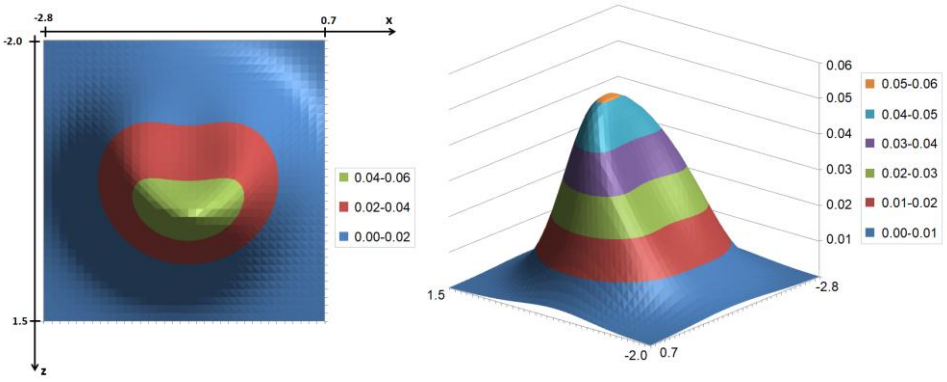
A. Levichev: alevichev@gmail.com & **СОАВТОРЫ!**

ABSTRACT

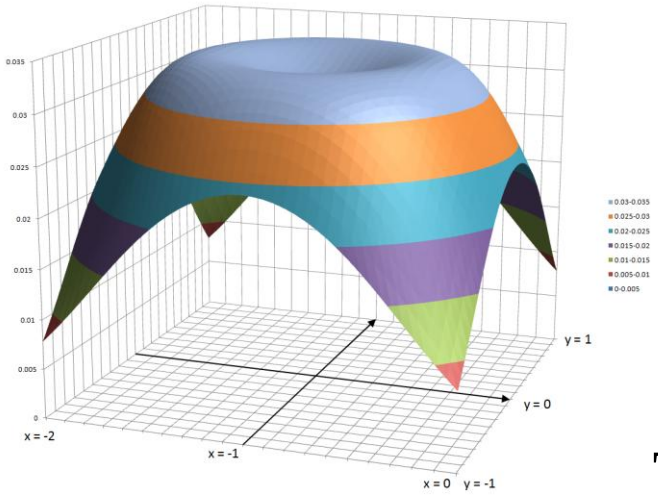
In [1] (i.e., the year 2024 “Proton Therapy – Scientific Questions and Future Direction” edited by T. J. FitzGerald), the Multi-Level Model (= MLM) was outlined as a conceptual framework proposed by Levichev. In particular, we presented there, in our perspective chapter ([2]), the proton’s theoretical description in an endeavor of its future application in proton therapy for cancer patients. This exploration potentially opens a novel era of the intricate interplay between wave functions (mathematically, they form an infinite-dimensional space F_p, see [3]) and proton beams produced by different vaults. An overview of this chapter, as well as of certain recent findings of F_p–elements, is part of the talk. Besides, due to the mere scope of the MLM-approach, it is now expected to be applied in a broader context (rather than within proton therapy, alone). The MLM becomes, so to say, part of the *holistic medicine approach*.

An Overview of [2], "The proton's theoretical description based on Wigner-Segal approach to elementary particles"

...The potential applications of MLM in proton therapy are predicated on the concept of proton *wave functions*. The chapter outlines the inherent properties of functions f belonging to F_p. We capture distinct instances ("snap shot photos") of these functions at the temporal instant $t = 0$.



This is figure B4, the ND case: a typical 3d-section of the 4d-graph with all three space variables involved.



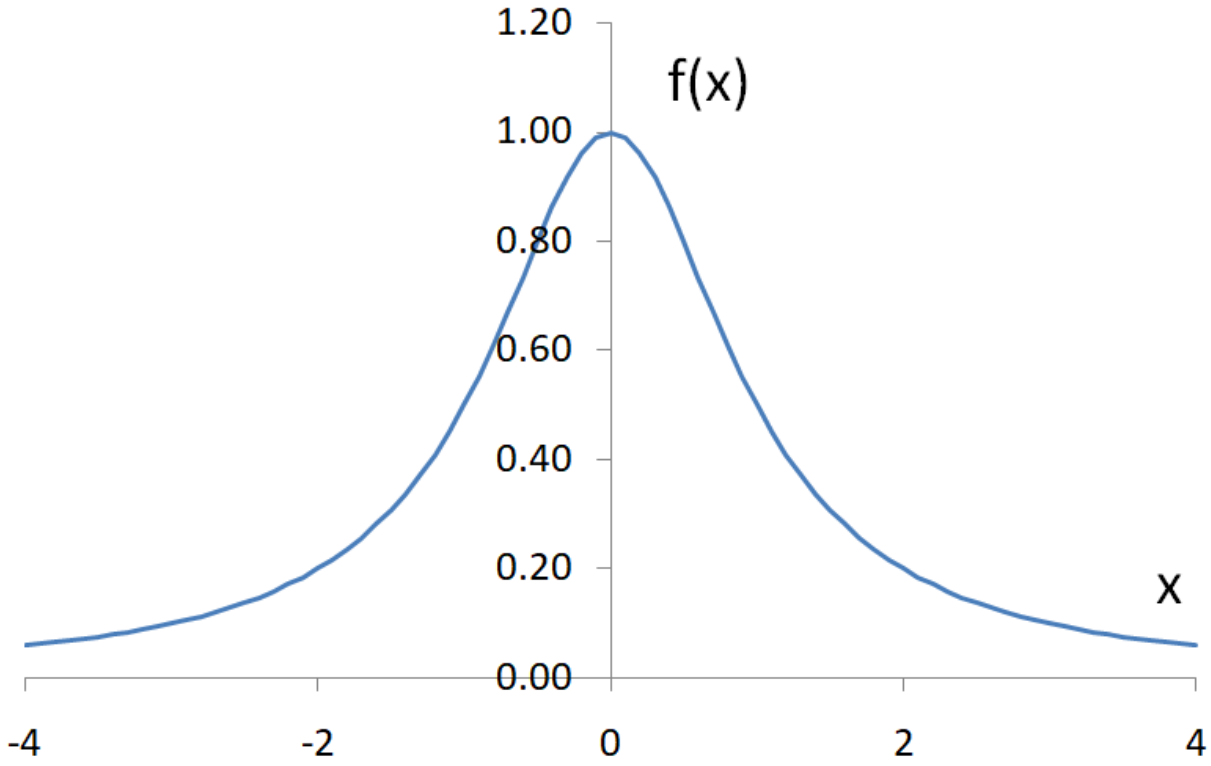
This is B3, the WD-case. It is a 'toy' example, since only two space variables were involved. One can go (see below) beyond

