Do no observations so far of the fourth family quarks speak against the spin-charge-family theory?

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19th workshop "What comes beyond the standard models"

Bled 11 - 19 of July, 2016

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- *New J. of Phys.* (**2011**) 103027, *J. Phys. A: Math. Theor.* **45** (**2012**) 465401, *J. Phys. A: Math. Theor.* **45** (**2012**) 465401, *J. of Mod. Phys.* **4** (**2013**) 823-847, arxiv:1409.4981, **6** (**2015**) 2244-2247, *Phys. Rev.* **D 91** (**2015**) 6, 065004.

We all are are trying to understand:

- **Is Nature simple and elegant in law with one constant only, while complications arrive due to many degrees of freedom of fermions and bosons, with symmetries showing up also in these cases?**
- **Or Nature is neither simple nor elegant in laws, and yet she manifests many times - under special conditions - in extremely elegant ways showing up symmetries?**
  But where then all the constants come from—

- **Spin-Charge-Family theory offers explanation for all the assumptions of the Standard model, for Dark matter, Matter-antimatter asymmetry, ... , making predictions.**
- The **Spin-Charge-Family theory predicts among other things several scalar fields, all with properties of the higgs with respect to the weak and the hyper charge, explaining the appearance of the masses of fermions, their mixing matrices and their couplings to higgs scalar, calledYukawa couplings.**
  It predicts the existence of the fourth family to the observed three.

- **There are no observations so far of the fourth family, predicted by the spin-charge-family theory.**
  Does this mean that the spin-charge-family theory is not the right theory, showing the next step beyond the standard model?

More than **40 years ago**, when **our interpretation of the elementary law of nature looked quite complicated**, the **standard model** **offered an elegant new step in understanding the origin of fermions and bosons by postulating**:

- The existence of the **massless family members**: **coloured quarks and colourless leptons**, **both left and right handed**, the **left handed members** distinguishing from the **right handed ones** in the **weak** and **hyper charges** and correspondingly **mass protected**.

α name	hand-edness $-4iS^{03}S^{12}$	weak charge τ^{13}	hyper charge Y	colour charge	elm charge Q
u^i_L	-1	$\frac{1}{2}$	$\frac{1}{6}$	colour triplet	$\frac{2}{3}$
d^i_L	-1	$-\frac{1}{2}$	$\frac{1}{6}$	colour triplet	$-\frac{1}{3}$
ν^i_L	-1	$\frac{1}{2}$	$-\frac{1}{2}$	colourless	0
e^i_L	-1	$-\frac{1}{2}$	$-\frac{1}{2}$	colourless	-1
u^i_R	1	weakless	$\frac{2}{3}$	colour triplet	$\frac{2}{3}$
d^i_R	1	weakless	$-\frac{1}{3}$	colour triplet	$-\frac{1}{3}$
ν^i_R	1	weakless	0	colourless	0
e^i_R	1	weakless	-1	colourless	-1

Members of each of the $i = 1, 2, 3$ massless families before the electroweak break. Each family contains the left handed weak charged quarks and the right handed weak chargeless quarks, belonging to the colour triplet $(1/2, 1/(2\sqrt{3}))$, $(-1/2, 1/(2\sqrt{3}))$, $(0, -1/(\sqrt{3}))$.

- The existence of **massless families to each of a family member.**

- The existence of the **massless** **gauge fields** to the observed **charges** of the family **members**.

Gauge fields before the electroweak break

- **Three massless vector fields**, **the gauge fields of the three charges**.

name	hand-edness	weak charge	hyper charge	colour charge	elm charge
hyper photon	0	0	0	colourless	0
weak bosons	0	triplet	0	colourless	triplet
gluons	0	0	0	colour octet	0

They all are vectors in $d = (3+1)$, **in the adjoint representations with respect to the weak, colour and hyper charges**.

- The existence of a massive **scalar field** carrying the weak charge $\pm\frac{1}{2}$ and the hyper charge $\mp\frac{1}{2}$ with "nonzero vacuum expectation values", breaking the weak and the hyper charge and correspondingly breaking the **mass protection**.
- **The existence** of the **Yukawa couplings** of fermions to the higgs

$$\mathbf{Y}^{\alpha}\,\frac{\mathbf{v}}{\sqrt{\mathbf{2}}}\,,$$

which, together (with the **gluons** and) the **scalar Higgs** - after it breaks the weak and the hyper charge - take care of the masses of **fermions** and of the **weak bosons**.

- **The Higgs field**, **the scalar in** $d = (3 + 1)$, **a doublet with respect to the weak charge**. $P_R = (-1)^{2s+3B+L} = 1$.

name	hand-edness	weak charge	hyper charge	colour charge	elm charge
$0 \cdot$ **Higgs**$_u$	0	$\frac{1}{2}$	$\frac{1}{2}$	colourless	1
$< Higgs_d >$	0	$-\frac{1}{2}$	$\frac{1}{2}$	colourless	0

name	hand-edness	weak charge	hyper charge	colour charge	elm charge
$< Higgs_u >$	0	$\frac{1}{2}$	$-\frac{1}{2}$	colourless	0
$0 \cdot$ **Higgs**$_d$	0	$-\frac{1}{2}$	$-\frac{1}{2}$	colourless	-1

The *standard model* assumptions have been confirmed without offering surprises.

The last unobserved field, the Higgs scalar, detected in June 2012, was confirmed in March 2013.

The idea that all the fermion and vector fields are massless, if they are free, was an elegant assumption, which is not the case with the massive higgs and also not with so many unexplained assumptions.

What questions should one ask to see the next step beyond the standard model, which would extend the elegance of the standard model and offer the explanation for its assumptions?

I suggest the most urgent questions:

- Where do families originate? Why there exist families at all? How many families are there?
- Why there are left and right handed family members, distinguishing so much in charges?
  Why family members – quarks and leptons – manifest so different properties if they all start as massless?
- How is the origin of the scalar field (the Higgs) and the Yukawa couplings connected with the origin of families?
- How many scalar fields determine properties of the so far (and others possibly be) observed fermions and masses of weak bosons?

- **Why is the Higgs's scalar, or are all the scalar fields, if there are several, doublets with respect to the weak and the hyper charge?**
- **Where do the scalar fields masses originate?**
- **Are there scalar fields with the colour charge in the fundamental representation and where, if they are, do they manifest?**
- **Where does** the **dark matter originate?**
- **Where does** the **dark energy originate and why is it so small?**
- **Where does** the **"ordinary" matter-antimatter asymmetry originate?**
- **Where do** the **charges and correspondingly the so far** (and others possibly be) **observed gauge originate?**

- What is the dimension of space? $(3+1)$?, $((d-1)+1)$?, infinite?
- What is the role of the **symmetries**– discrete, continuous, global and gauge –in Nature?
- **Why there exist fermions and bosons?**
- **And many others.**

My statement:

- **An elegant trustworthy step beyond the standard model must offer answers to several open questions, explaining:**
  o The origin of the charges.
  o The origin and properties of the families.
  o The origin and properties of the scalar fields.
  o The origin and properties of the vector gauge fields.
  o The origin of the dark matter.
  o The origin of the "ordinary" matter-antimatter asymmetry.

- **There exist not yet observed families, gauge fields, scalar fields.**
- **Dimension of space is larger than** 4 (very probably infinite).
- **Inventing a next step which covers only one of the open questions**, **can hardly be the right step.**

In the literature **NO explanation for the existence of the families can be found**, which would not just assume the family groups. Several extensions of the **standard model** are, however, proposed, like:

- **A tiny** extension: The inclusion of the right handed neutrinos into the family.
- The $SU(3)$ group is assumed to describe – not explain – the existence of three families.
  Like the**Higgs's** scalar charges are in the **fundamental** representations of the groups, also the **Yukawas** are assumed to emerge from the scalar fields, in the **fundamental** representation of the $SU(3)$ group.

- **SU(5) and SU(10) grand unified theories are proposed, unifying all the charges.** But the **spin** (the handedness) **is** obviously **connected with** the (weak and the hyper) **charges** and the **appearance of families is not explained**.
- **Supersymmetric theories, assuming the existence of bosons with the charges of quarks and leptons and fermions with the charges of the gauge vector fields, although having several nice properties but not explaining the occurrence of families (except again by assuming larger groups), are not, to my understanding, the right next step beyond the** *standard model*.

The **Spin-Charge-Family** **theory does offer** **the explanation for all the assumptions of the standard model** **and answers several above cited open questions!**

Starting **with a** **simple action for fermions and gravity only** **it is an elegant next step beyond the standard model .**

- A brief introduction into the **spin-charge-family theory**.

- **Spinors carry in $d \geq (13+1)$ two kinds of spin, no charges.**

  O The **Dirac spin (γ^a) in $d = (13+1)$ describes in $d = (3+1)$ the spin and ALL the charges of quarks and leptons, left and right handed.**

  O The **second kind of the spin ($\tilde{\gamma}^a$) describes FAMILIES.**

  O There is **NO third kind of spin.**

- **C,P,T symmetries in $d = (3+1)$ follow from the C,P,T symmetry in $d \geq (13+1)$.** (*JHEP* **04** (**2014**) 165)

- **Spinors interact correspondingly with the vielbeins and the two kinds of the spin connection fields.**
- **In** $d = (3+1)$ the **spin-connection fields, together with the vielbeins, manifest either** as
  o the **vector gauge fields** with all the **charges** in the **adjoint representations** (contribution to the Bled proceedings 2015) or as
  o the **scalar gauge fields** with the **charges with respect to the space index** in the **fundamental representations** and all the other **charges** in the **adjoint representations** or as
  o the **tensor gravitational field**.
- **If there are no spinor sources present, then either vector** $(\vec{A}^A_m,\ m = 0,1,2,3)$ **or scalar** $(\vec{A}^A_s,\ s = 5,6,..,d)$ **gauge fields are determined by vielbeins**.

There are two kinds of scalar fields with respect to the space index s:

- **Those** with zero "spinor charge" and $s = 5, 6, 7, 8$ **are doublets with respect to the weak charge and the second** $SU(2)_{II}$ **charge. They are in the adjoint representations** with respect to the family and the family members **charges**.

  o These scalars explain the Higgs scalar and Yukawa couplings.

- **Those** with twice the "spinor charge" of a quark and $s = 9, 10, ..d$ **are colour triplets. Also they are in the adjoint representations** with respect to the family and the family members **charges**.

  o These scalars transform antileptons into quarks, and antiquarks into quarks and back and correspondingly **contribute to matter-antimatter asymmetry of our universe and to proton decay**.

- **There are no additional scalar fields in the spin-charge-family theory.**

- **The (assumed) scalar condensate of two right handed neutrinos with the family quantum numbers of the upper four families (there are two four family groups in the theory)**, appearing $\approx 10^{16}$ GeV,

  o breaks the CP symmetry, causing the matter-antimatter asymmetry and the proton decay,

  o couples to all the scalar fields, making them massive,

  o couples to all the phenomenologically unobserved vector gauge fields, making them massive.

- The **vector fields, which do not couple to the condensate and remain massless, are:**

  o the hyper charge vector field.

  o the weak vector fields,

  o the colour vector fields,

  o the gravity fields.

  The $SU(2)_{II}$ symmetry breaks due to the condensate.

- **When the scalar fields with the space index $(7,8)$ gain nonzero vacuum expectation values,**
  o they cause the electroweak break,
  o breaking the weak and the hyper charge.
  o They change their own masses,
  o bring masses to the weak bosons,
  o bring masses to the families of quarks and leptons.
- **The only gauge fields which do not couple to these scalars and remain massless are the electromagnetic and colour vector gauge fields, and the gravity.**
- **There are two times four decoupled massive families of quarks and leptons after the electroweak break .**

- **It is extremely encouraging for the spin-charge-family theory, that a simple starting action manifests in the low energy regime all the directly or indirectly observed phenomena and that only the**

  O condensate and

  O nonzero vacuum expectation values of all the scalar fields with $s = (7, 8)$

  explain all the assumptions of the standard model, explaining also the dark matter, the matter/antimatter asymmetry and...

A brief overview of the spin-charge-family theory.

There are two kinds of the Clifford algebra objects (only two):

- The **Dirac γ^a operators** (used by Dirac 90 years ago).
- The **second one:** $\tilde{\gamma}^a$, which I recognized in the Grassmann space.

$$
\begin{aligned}
\{\gamma^{\mathbf{a}}, \gamma^{\mathbf{b}}\}_{+} &= 2\eta^{\mathbf{ab}} = \{\tilde{\gamma}^{\mathbf{a}}, \tilde{\gamma}^{\mathbf{b}}\}_{+}, \\
\{\gamma^{\mathbf{a}}, \tilde{\gamma}^{\mathbf{b}}\}_{+} &= 0, \\
(\tilde{\gamma}^{\mathbf{a}}\mathbf{B} : &= \mathbf{i}(-)^{\mathbf{n_B}}\mathbf{B}\gamma^{\mathbf{a}}\,)\,|\psi_0>, \\
(\mathbf{B} &= a_0 + a_a\gamma^a + a_{ab}\gamma^a\gamma^b + \cdots + a_{a_1\cdots a_d}\gamma^{a_1}\ldots\gamma^{a_d})|\psi_0>
\end{aligned}
$$

$(-)^{n_B} = +1, -1$, when the object B has a Clifford even or odd character, respectively.

$|\psi_0>$ is a vacuum state on which the operators γ^a **apply**.

$$\mathbf{S}^{ab} := (i/4)(\gamma^a\gamma^b - \gamma^b\gamma^a),$$

$$\tilde{\mathbf{S}}^{ab} := (i/4)(\tilde{\gamma}^a\tilde{\gamma}^b - \tilde{\gamma}^b\tilde{\gamma}^a),$$

$$\{\mathbf{S}^{ab}, \tilde{\mathbf{S}}^{cd}\}_- = 0.$$

- $\tilde{\mathbf{S}}^{ab}$ define the equivalent representations with respect to $\mathbf{S}^{ab}$.

My **recognition:**

- If γ^a **are used to describe the spin and the charges of spinors,**
  $\tilde{\gamma}^a$ **can be used to describe families of spinors**.

Must be used!!

- S^{ab}, **applied on the object** B, **extract family members of spinors and determine their quantum numbers**,
- $\tilde{S}^{ab}$, **applied on the spinors, determine to each family member the families and their quantum numbers**,
- $(S^{ab} + \tilde{S}^{ab})$, **applied on the object** B, **extract vector, scalar and tensor states and determine their quantum numbers**.