these two cases (ND– & WD-). As ongoing proton therapy clinical trials amass substantial statistical data, our research might be put to the test through experimental validation. Intriguingly, a different perspective could also shed light on the perplexing "reality of the wave function" enigma. Notably, a substantial contingent of experts – though perhaps not the dominant majority – align with our standpoint: that the wave function must indeed possess an objective and physical reality. This perspective opens the door to exploring correlations between our findings and distinct designs of *proton vaults* (see [4]). Now, to get closer to the point of presenting our new findings, let us deal with the most simple 'toy-case'. Namely, let f(x), g(x), etc., be functions of one real variable, x.

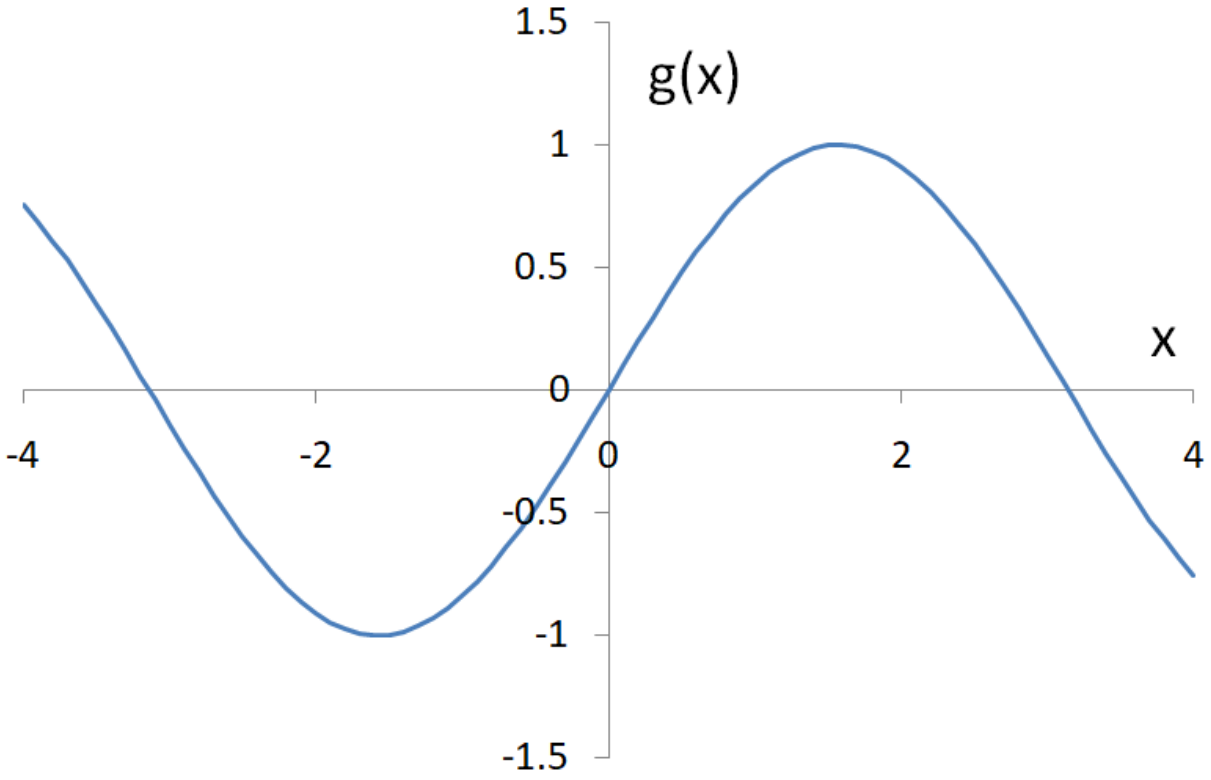
Wave Functions (an Intro 'in pictures' to)

To get closer to understanding F_p, use *f* and *g* when we think of the two functions as of *vectors* (and interpret them as *states*). Let us deal with stages 1) through 5). Namely, 3) illustrates the notion of the sum *f* + *g*.

1) $f(x)=1/(1+x^2)$

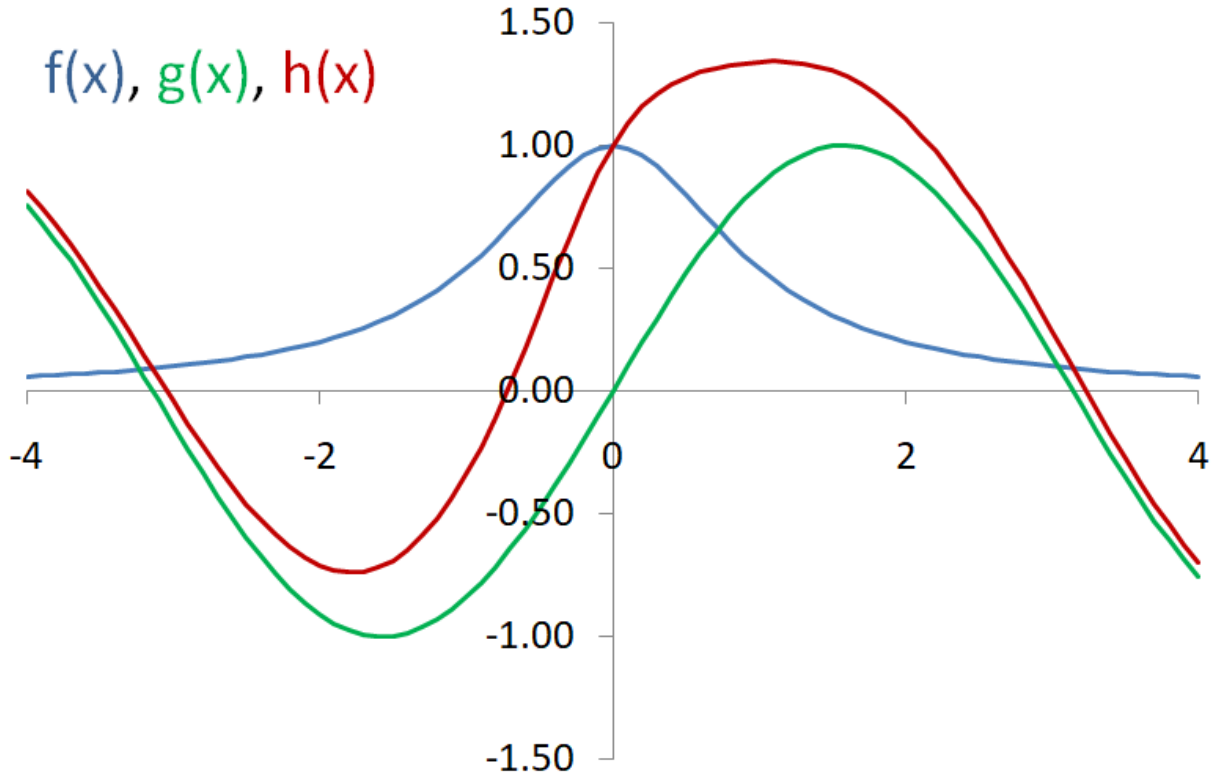


2) $g(x) = \sin x$



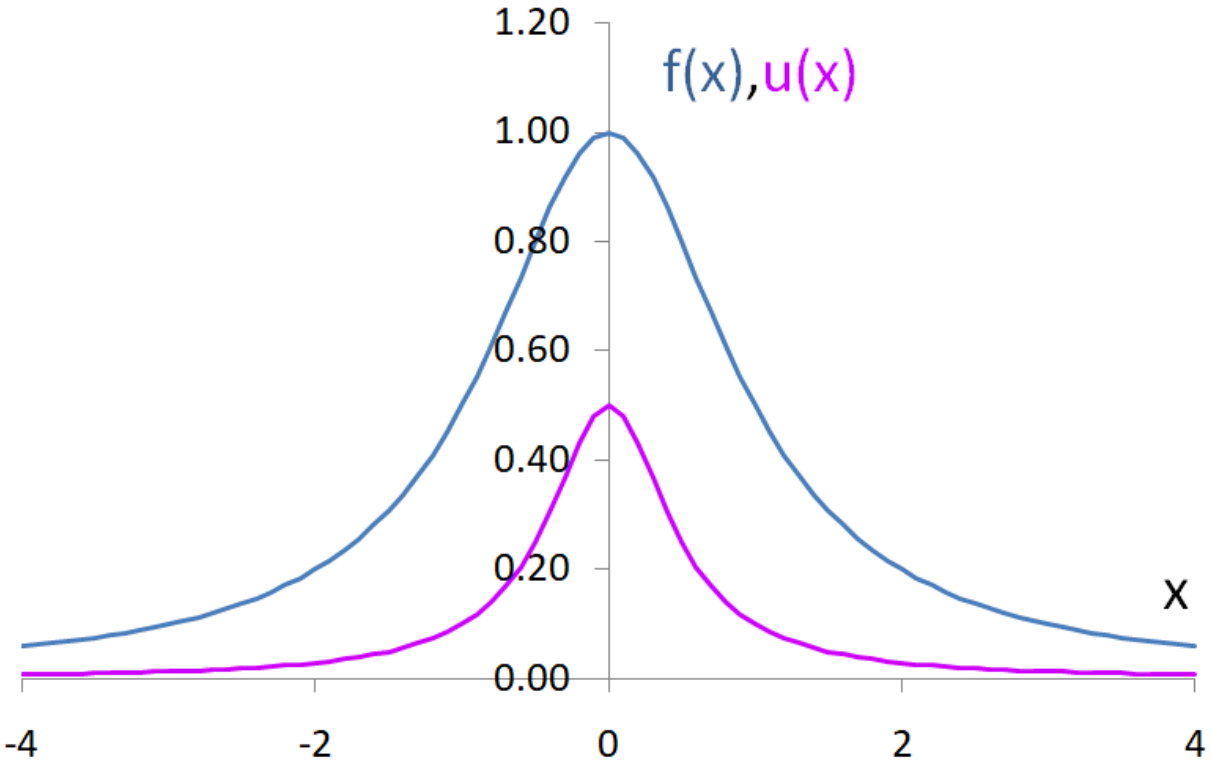
One can think of the sum $f + g$ as the result of (point-wise) addition of vectors on an *ordinary* two-dimensional (x,y)-plane R^2:

3) h(x) = f(x) + g(x)

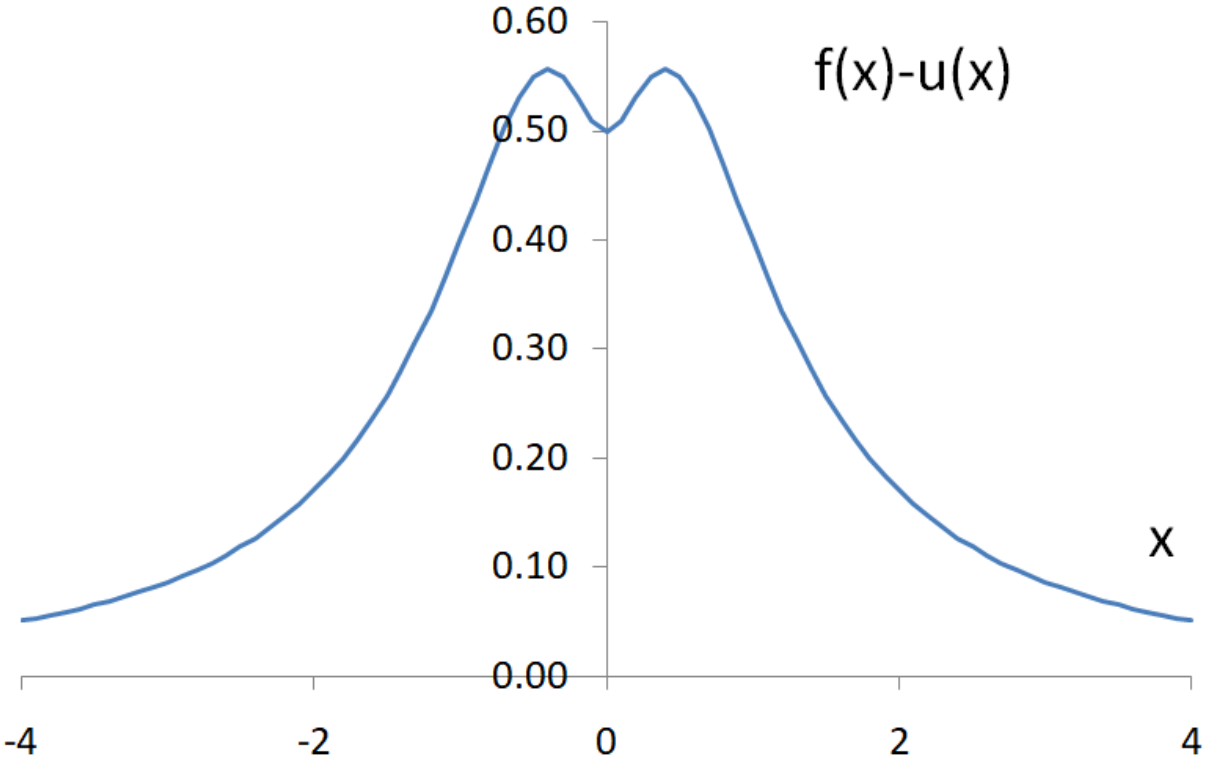


4) F_p is an arena for different **transformations**. If a scaling in R^2 moves each (x,y) into (x/2,y/2), then a 'vector' f(x) goes into u(x)

u(x)=1/{2(1+ $4x^2$)}. Recall that scaling is of fundamental importance in theoretical physics.



5)Here is the graph of *f-u*:



We managed to produce an WD-element *f-u*. Here *u* was obtained from an ND-element *f* by scaling. This observation we are going to apply in $\mathbf{F_p}$, itself.

On the space $\mathbf{F_p}$ of proton's wave function

Like in equation (6) of [2], but now we do not provide the *kernel K*(h,w) explicitly, the f-value at *event* h is the 2-dim complex vector **L**:

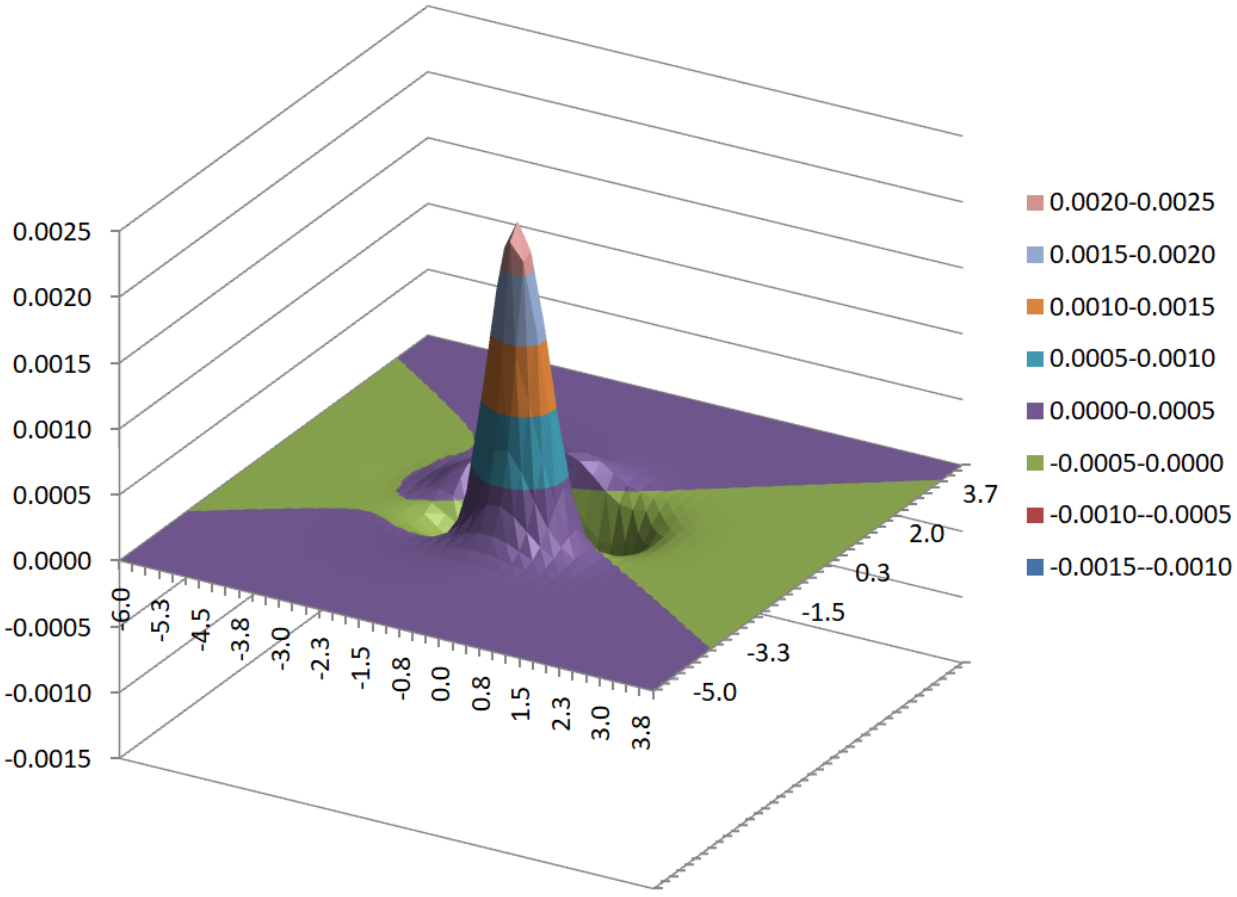
$$\mathbf{L}(h) = K(h,w)v \qquad (1)$$

Event h (with time coordinate x_0 and space coordinates x_1, x_2, x_3) is presented in a (well-known in theoretical physics) 2 by 2 *matrix form*. That is, each wave function (or state) *of that type* is defined by choosing a matrix w and a vector v. In [2, Theorem 4] we managed to choose w and v in such a way, that the (real) values $f(h)=\mathbf{L}\mathbf{L}^*$ define an ND-state *f* (compare to 1) – with a single point of maximum - of the prior section, and to Fig. B4. In the canonical product $\mathbf{L}\mathbf{L}^*$ (which is a real number) the vector $\mathbf{L}^*$ is a complex conjugate of **L**.

The validity of the following statement (t there is a real parameter, while e^t is the coefficient of the scaling involved) **is based on** [3]:

Lemma 1. The image of *f* under scaling (with coefficient e^t) is *u* of type (1) but with $w\sim = e^{-t}w$, $v\sim = e^{-5t/2}v$.

Now, as in 5), above, consider $f - u$. After calculations (they are pretty involved, see below), we put time x_0 to 0, for a "snap shot photo". We expect to end up with such a state $F = f - u$, from F_p, which has MORE THAN one points of (local or global) extrema. Here is the graphics obtained:



Here the scaling coefficient e^t was chosen as 2/3.

In the following statement (where x_0 is already set to 0), we allow an arbitrary coefficient e^t :

Lemma 2. The canonical product $\mathbf{LL}^*$ equals to the following sum of (2) & (3), below - where by L_1, L_2, we mean the corresponding components of 2-dim vector **L** in (1)):

$$L_1L^*_1=\mathbf{e^{5t}[(x+e^{-t})^2 + y^2]/(L_tL_t^*)^3 +}$$

$$\mathbf{2e^{5t/2}(aA + bB) + [(x+1)^2 + y^2]/(LL^*)^3},\quad (2)$$

$$L_2L^*_2=\mathbf{e^{5t}[(z-e^{-t})^2 + e^{-2t}]/(L_tL_t^*)^3 +}$$

$$\mathbf{2e^{5t/2}(uA + vB) + [(z-1)^2 + 1]/(LL^*)^3}.\quad (3)$$

In the above, the space variables are as usual (that is: x, y, z), while other symbols are as follows:

$\mathbf{L_t}$ $=[(x+ e^{-t})^2+z^2+y^2+2ie^{-2t}]$, **L** $=[(x+1)^2+z^2+y^2+2i]$,

a, **b**, **u**, **v** are (pretty simple) functions of x, y, z (we do not provide explicit expressions for these functions here); expressions for (real) functions **A**, **B** are quite complicated, we only indicate that they are determined by this (4):

$$\mathbf{(L_tL^*)^{-3} =A + iB}.\qquad (4)$$

On the basis of Lemma 2, we started to look for points of extrema for the (real) function

$$\mathbf{LL}^{*} = L_1 L^{*}_{1} + L_2 L^{*}_{2}. \quad (5)$$

We have concluded that in the y=0 section of the graph of (5), there should be *critical points* (at this moment we do not provide them explicitly but the existence of at least one global maximum and of one local minimum follows from our graphics - above – for this very section).УСТНО: о 33й степ.