A simple action for **a spinor which carries in** $d=(13+1)$ **only two kinds of a spin** (no charges) and for **the gauge fields**

$$\mathbf{S} = \int d^dx\, E\, \mathcal{L}_f + \int d^dx\, E\, (\alpha\, R + \tilde{\alpha}\, \tilde{R})$$

$$\mathcal{L}_f = \frac{1}{2}(\bar{\psi}\,\gamma^a p_{0a}\psi) + h.c.$$

$$p_{0a} = f^{\alpha}{}_a p_{0\alpha} + \frac{1}{2E}\,\{p_\alpha, Ef^{\alpha}{}_a\}_-$$

$$\mathbf{p_{0\alpha}} = \mathbf{p}_\alpha - \frac{1}{2}\mathbf{S^{ab}}\omega_{\mathbf{ab}\alpha} - \frac{1}{2}\mathbf{\tilde{S}^{ab}}\tilde{\omega}_{\mathbf{ab}\alpha}$$

- **The only internal degrees of freedom of spinors fermions) are the two kinds of the spin.**
- **The only gauge fields are the gravitational ones – vielbeins and the two kinds of spin connections.**
- **Either γ^a or $\tilde{\gamma}^a$ transform as vectors in d,**

$$\gamma'^a = \Lambda^a{}_b \;\gamma^b\,, \quad \tilde{\gamma}'^a = \Lambda^a{}_b \;\tilde{\gamma}^b\,,$$
$$\delta\gamma^c = -\frac{i}{2}\,\alpha_{ab}\, S^{ab}\,\gamma^c = \alpha^c{}_a \gamma^a\,,$$
$$\delta\tilde{\gamma}^c = -\frac{i}{2}\,\alpha_{ab}\, \tilde{S}^{ab}\,\tilde{\gamma}^c = \alpha^c{}_a\, \tilde{\gamma}^a\,,$$
$$\delta A^{c\ldots ef} = -\frac{i}{2}\,\alpha_{ab}\,\mathcal{S}^{ab}\, A^{c\ldots ef} = \alpha^e{}_a\, A^{c\ldots af}\,,$$
$$\mathcal{S}^{ab}\, A^{c\ldots e\ldots f} = i\,(\eta^{ae}\, A^{c\ldots b\ldots f} - \eta^{be}\, A^{c\ldots a\ldots f})$$

and correspondingly also $f^{\alpha}{}_a\,\omega_{bc\alpha}$ and $f^{\alpha}{}_a\,\tilde{\omega}_{bc\alpha}$ transform as tensors with respect to the flat index a.

- The action for spinors seen from d=(3+1) and analyzed with respect to the standard model groups as subgroups of $SO(1+13)$, J.of Mod.Phys.**4**(**2013**)823:

$$
\begin{aligned}
\mathcal{L}_f &= \bar{\psi}\gamma^m(p_m - \sum_{A,i} g^A \tau^{Ai} A^{Ai}_m)\psi + \\
&\{ \sum_{s=[7],[8]} \bar{\psi}\gamma^s p_{0s}\,\psi\} + \\
&\{ \sum_{s=[5],[6]} \bar{\psi}\gamma^s p_{0s}\,\psi + \\
&\sum_{t=[9],\dots[14]} \bar{\psi}\gamma^t p_{0t}\,\psi\}\,.
\end{aligned}
$$

$$
\begin{aligned}
p_{0m} &= \{p_m - \sum_A g^A \vec{\tau}^A \vec{A}^A_m\} \\
m &\in (0,1,2,3)\,, \\
p_{0s} &= f^{\sigma}_{s}[p_\sigma - \sum_A g^A \vec{\tau}^A \vec{A}^A_\sigma - \sum_A \tilde{g}^A \vec{\tilde{\tau}}^A \vec{\tilde{A}}^A_\sigma]\,, \\
s &\in (7,8)\,, \\
p_{0s} &= f^{\sigma}_{s}[p_\sigma - \sum_A g^A \vec{\tau}^A \vec{A}^A_\sigma - \sum_A \tilde{g}^A \vec{\tilde{\tau}}^A \vec{\tilde{A}}^A_\sigma]\,, \\
s &\in (5,6)\,, \\
p_{0t} &= f^{\sigma'}_{t}(p_{\sigma'} - \sum_A g^A \vec{\tau}^A \vec{A}^A_{\sigma'} - \sum_A \tilde{g}^A \vec{\tilde{\tau}}^A \vec{\tilde{A}}^A_{\sigma'})\,, \\
t &\in (9,10,11,\ldots,14)\,,
\end{aligned}
$$

$$\mathbf{A}^{\mathbf{Ai}}_{\mathbf{s}} = \sum_{\mathbf{a,b}} \mathbf{c}^{\mathbf{Ai}}{}_{\mathbf{ab}} \omega_{\mathbf{abs}} \,,$$

$$\mathbf{A}^{\mathbf{Ai}}_{\mathbf{t}} = \sum_{\mathbf{a,b}} \mathbf{c}^{\mathbf{Ai}}{}_{\mathbf{ab}} \omega_{\mathbf{abt}} \,,$$

$$\tilde{\mathbf{A}}^{\mathbf{Ai}}_{\mathbf{s}} = \sum_{\mathbf{a,b}} \tilde{\mathbf{c}}^{\mathbf{Ai}}{}_{\mathbf{ab}} \tilde{\omega}_{\mathbf{abs}} \,,$$

$$\tilde{\mathbf{A}}^{\mathbf{Ai}}_{\mathbf{t}} = \sum_{\mathbf{a,b}} \tilde{\mathbf{c}}^{\mathbf{Ai}}{}_{\mathbf{ab}} \tilde{\omega}_{\mathbf{abt}} \,.$$

$$
\begin{aligned}
\tau^{\mathbf{Ai}} &= \sum_{a,b} c^{Ai}{}_{ab}\, \mathbf{S}^{\mathbf{ab}}\,,\\
\tilde{\tau}^{\mathbf{Ai}} &= \sum_{a,b} \tilde{c}^{Ai}{}_{ab}\, \tilde{\mathbf{S}}^{\mathbf{ab}}\,,\\
\{\tau^{\mathbf{Ai}}, \tau^{\mathbf{Bj}}\}_- &= i\delta^{AB} f^{Aijk} \tau^{\mathbf{Ak}}\,,\\
\{\tilde{\tau}^{\mathbf{Ai}}, \tilde{\tau}^{\mathbf{Bj}}\}_- &= i\delta^{AB} f^{Aijk} \tilde{\tau}^{\mathbf{Ak}}\,,\\
\{\tau^{\mathbf{Ai}}, \tilde{\tau}^{\mathbf{Bj}}\}_- &= 0\,.
\end{aligned}
$$

o τ^{Ai} represents the standard model charge groups,
for the second $SU(2)_{II}$,
for the "spinor" charge,
$\tilde{\tau}^{Ai}$ denote the family quantum numbers.

$$
\begin{aligned}
\vec{N}_{(L,R)} : &= \frac{1}{2}(S^{23} \pm iS^{01}, S^{31} \pm iS^{02}, S^{12} \pm iS^{03}) \,, \\
\vec{\tau}^{(1,2)} : &= \frac{1}{2}(S^{58} \mp S^{67}, \; S^{57} \pm S^{68}, \; S^{56} \mp S^{78}) \,, \\
\vec{\tau}^{3} := & \quad \frac{1}{2}\, \{S^{9\,12} - S^{10\,11}\,, S^{9\,11} + S^{10\,12}, \; S^{9\,10} - S^{11\,12}, \\
& \quad S^{9\,14} - S^{10\,13}, \; S^{9\,13} + S^{10\,14}\,, S^{11\,14} - S^{12\,13}\,, \\
& \quad S^{11\,13} + S^{12\,14}, \; \frac{1}{\sqrt{3}}(S^{9\,10} + S^{11\,12} - 2S^{13\,14})\} \,, \\
\tau^{4} := & \quad -\frac{1}{3}(S^{9\,10} + S^{11\,12} + S^{13\,14}) \,, \qquad Y := \tau^{4} + \tau^{23} \,, \\
Y' := & \quad -\tau^{4} \tan^{2}\vartheta_{2} + \tau^{23}, \, Q := \tau^{13} + Y, \, Q' := -Y \tan^{2}\vartheta_{1} + \tau^{13} \,,
\end{aligned}
$$

and equivalently for $\tilde{S}^{ab}$ and $\mathcal{S}^{ab}$.

Breaks of symmetries when starting with the **massless spinors** (fermions), **vielbeins and two kinds of spin connection fields**

The action

$$\mathbf{SO(1,13)} \times \widetilde{\mathbf{SO}(1,13)} \times$$

BREAK I

$$\downarrow$$

$$\mathbf{SO(1,7)} \times \qquad \mathbf{U(1)} \times \qquad \mathbf{SU(3)}$$
$$\times \widetilde{\mathbf{SO}(1,7)}$$

$$\swarrow \qquad \searrow$$

eight massless families

$$\mathbf{SO(1,3)} \times \mathbf{SO(4)} \times \mathbf{U(1)} \times \quad (\widetilde{\mathbf{SU}}(2)_{\mathbf{I}_{\widetilde{\mathbf{SO}}(1,3)}} \times \widetilde{\mathbf{SU}}(2)_{\mathbf{I}_{\widetilde{\mathbf{SO}}(4)}}) \times \quad (\widetilde{\mathbf{SU}}(2)_{\mathbf{II}_{\widetilde{\mathbf{SO}}(1,3)}} \times \widetilde{\mathbf{SU}}(2)_{\mathbf{II}_{\widetilde{\mathbf{SO}}(4)}}) \times \quad \mathbf{SU(3)}$$

(devided into two groups)

BREAK II

$$\downarrow$$

The Standard Model like way of breaking

$$\downarrow$$

$$\mathbf{SO(1,3)} \times \mathbf{U(1)} \times \mathbf{SU(3)}$$
$$\times (\text{two groups of four massive families})$$

Breaking the starting symmetry from:

- $SO(1,13) \times \widetilde{SO}(1,13)$ to
  $SO(1,7) \times \widetilde{SO}(1,7) \times U(1)_{II} \times SU(3)$ (at E $\geq 10^{16}$ GeV)

  O makes the spin (the handedness) in $d = (1+3)$ of two massless groups of four families of spinors connected with the weak and the hyper charge ,

- $SO(1,7) \times \widetilde{SO}(1,7) \times U(1)_{II} \times SU(3)$ to
  $SO(1,3) \times SU(2)_{I} \times SU(2)_{II} \times U(1)_{II} \times SU(3)$
  $\widetilde{SO}(1,3) \times \widetilde{SU}(2)_{I} \times \widetilde{SU}(2)_{II}$

  O makes that each member of the two groups of four massless families manifests in $d = (1+3)$ the weak ($SU(2)_{I}$), the hyper ($SU(2)_{II}$), the colour ($SU(3)$) and the "spin charge" ($U(1) = \tau^4$).

- **Both breaks leave** **eight families** **($2^{8/2-1}=8$, determined by the symmetry of $SO(1,7)$) massless.**

- **The appearance of the condensate of the two right handed neutrinos, coupled to spin 0, makes all the boson fields**

  O that is the scalar fields with the space index $s \geq 5$

  O and the vector bosons, $m \leq 3$, with the charge which is the superposition of $(SU(2)_{II})$ and $\mathbf{U(1)_{II}}$, massive,

  O while the colour, elm, weak and hyper vector gauge fields remain massless.

- **In Ref. [arXiv:1604.00675] it is proven the one-to-one correspondence between** the **vielbeins in the Kaluza-Klein theories, which represent gauge fields in (d=(3+1)) after the isometry procedure, and the spin connection fields used in the** *spin-charge-family* **theory to describe the vector gauge fields in** $d=(3+1)$**.**
- **The vielbeins** $f^{\sigma}{}_{m}$ **relation to the spin connections:**

$$\mathbf{f}^{\sigma}{}_{\mathbf{m}} = -\mathbf{i} \sum_{\mathbf{A}} \tilde{\mathbf{A}}^{\mathbf{A}}_{\mathbf{m}} \tilde{\tau}^{\mathbf{A}\sigma}{}_{\tau} \mathbf{x}^{\tau} \,,$$

$\vec{A}^{A}_{m}$ **are the superposition of** $\omega^{st}{}_{m}$, $A^{Ai}_{m} = c^{Ai}{}_{st}\, \omega^{st}{}_{m}$, **what demonstrates the symmetry of the space with** $s \geq 5$.

- **At the electroweak break** from
  $SO(1,3) \times SU(2)_I \times U(1)_I \times SU(3)$ to
  $SO(1,3) \times U(1) \times SU(3)$
  the scalar fields with the space index $s = (7,8)$ **obtain nonzero vacuum expectation values**,
  O breaking correspondingly the weak and the hyper charge and changing their own masses.
  O They leave massless only the colour and the elm gauge fields, while all eight massless families gain masses.

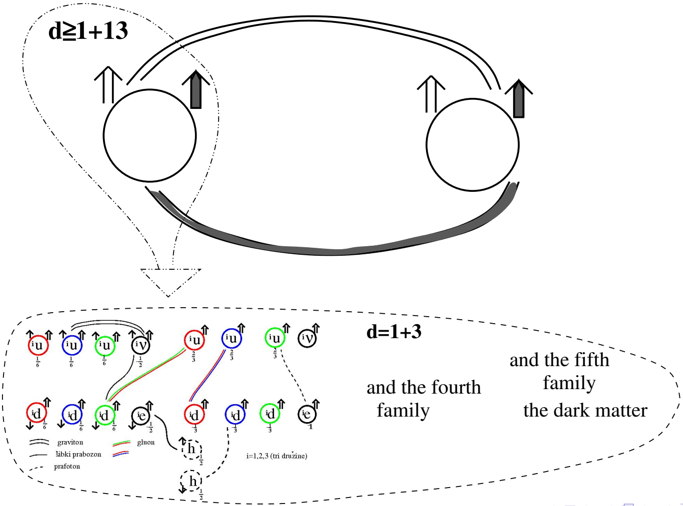
- **To the electroweak break several scalar fields contribute, all with the weak and the hyper charge of the *standard model* Higgs, carrying besides the weak and the hyper charge either the family members quantum numbers (Q,Q',Y') or the family quantum numbers.**

- **Both, $SO(n)$ and $\widetilde{SO}(n)$ break simultaneously.**
- We studied (with H.B. Nielsen, D. Lukman) on a toy model of $d = (1 + 5)$ conditions which lead after breaking symmetries to massless spinors chirally coupled to the Kaluza-Klein-like gauge fields, New J.Phys.**13**(2011)103027,1-25.