The Multi-Level Model as the Unification of SM with Segal's Chronometry

https://doi.org/10.20944/preprints202202.0280.v2

Preprint: 785 просмотров, 423 загрузок

Segal's Compact Cosmos D: U(2), def.by a form on u(2). Embeddings: U(2) into U(3), U(2) into U(4), etc. 'Levels': U(2) - the 0th , U(3) - the 1st, U(4) - the 2nd, etc. Matches SM-quarks' generations list.SM-quark is a sunken proton.

$$U(2) = \mathrm{mathit}D: \begin{bmatrix} * & * \\ * & * \end{bmatrix}$$

$$\underset{D_{12}}{\begin{bmatrix} * & * & 0 \\ * & * & 0 \\ 0 & 0 & 1 \end{bmatrix}} \quad \underset{D_{13}}{\begin{bmatrix} * & 0 & * \\ 0 & 1 & 0 \\ * & 0 & * \end{bmatrix}} \quad \underset{D_{23}}{\begin{bmatrix} 1 & 0 & 0 \\ 0 & * & * \\ 0 & * & * \end{bmatrix}}$$

D_{12}, quark *u*; D_{13}, *d*; D_{23}, *u* – $U(2)$-subgroups in $U(3)$.

$$P_2:\begin{bmatrix} z_1 & z_2 \\ z_3 & z_4 \end{bmatrix} \to \begin{bmatrix} z_4 & z_2 \\ z_3 & z_1 \end{bmatrix};\ \mathrm{P}_3:\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \to \begin{bmatrix} i & f & c \\ h & e & b \\ g & d & a \end{bmatrix}.$$

$A_{23}=P_3A_{12}P_2$; $P_3(D_{12})=D_{23}$; $P_3(D_{13})=D_{13}$

The Chr-(=MLM-)proton is elementary, indestructible; F_p consists of proton wave functions (= of certain spannors) – см.(1), выше. For MLM-quarks, in terms of *ruling groups*, flavor and color are mathematically defined. The number of colors (and of flavors) is level-dependent. For U(3) through U(6), the correspondence with the SM-quarks is established.

$$U(2) = \mathrm{mathit}D:\begin{bmatrix} * & * \\ * & * \end{bmatrix}$$

$$\underset{D_{12}}{\begin{bmatrix} * & * & 0 & 0 \\ * & * & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}} \quad \underset{D_{13}}{\begin{bmatrix} * & 0 & * & 0 \\ 0 & 1 & 0 & 0 \\ * & 0 & * & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}} \quad \underset{D_{14}}{\begin{bmatrix} * & 0 & 0 & * \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ * & 0 & 0 & * \end{bmatrix}} \quad \ldots \quad \underset{D_{34}}{\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & * & * \\ 0 & 0 & * & * \end{bmatrix}}$$

$$A_{24} = P_4 \circ A_{13} \circ P_2, \quad A_{34} = P_4 \circ A_{12} \circ P_2, \quad P_4(D_{13}) = D_{24}, \quad P_4(D_{24}) = D_{13},$$

$$P_4(D_{14}) = D_{14} - \text{quarks}; \quad P_4(D_{23}) = D_{23} - \text{quarkc}.$$

$$U(4): \underset{2/3}{D^u_{12}} \quad \underset{-1/3}{D^d_{13}} \quad \underset{2/3}{D^{\mathrm{c}}_{23}} \quad \underset{-1/3}{D^d_{24}} \quad \underset{2/3}{D^u_{34}} \quad \underset{-1/3}{D^s_{14}}$$

Three new SM-quarks in U(6):

$$\begin{cases} D_{12}^{u} & D_{13}^{d} & D_{14}^{s} & D_{15}^{t} & D_{16}^{q(4;1,6)} \\ & & & & 2/3 \\ D_{23}^{c} & D_{24}^{b} & D_{25}^{q(4;2,5)} & D_{26}^{t} & D_{34}^{q(4;3,4)} \\ & & -1/3 & & 2/3 \\ D_{35}^{b} & D_{36}^{s} & D_{45}^{c} & D_{46}^{d} & D_{56}^{u} \end{cases}$$

At different levels, the so-called quark matter is suggested to be modeled on the basis of the captured proton notion.

On quark matter & on two new SM-leptons (in U(5)):

***U*(2)**:	p, ν_e, e.
***U*(3)**:	p_{12} (or p_{23}), ν_μ, μ; p_{13}, ν_μ, μ.
***U*(4)**:	p_{12} (or p_{34}), mathbf$\nu_{\text{mathit}\mu}$, μ; p_{13} (or p_{24}), mathbf$\nu_{\text{mathit}\mu}$, mathitμ; p_{23}, mathbf$\nu_{\text{mathit}\tau}$, τ; p_{14}, mathbf$\nu_{\text{mathit}\tau}$, mathitτ.
***U*(5)**:	p_{12} (or p_{45}), mathbf$\nu_{\text{mathit}\mu}$, μ; p_{13} (or p_{24}), mathbf$\nu_{\text{mathit}\mu}$, mathitμ; p_{23} (or p_{35}), mathbf$\nu_{\text{mathit}\tau}$, τ; p_{14} (or p_{25}), mathbf$\nu_{\text{mathit}\tau}$,

	mathitτ; p_{24}, 4th generation neutrino, 4th generation positron; p_{15}, 4th generation antineutrino, 4th generation electron.