- **Is Nature elegant with simple laws**

$$\mathbf{S} \;=\; \int d^d x\, E\, \mathcal{L}_f + \int d^d x\, E\, (\alpha\, R + \tilde{\alpha}\, \tilde{R})\,,$$

Or it is complicated and only "from time to time" symmetries show up?


d≧1+13
d=1+3
and the fourth family
and the fifth family
the dark matter
graviton
šibki prabozon
prafoton
gluon
i=1,2,3 (tri družine)

Our technique to represent spinors is elegant.

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- *J. of Math. Phys.* **43**, 5782-5803 (2002), hep-th/0111257,
- *J. of Math. Phys.* **44** 4817-4827 (2003), hep-th/0303224,
- *J. of High Ener. Phys.* **04** (2014) 165, arxiv:1212.2362v2, the last three with H.B. Nielsen.

$$\stackrel{ab}{(\pm i)}: \;=\; \frac{1}{2}(\gamma^a \mp \gamma^b), \; \stackrel{ab}{[\pm i]} := \frac{1}{2}(1 \pm \gamma^a \gamma^b)$$
$$\text{for } \eta^{aa}\eta^{bb} = -1,$$
$$\stackrel{ab}{(\pm)}: \;=\; \frac{1}{2}(\gamma^a \pm i\gamma^b), \; \stackrel{ab}{[\pm]} := \frac{1}{2}(1 \pm i\gamma^a \gamma^b),$$
$$\text{for } \eta^{aa}\eta^{bb} = 1$$

with γ^a which are the usual **Dirac operators**

Our technique

$$\mathbf{S}^{ab} \overset{ab}{(\mathbf{k})} = \frac{k}{2} \overset{ab}{(\mathbf{k})}, \quad \mathbf{S}^{ab} \overset{ab}{[\mathbf{k}]} = \frac{k}{2} \overset{ab}{[\mathbf{k}]},$$

$$\tilde{\mathbf{S}}^{ab} \overset{ab}{(\mathbf{k})} = \frac{k}{2} \overset{ab}{(\mathbf{k})}, \quad \tilde{\mathbf{S}}^{ab} \overset{ab}{[\mathbf{k}]} = -\frac{k}{2} \overset{ab}{[\mathbf{k}]}.$$

γ^a **transforms** $\overset{ab}{(k)}$ **into** $\overset{ab}{[-k]}$**, never to** $\overset{ab}{[k]}$**.**

$\tilde{\gamma}^a$ transforms $\overset{ab}{(k)}$ **into** $\overset{ab}{[k]}$**, never to** $\overset{ab}{[-k]}$**.**

- One Weyl representation of one family contains all the **family members** with the **right handed neutrinos included**. It includes also **antimembers**, reachable by $\mathbb{C}_{\mathcal{N}}\ \mathcal{P}_{\mathcal{N}}$ **on a family member**.
- There are $2^{(7+1)/2-1} = 8$ **families**, which decouple into twice four families, with the quantum numbers $(\tilde{\tau}^{2i}, \tilde{N}_R^i)$ and $(\tilde{\tau}^{1i}, \tilde{N}_L^i)$, respectively.

S^{ab} generate **all the members of one family**. The eightplet (the representation of $SO(7,1)$) of quarks of a particular colour charge

i		$\|^a\psi_i>$	$\Gamma^{(3,1)}$	S^{12}	$\Gamma^{(4)}$	τ^{13}	τ^{23}	Y	τ^4
		Octet, $\Gamma^{(7,1)}=1$, $\Gamma^{(6)}=-1$, of quarks							
1	$\mathbf{u_R^{c1}}$	$\stackrel{03}{(+\mathbf{i})}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	1	$\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{1}{6}$
2	u_R^{c1}	$\stackrel{03}{[-i]}\stackrel{12}{[-]} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	1	$-\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{1}{6}$
3	d_R^{c1}	$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{[-]}\stackrel{78}{[-]} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	1	$\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{1}{3}$	$\frac{1}{6}$
4	$\mathbf{d_R^{c1}}$	$\stackrel{03}{[-\mathbf{i}]}\stackrel{12}{[-]} \mid \stackrel{56}{[-]}\stackrel{78}{[-]} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	1	$-\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{1}{3}$	$\frac{1}{6}$
5	d_L^{c1}	$\stackrel{03}{[-i]}\stackrel{12}{(+)} \mid \stackrel{56}{[-]}\stackrel{78}{(+)} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	-1	$\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
6	$\mathbf{d_L^{c1}}$	$\stackrel{03}{(+\mathbf{i})}\stackrel{12}{[-]} \mid \stackrel{56}{[-]}\stackrel{78}{(+)} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	-1	$-\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
7	$\mathbf{u_L^{c1}}$	$\stackrel{03}{[-\mathbf{i}]}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{[-]} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	-1	$\frac{1}{2}$	-1	$\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
8	u_L^{c1}	$\stackrel{03}{(+i)}\stackrel{12}{[-]} \mid \stackrel{56}{(+)}\stackrel{78}{[-]} \mid\mid \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(-)}\;\stackrel{13\,14}{(-)}$	-1	$-\frac{1}{2}$	-1	$\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$

$\gamma^0\gamma^7$ and $\gamma^0\gamma^8$ transform $\mathbf{u_R}$ of the 1^{st} row into $\mathbf{u_L}$ of the 7^{th} row, and $\mathbf{d_R}$ of the 4^{rd} row into $\mathbf{d_L}$ of the 6^{th} row, doing what the Higgs scalars and γ^0 do in the Stan. model.

The **anti-eightplet** (the representation of $SO(7,1)$) of anti-quarks of the anti-colour charge, reachable by either S^{ab} or $\mathbb{C}_{\mathcal{N}}\mathcal{P}_{\mathcal{N}}^{(d-1)}$:

i		$\|^{a}\psi_i >$	$\Gamma^{(3,1)}$	S^{12}	$\Gamma^{(4)}$	τ^{13}	τ^{23}	Y	τ^{4}
		Antioctet, $\Gamma^{(7,1)} = -1$, $\Gamma^{(6)} = 1$, of antiquarks							
33	$\bar{\mathbf{d}}_{\mathbf{L}}^{\bar{\mathbf{c}}\mathbf{1}}$	$\overset{03}{[-i]}\overset{12}{(+)} \mid \overset{56}{(+)}\overset{78}{(+)} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	-1	$\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{6}$
34	$\bar{d}_L^{\bar{c}1}$	$\overset{03}{(+i)}\overset{12}{[-]} \mid \overset{56}{(+)}\overset{78}{(+)} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	-1	$-\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{6}$
35	$\bar{u}_L^{\bar{c}1}$	$\overset{03}{[-i]}\overset{12}{(+)} \mid \overset{56}{[-]}\overset{78}{[-]} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	-1	$\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{2}{3}$	$-\frac{1}{6}$
36	$\bar{\mathbf{u}}_{\mathbf{L}}^{\bar{\mathbf{c}}\mathbf{1}}$	$\overset{03}{(+i)}\overset{12}{[-]} \mid \overset{56}{[-]}\overset{78}{[-]} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	- 1	$-\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{2}{3}$	$-\frac{1}{6}$
37	$\bar{\mathbf{d}}_{\mathbf{R}}^{\bar{\mathbf{c}}\mathbf{1}}$	$\overset{03}{(+i)}\overset{12}{(+)} \mid \overset{56}{(+)}\overset{78}{[-]} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	1	$\frac{1}{2}$	-1	$\frac{1}{2}$	0	$-\frac{1}{6}$	$-\frac{1}{6}$
38	$\bar{d}_R^{\bar{c}1}$	$\overset{03}{[-i]}\overset{12}{[-]} \mid \overset{56}{(+)}\overset{78}{[-]} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	1	$-\frac{1}{2}$	-1	$\frac{1}{2}$	0	$-\frac{1}{6}$	$-\frac{1}{6}$
39	$\bar{u}_R^{\bar{c}1}$	$\overset{03}{(+i)}\overset{12}{(+)} \mid \overset{56}{[-]}\overset{78}{(+)} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	1	$\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$-\frac{1}{6}$	$-\frac{1}{6}$
40	$\bar{\mathbf{u}}_{\mathbf{R}}^{\bar{\mathbf{c}}\mathbf{1}}$	$\overset{03}{[-i]}\overset{12}{[-]} \mid \overset{56}{[-]}\overset{78}{(+)} \mid\mid \overset{9\,10}{[-]}\;\overset{11\,12}{[+]}\;\overset{13\,14}{[+]}$	1	$-\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$-\frac{1}{6}$	$-\frac{1}{6}$