Sol-n to SM-puzzle of quarks' & leptons' generations:

Нейтрон, два U(3)-нейтрона, один U(3)-антинейтрон

Han-Nambu scheme: each quark's (fractional) electric charge is expressed in terms of (integer) color charges. The total number of colors at the *U*(n)-level is n(n-1)/2.

f \ c	**12**	**23**	**13**
u: 12, 23	1	1	0
d: 13	0	0	-1

f \ c	**12**	**13**	**14**	**23**	**24**	**34**
u:12, 34	1	0	1	1	0	1
d:13, 24	0	-1	0	0	-1	0

s: 14	0	-1	0	0	-1	0
c: 23	1	0	1	1	0	1

At U(5), SM- and MLM-data numerically contradict, for SM-quarks' electric charges: there are 10 colors which implies charges of 7/10 for each of *u*, *c*, *t* and negative 3/10 charges for each of *d*, *s*, *b*.

On ruling groups G_{12} and G_{13} in SU(3,3):

$$g_{12}=\begin{bmatrix} A & 0 & B & 0 \\ 0 & 1 & 0 & 0 \\ C & 0 & D & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, g_{13}=\begin{bmatrix} A_1 & 0 & A_2 & B_1 & 0 & B_2 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ A_3 & 0 & A_4 & B_3 & 0 & B_4 \\ C_1 & 0 & C_2 & D_1 & 0 & D_2 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ C_3 & 0 & C_4 & D_3 & 0 & D_4 \end{bmatrix},$$

where in case of g_{12} the 4 by 4 matrix g_2 from SU(2,2) was denoted as $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$, while in case of g_{13} the 4 by 4 matrix $g_2$was also denoted as $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$, but with further specification of its 2 by 2 blocks: $A=\begin{bmatrix} A_1 & A_2 \\ A_3 & A_4 \end{bmatrix}$, $B=\begin{bmatrix} B_1 & B_2 \\ B_3 & B_4 \end{bmatrix}, C=\begin{bmatrix} C_1 & C_2 \\ C_3 & C_4 \end{bmatrix}, D=\begin{bmatrix} D_1 & D_2 \\ D_3 & D_4 \end{bmatrix}.$

Check the bosonic sector chronometric findings first. W and Z and γ have been math.detected [5], where chronometric interactions classified but we've corrected the neutrino case: *conformal weight*. Higgs boson (Segal: no one!) existence is an open MLM-question. Also, from [5]: "Chronometric interaction is between f- and b-*clans* as entities, while the total interaction Lagrangian can be

represented as a sum of interactions between elementary particles only in the relativistic limit”.

The Multi-Level Model as the Unification of Standard Model with Segal’s Chronometry, Левичев, Клевцова – в ЭЧАЯ

Ответ на (отклоняющую) Рецензию

>1) While the approach is conceptually ambitious, the model suffers from **several fundamental issues** that significantly weaken its scientific validity and relevance to particle physics.

Посмотрим, что это за ‘**фундаментальные недостатки**’… Сразу же хочу отметить, что **о глюонах речи в статье,** ФАКТИЧЕСКИ**, не идёт**… (поэтому ‘замечания по глюонам’ я буду как бы игнорировать – выделяя их красным)

>2) The MLM claims to provide a **mathematical description of quarks** and gluons, yet **it offers no substantial experimental evidence** to validate its predictions.

По поводу ‘кварк-упрёка’ Рецензента: далее (как только увижу КОНКРЕТНОЕ замечание) попробую ‘отстаивать MLM-подход‘. СРАЗУ ЖЕ обозначаю **важный момент:** в статье дано математическое описание MLM-кварков, исходя из описания хронометрического протона. Математические

термины ‘хронометрический протон’ и ‘MLM-протон’ – это СИНОНИМЫ. Считаю, что **Описание** (=description) **хронометрического протона математически безупречно.**

>3)…the MLM relies heavily on abstract group-theoretical constructs (e.g., embeddings of U(n) groups) without clear physical justification.

Согласен с первой половиной этой полу-фразы (это я её ‘выдернул’ из полной фразы Рецензента). А вот её начало: . **Unlike the SM—which is extensively tested and empirically verified**. Послушайте, но ведь авторы НЕ ПРОТИВОПОСТАВЛЯЮТ SM и MLM друг другу. Как бы НАОБОРОТ: с точки зрения physical justification, MLM ‘старается опереться’ на SM. Чуть подправлю/дополню Рецензента: важны вложения U(2) в U(n) и SU(2,2) в SU(n,n).

>4)… raises concerns about the model’s current standing in the scientific literature.

Да о каком-таком СТАТУСЕ (= standing) Вы говорите?! Да у MLM нет НИКАКОГО СТАТУСА! Эта Рецензия – первая, что я

получил (за вот почти уже 10 лет). Была подана статья в Particles, в 2023г ‘по рецензиям’ там был счёт 2-1 в нашу пользу (но все три рецензии были не слишком-то содержательными). Дж.Погосян (главред там) запросил ещё кого-то. Тот дал совет, после которого статью отклонили из-за «ОТСУТСТВИЯ ЛАГРАНЖИАНА»

(см. наше Remark 2 в статье), без права возразить. Хорошо, я догадался (ЗАРАНЕЕ, была такая option в Particles) застолбить приоритет препринтом. Дж.Погосян (незадолго до кончины) пригласил меня в Ереван. В сентябре 2024г я там успешно выступил (получив, кстати, из зала вопрос об ОТСУТСТВИЯ ЛАГРАНЖИАНА). Можно и ещё рассказать про MLM-противодействие/неприятие (вплоть до намеренно испорченных формул при online перепечатке [3]),

In ScienceDirect ур-Эйн ОТО - вместо наших…

>**5)**The model introduces unconventional and ad-hoc definitions, such as protons being "sunken" or "captured", without sufficient theoretical or experimental motivation.