$\gamma^0\gamma^7$ and $\gamma^0\gamma^8$ transform $\bar{\mathbf{d}}_{\mathbf{L}}$ of the 1^{st} row into $\bar{\mathbf{d}}_{\mathbf{R}}$ of the 5^{th} row, and $\bar{\mathbf{u}}_{\mathbf{L}}$ of the 4^{rd} row into $\bar{\mathbf{u}}_{\mathbf{R}}$ of the 8^{th} row.

- **All the vector gauge fields, manifesting at the observable energies, have all the properties assumed by the *standard model*.**
  They carry with respect to the space index $m \in (0,1,2,3)$ the vector degrees of freedom while they have additional internal degrees of freedom ($\tau^{Ai} = \sum_{st} c^{Ai}{}_{st}$) in the adjoint representations.

Analyzing all the indexes of the gauge fields, manifesting at low energy, with respect to $\mathcal{S}^{ab}$, where $A^{Ai}_{m} = C^{Aist}\,\omega_{stm}$ and $\mathcal{S}^{ab}$, applies on index (s,t,m) as follows

$$\mathcal{S}^{ab}\,\omega_{stm\dots g} \;=\; i\,(\delta^a_s\,\omega^b_{tm\dots g} - \delta^b_s\,\omega^a_{tm\dots g})\,,$$

one finds that the weak, colour and hyper charge fields have just the properties required for them by the *standard model*.

- **There are several scalar gauge fields - twice three triplets with respect to the family quantum numbers ($\tilde{\tau}^{Ai} = \sum \tilde{c}^{Ai}{}_{ab} \tilde{S}^{ab}$) and three singlets with the quantum numbers (Q,Q',Y') - which manifest at the so far observable energies explaining the Higgs's scalar** and **the Yukawa couplings**.
  They all carry the weak charge and the hyper charge as required by the *standard model* **for the Higg's scalar**, **while all the rest of quantum numbers are in the adjoint representations**.

Their properties have to be analyzed with respect to the generators of the corresponding subgroups, expressible with $\mathcal{S}^{ab}$.

The scalar condensate of two right handed neutrinos couple to all the scalar and vector gauge fields, **except to the weak charge $SU(2)_I$, the hyper charge $U(1)$**, and **the colour $SU(3)$ charge gauge fields, as well as the gravity, leaving them massless**, J.of Mod.Phys.**4**(**2013**)823-847, J.of Mod.Phys.**6**(**2015**)2244-2247, Phys Rev.**D 91**(**2015**)6,065004.

state	S^{03}	S^{12}	τ^{13}	τ^{23}	τ^{4}	Y	Q	$\tilde{\tau}^{13}$	$\tilde{\tau}^{23}$	$\tilde{Y}$	$\tilde{Q}$	$\tilde{N}^3_R$	$\tilde{N}^3_L$
$\vert\nu^{\mathbf{VIII}}_{\mathbf{1R}} >_1 \vert\nu^{\mathbf{VIII}}_{\mathbf{2R}} >_2$	0	0	0	1	-1	0	0	0	1	0	0	1	0
$\vert\nu^{VIII}_{1R} >_1 \vert e^{VIII}_{2R} >_2$	0	0	0	0	-1	-1	-1	0	1	0	0	1	0
$\vert e^{VIII}_{1R} >_1 \vert e^{VIII}_{2R} >_2$	0	0	0	-1	-1	-2	-2	0	1	0	0	1	0

Before the appearance of the condensate, which breaks the CP symmetry,

scalars form

- **2 doublets**, $s = (5, 6, 7, 8)$, and
- **a triplet and an antitriplet**, $s = (9, \ldots, 14)$.

There are no additional scalars.

All the scalars have the family and the family members quantum numbers in the **adjoint** representation.

The two doublets are:

	state	τ^{13}	$\tau^{23}=Y$	spin	τ^4	Q
$A^{Ai}_{\substack{78\\(-)}}$	$A^{Ai}_7 + iA^{Ai}_8$	$+\frac{1}{2}$	$-\frac{1}{2}$	0	0	0
$A^{Ai}_{\substack{56\\(-)}}$	$A^{Ai}_5 + iA^{Ai}_6$	$-\frac{1}{2}$	$-\frac{1}{2}$	0	0	-1
$A^{Ai}_{\substack{78\\(+)}}$	$A^{Ai}_7 - iA^{Ai}_8$	$-\frac{1}{2}$	$+\frac{1}{2}$	0	0	0
$A^{Ai}_{\substack{56\\(+)}}$	$A^{Ai}_5 - iA^{Ai}_6$	$+\frac{1}{2}$	$+\frac{1}{2}$	0	0	$+1$

There are $A^{Ai}_{\substack{78\\(-)}}$ and $A^{Ai}_{\substack{78\\(+)}}$ which gain a nonzero vacuum expectation values at the electroweak break.

Index Ai determine the family ($\tilde{\tau}^{Ai}$) and the family members (Q,Q',Y') quantum numbers.

Scalars with s=(7,8) gain nonzero vacuum expectation values breaking the weak and the hyper symmetry, and conserving the electromagnetic and colour charge.

$$\begin{aligned} \mathbf{A}^{\mathbf{Ai}}_{\mathbf{s}} &\supset (\mathbf{A}^{\mathbf{Q}}_{\mathbf{s}}, \mathbf{A}^{\mathbf{Q}'}_{\mathbf{s}}, \mathbf{A}^{\mathbf{Y}'}_{\mathbf{s}}, \tilde{\tilde{\mathbf{A}}}^{\tilde{1}}_{\mathbf{s}}, \tilde{\tilde{\mathbf{A}}}^{\tilde{\mathbf{N}}_{\tilde{\mathbf{L}}}}_{\mathbf{s}}, \tilde{\tilde{\mathbf{A}}}^{\tilde{2}}_{\mathbf{s}}), \\ \tau^{\mathbf{Ai}} &\supset (\mathbf{Q}, \quad \mathbf{Q}', \quad \mathbf{Y}', \quad \tilde{\tilde{\tau}}^{1}, \quad \tilde{\tilde{\mathbf{N}}}_{\mathbf{L}}), \\ \mathbf{s} &= (\mathbf{7}, \mathbf{8}). \end{aligned}$$

Ai denotes family quantum numbers and (Q, Q', Y'), $(\tilde{\tilde{\tau}}^{1}, \ \tilde{\tilde{\mathbf{N}}}_{\mathbf{L}})$ quantum numbers of the first group of four families and
$(\tilde{\tilde{\tau}}^{2}, \ \tilde{\tilde{\mathbf{N}}}_{\mathbf{R}}))$ quantum numbers of the second group of four families.