Это физ-матем определения. Считаю, что "sunken" or "captured" protons введены строго. В частности, эл. заряд of "sunken" proton – дробный (в почти полном согласии с SM, кстати, но НЕ ВЕЗДЕ – здесь-то есть одно, по крайней мере, потенциальное место, чтобы **экспериментально опровергнуть** MLM: At U(5), SM- and MLM-data numerically contradict, for SM-quarks’ electric charges: there are 10 colors which implies charges of 7/10 for each of *u*, *c*, *t* and negative 3/10 charges for each of *d*, *s*, *b*. А электрический заряд of "captured" proton равен 1.

>**6)**More critically, the assertion that the MLM-proton is "elementary and indestructible" directly contradicts

MLM-proton элементарен и неуничтожаем (элементарен – согласно строгим определениям – Вигнера и от школы Сигала, неуничтожаем – согласно MLM-подходу); ведь MLM-proton - это математический конструкт, см. >2) выше

>well-established evidence

Ничего подобного, об этом я со Скринским ещё в 90х (у Коптюга) спорил: он говорил, что “вот-вот раздолбаем протон!” Ну и как?

>in high-energy physics, where protons are known to be composite, dynamic systems subject to fragmentation.

Слова, слова, слова... А вот fragmentation (Вы о струях, jets?) как раз-то и довод в пользу МНОГО-УРОВНЕВОСТИ.

>Such claims require far stronger justification than provided.

Считаю, что некоторая (даже немалая) justification есть: все те места, где MLM даёт те предсказания, которые согласуются с SM.

>6) The MLM postulates three new SM quarks, yet it fails to propose a detectable signature or experimental test that could confirm or refute their existence.

Не постулирует, а выводит (из самОй своей стр-ры). Как это fails to propose где искать?! Вот, что в статье : In level U(6), three new SM-quarks are predicted, as illustrated by Figure A3 of Препринта. Т.е. надо с тем текстом разбираться. Там есть ‘намёки’, где искать (см. выше - о нестанд. эл.зарядах кварков , оба замечания предлагают определённую конкретику того, как MLM может быть эксперим. опровергнута).

>**6)**The reintroduction of the Han-Nambu scheme to explain fractional charges adds unnecessary complexity without offering clear advantages over existing SM formulations.

Это – достоинство: нет дробных эл. зарядов. Все (т.н. цветовые) заряды единичны. На уровне U(2) – единственный цветовой заряд интерпр-ся как электр. Усложнение - управляющая группа. Зато на этой основе предсказаны (противоречащие SM) дробные эл.заряды кварков (в некотором диапазоне энергий) – см.выше.

>**7)**Without falsifiable predictions, the model remains purely conjectural.

Без falsifiable predictions? Уже два (см. пп 5 и 6).

>**8)**Last, but not least, the paper looks pathological since most of the citations are to just one of the Authors.

Мне непонятно, в чём здесь pathology?

>9) For example, the Authors mention the conjecture: "at each level, a gluon can be interpreted as a colored and flavored photon". The very formulation of the conjecture looks very strange to a particle physicist. From one side, it is well known that both gluons and photons are described by gauge fields, and of course gluons carry color (but not the flavor in common sense). From the other side, gluons have coupling with themselves, contrary to the photons. So the conjecture looks completely incomprehensible. Как было (СРАЗУ ЖЕ) отмечено выше (в п.1), о глюонах в данной статье речи не идёт. Всё же, поясним, что фотоны и глюоны – это про бозонный клан (по терминологии Сигала, будем говорить проще – про бозоны). В этой conjecture подразумеваются *цвета и поколения* для бозонов. Они нами строго сформулированы для фермионов спина ½. А для бозонов такая схема ещё не сформулирована. В этом смысле мы благодарны Рецензенту. Надеемся, что схема (для бозонов) будет жизнеспособна, что в ней gluons will have coupling with themselves.

С надеждой на продолж. разговора. С уважением,

А.В.Левичев, the corresponding author. Segal, из [5]:

(i) The fermion clan is based on the half-spin repr. of G, as locally SU (2, 2). Equivalently, it is induced to G from the simplest faithful finite-dim. repr. of P, which in the relativistic limit is just the usual spin repr., as extended to

P. (The corresp. reduced particles are massive & massless spinors.)(ii) The boson clan … is similarly based on the adjoint repr. of G. Equivalently, it is induced from a certain 15-dimensional indecomp. repr. of P. (The corr. reduced particles are scalar and vector, as reps. of P_0.)

(iii) The interaction Lagrangian L_I is the essentially unique G-invariant bilinear coupling of the boson clan with the local bilinear fermion clan current. (In the relativistic limit, L_I represents three distinct types of interactions. One is similar to the electroweak Lagrangian without the Higgs boson. The two others are roughly semihadronic and purely hadronic.)(iv) Charged particles are either electrons or composites with electrons. These assumptions determine chronometric theory practically uniquely, apart from a possible enlargement of the boson clan (22) and specification of the role of tachyons (if any).

MLM – это развёрнутая матем. система - просто 'идёшь по ней и смотришь'... В [3], in ROMP-2022, было сравн. с [6]. Лишь недавно (готовя доклад): у них 'наш протон' уже был (с конф веса 5/2), и электрон (вес 3/2), они его так и называли. А вот нейтрино/антинейтрино, у них не было. М.б.потому, что у 'нашего' нейтрино нет конф. веса (и 3/2, и 5/2 есть). Сигал тоже здесь недоработал...It is a part of my Tribute to Ivan Todorov (1933 - February 2025)

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