The **mass term** in the **starting action** (p_s, when treating the lowest energy solutions, is left out) is

$$
\begin{aligned}
\mathcal{L}_M &= \sum_{s=(7,8),Ai} \bar{\psi}\,\gamma^s\,(-\tau^{Ai}\,A^{Ai}_s\,)\psi = \\
&-\bar{\psi}\,\{\,\overset{78}{(+)}\;\tau^{Ai}\,(A^{Ai}_7 - i\,A^{Ai}_8) + \overset{78}{(-)}\;\tau^{Ai}\,(A^{Ai}_7 + i\,A^{Ai}_8)\,\}\psi\;,
\end{aligned}
$$

$$
\overset{78}{(\pm)} = \frac{1}{2}\,(\gamma^7 \pm\, i\,\gamma^8\,)\,,\quad A^{Ai}_{\overset{78}{(\pm)}} := (A^{Ai}_7 \mp i\,A^{Ai}_8)\,.
$$

Operators Y, Q and τ^{13}, applied on $(A^{Ai}_{7} \mp i\, A^{Ai}_{8})$

$$
\begin{aligned}
\tau^{13}\,(A^{Ai}_{7} \mp i\, A^{Ai}_{8}) &= \pm\frac{1}{2}\,(A^{Ai}_{7} \mp i\, A^{Ai}_{8})\,,\\
\mathbf{Y}\,(A^{Ai}_{7} \mp i\, A^{Ai}_{8}) &= \mp\frac{1}{2}\,(A^{Ai}_{7} \mp i\, A^{Ai}_{8})\,,\\
\mathbf{Q}\,(A^{Ai}_{7} \mp i\, A^{Ai}_{8}) &= 0\,,
\end{aligned}
$$

manifest that **all** $(A^{Ai}_{7} \mp i\, A^{Ai}_{8})$ have quantum numbers of the **Higgs's scalar of the standard model**, "dressing", after **gaining nonzero expectation values**, the right handed members of a family with appropriate charges, so that they gain charges of the left handed partners:
$A^{Ai}_{7} + i\, A^{Ai}_{8}$ "dresses" u_R, ν_R and $A^{Ai}_{7} - i\, A^{Ai}_{8}$ "dresses" d_R, e_R, with quantum numbers of their left handed partners, just as required by the "standard model".

Ai represents:

O either the **Q,Q',Y' charges of** the **family members**

O or **transforms a family member of one family into the same family member of another family, within each** of the **two groups of four families**,

manifesting in each group of four families $\widetilde{SU}(2) \times \widetilde{SU}(2) \times U(1)$ **symmetry**.

Eight families of u_R (spin 1/2, colour $(\frac{1}{2}, \frac{1}{2\sqrt{3}})$) and of colourless ν_R (spin 1/2). All have the weak charge $\tau^{13} = 0$, $\tau^{23} = \frac{1}{2}$, $\tilde{\tau}^4 = -\frac{1}{2}$. Quarks have "spinor" q.no. $\tau^4 = \frac{1}{6}$ and leptons $\tau^4 = -\frac{1}{2}$. The first four families have $\tilde{\tau}^{23} = 0$, $\tilde{N}^3_R = 0$, the second four families have $\tilde{\tau}^{13} = 0$, $\tilde{N}^3_L = 0$.

				$\tilde{\tau}^{13}$	$\tilde{N}^3_L$
$u^{c1}_{R\,1}$	$\stackrel{03}{(+i)}\stackrel{12}{[+]} \mid \stackrel{56}{[+]}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,1}$	$\stackrel{03}{(+i)}\stackrel{12}{[+]} \mid \stackrel{56}{[+]}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$-\frac{1}{2}$	$-\frac{1}{2}$
$u^{c1}_{R\,2}$	$\stackrel{03}{[+i]}\stackrel{12}{(+)} \mid \stackrel{56}{[+]}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,2}$	$\stackrel{03}{[+i]}\stackrel{12}{(+)} \mid \stackrel{56}{[+]}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$-\frac{1}{2}$	$\frac{1}{2}$
$u^{c1}_{R\,3}$	$\stackrel{03}{(+i)}\stackrel{12}{[+]} \mid \stackrel{56}{(+)}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,3}$	$\stackrel{03}{(+i)}\stackrel{12}{[+]} \mid \stackrel{56}{(+)}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$\frac{1}{2}$	$-\frac{1}{2}$
$u^{c1}_{R\,4}$	$\stackrel{03}{[+i]}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,4}$	$\stackrel{03}{[+i]}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$\frac{1}{2}$	$\frac{1}{2}$
				$\tilde{\tau}^{23}$	$\tilde{N}^3_R$
$u^{c1}_{R\,5}$	$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,5}$	$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$-\frac{1}{2}$	$-\frac{1}{2}$
$u^{c1}_{R\,6}$	$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{[+]}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,6}$	$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{[+]}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$-\frac{1}{2}$	$\frac{1}{2}$
$u^{c1}_{R\,7}$	$\stackrel{03}{[+i]}\stackrel{12}{[+]} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,7}$	$\stackrel{03}{[+i]}\stackrel{12}{[+]} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$\frac{1}{2}$	$-\frac{1}{2}$
$u^{c1}_{R\,8}$	$\stackrel{03}{[+i]}\stackrel{12}{[+]} \mid \stackrel{56}{[+]}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{[-]}\;\stackrel{13\,14}{[-]}$	$\nu_{R\,8}$	$\stackrel{03}{[+i]}\stackrel{12}{[+]} \mid \stackrel{56}{[+]}\stackrel{78}{[+]} \parallel \stackrel{9\,10}{(+)}\;\stackrel{11\,12}{(+)}\;\stackrel{13\,14}{(+)}$	$\frac{1}{2}$	$\frac{1}{2}$

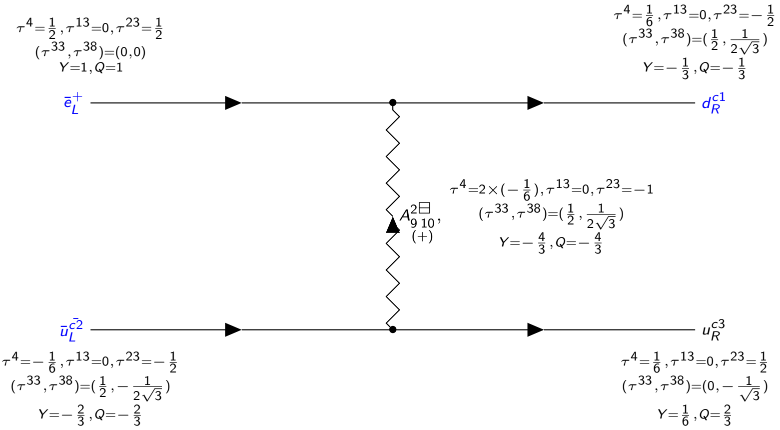
Before the electroweak break all the families are mass protected and correspondingly massless.

There are also triplet and anti-triplet scalars $s = (9, .., d)$:

	state	τ^{33}	τ^{38}	spin	τ^4	Q
$A^{Ai}_{9\,10\,(+)}$	$A^{Ai}_9 - iA^{Ai}_{10}$	$+\frac{1}{2}$	$\frac{1}{2\sqrt{3}}$	0	$-\frac{1}{3}$	$-\frac{1}{3}$
$A^{Ai}_{11\,12\,(+)}$	$A^{Ai}_{11} - iA^{Ai}_{12}$	$-\frac{1}{2}$	$\frac{1}{2\sqrt{3}}$	0	$-\frac{1}{3}$	$-\frac{1}{3}$
$A^{Ai}_{13\,14\,(+)}$	$A^{Ai}_{13} - iA^{Ai}_{14}$	0	$-\frac{1}{\sqrt{3}}$	0	$-\frac{1}{3}$	$-\frac{1}{3}$
$A^{Ai}_{9\,10\,(-)}$	$A^{Ai}_9 + iA^{Ai}_{10}$	$-\frac{1}{2}$	$-\frac{1}{2\sqrt{3}}$	0	$+\frac{1}{3}$	$+\frac{1}{3}$
$A^{Ai}_{11\,12\,(-)}$	$A^{Ai}_{11} + iA^{Ai}_{12}$	$\frac{1}{2}$	$-\frac{1}{2\sqrt{3}}$	0	$+\frac{1}{3}$	$+\frac{1}{3}$
$A^{Ai}_{13\,14\,(-)}$	$A^{Ai}_{13} + iA^{Ai}_{14}$	0	$\frac{1}{\sqrt{3}}$	0	$+\frac{1}{3}$	$+\frac{1}{3}$

They cause the transitions of anti-leptons into quarks and anti-quarks into quarks and back, transforming matter into antimatter and back. The condensate breaks CP symmetry, offering the explanation for the matter-antimatter asymmetry in the universe.

Let us look at scalar triplets, causing the **birth of a proton** from the left handed **positron**, **antiquark** and **quark**:



These two quarks, d_R^{c1} and u_R^{c3} can bind (at low enough energy) together with u_R^{c2} into the colour **chargeless baryon - a proton**.

After the appearance of the **condensate** the **CP is broken**.

In the expanding universe, fulfilling the Sakharov request for appropriate nonthermal equillibrium, **these triplet scalars have a chance to explain the matter-antimatter asymmetry**.

The opposite transition makes the proton decay.

- Due to

$$\tau^{1+}\tau^{1-}\,\mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(+)}} = \mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(+)}}\,,$$
$$\tau^{1-}\tau^{1+}\,\mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(-)}} = \mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(-)}}\,,$$
$$Q\,\mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(\mp)}} = 0\,,$$
$$Q'\,\mathbf{A}^{\mathbf{Ai}}{}_{\stackrel{78}{(\mp)}} = \pm\frac{1}{2\cos^2\theta_1}\,,\mathbf{Ai}^{\mathbf{Ai}}{}_{\stackrel{78}{(\mp)}}\,.\,,$$

the **vector gauge fields** $A^{1\pm}_m (= W^{\pm}_m)$ and $A^{Q'}_m\ (= Z_m)$ $= \cos\theta_1 A^{13}_m - \sin\theta_1 A^Y_m$ become massive, while $A^Q_m\ (= A_m)$ $= \sin\theta_2 A^{13}_m + \cos\theta_1 A^Y_m$ remain massless, if $\frac{g^1}{g^Y}\tan\theta_1 = 1\,.$

- Correspondingly the mass term of the **vector gauge bosons** is

$$(p_{0m}\, A^{Ai}_{\substack{78\\(\mp)}})^{\dagger}\, (p_0{}^{m}\, A^{Ai}_{\substack{78\\(\mp)}}) \to$$
$$(\frac{1}{2})^2\, (g^1)^2\, v^2 (\frac{1}{(\cos\theta_1)^2}\, Z^{Q'}_{m} Z^{Q'\, m} + 2\, W^{+}_{m} W^{-\, m})\,,$$

$$Tr(< A^{Ai\dagger}_{\mp} >< A^{vAi}_{\mp} >) = \frac{v^2}{2}\,.$$

- **It must be shown how can all the scalars contribute so little to the heavy bosons mass.**

$$v^2 = \frac{m^2}{\Lambda}$$

- These scalars with the weak and the hyper charge $(\mp\frac{1}{2}, \pm\frac{1}{2})$, respectively, determine together with the **gauge vector fields** masses of all the members α of the **lower four families**, and together with the **condensate** **also the masses** of the **upper four families**. **The group of the lower four families** manifest the $\widetilde{SU}(2)_{\widetilde{SO}(1,3)} \times \widetilde{SU}(2)_{\widetilde{SO}(4)} \times U(1)$ **symmetry** (after all loop corrections, what we have shown, I believe), with $(\mathbf{a}, \mathbf{a_1}, \mathbf{a_2}, \mathbf{e}, \mathbf{d}, \mathbf{b}$ as parameters:

$$\mathcal{M}^{\alpha} = \begin{pmatrix} -a_1 - a & e & d & b \\ e & -a_2 - a & b & d \\ d & b & a_2 - a & e \\ b & d & e & a_1 - a \end{pmatrix}^{\alpha} .$$

Does the fourth family exist at all?

- No direct observation of the fourth family quarks with the masses below 1 TeV.
- The fourth family quarks with masses above 1 TeV contributions to the quark-gluon fusion production of higgs would be according to the *standard model* proportional to $\frac{m_4^{\alpha}}{v}$, $\alpha = u, d$, and correspondingly ≈ 10 times too much in comparison with the observations.
- Similarly it goes also for the scalar field decay into two photons.
- Correspondingly the high energy physicists do not expect the existence of the fourth family members at all.

Let us try to understand whether the observations really forbid the fourth family!

- In the *spin-charge-family* **theory** there are **two triplets with the family quantum numbers** and **three singlets with the family members quantum numbers.**
- **All scalars carry the weak and the hyper charge like the higgs**.
- **Due to our calculations** [arxiv:1412.5866] and the **experimental observations** to the **masses** of the **lower three families mainly** the **three singlets** with the **family members quantum numbers contribute**, **causing the large differences in masses of the lower three families**.

- To the **masses** of the **fourth family, weakly coupled to the observed three families**, again due to our calculation, mainly **two triplets** with the **family quantum numbers contribute, causing that the fourth family quarks have comparable masses.**
- Correspondingly the **three observed families couple mostly** to the **three singlets**, while the **fourth family couple mostly to two triplets**.
- Then to the **quark-gluon production of scalars with the family members quantum numbers, as it is the higgs, mostly the top quark contributes, and so it also mainly contributes to the decay of the higgs into two photons, in agreement with the observations**.

- $\mathcal{L}_{qm}$ for quarks mass term, k, j are the family index, (phases of the quarks states assures that fermions have the ordinary properties under the spin rotation and under $\mathcal{C}_{\mathcal{N}}\ \mathcal{P}_{\mathcal{N}}$):

$$\mathcal{L}_{qm} = \frac{1}{2}\sum_{k,l}\{(u_L^{k\dagger}\gamma^0 \sum_{A,i,-} \stackrel{78}{(-)}\ \tau^{Ai} g^{Ai} A_-^{Ai} u_R^l)+$$

$$(u_R^{l\dagger}\gamma^0 \sum_{A,i,-} \tau^{Ai}\ \stackrel{78}{(+)}\ g^{Ai} A_+^{Ai} u_L^k)+$$

$$(d_L^{k\dagger}\gamma^0 \sum_{A,i,+} \stackrel{78}{(+)}\ \tau^{Ai} g^{Ai} A_+^{Ai} d_R^l)+$$

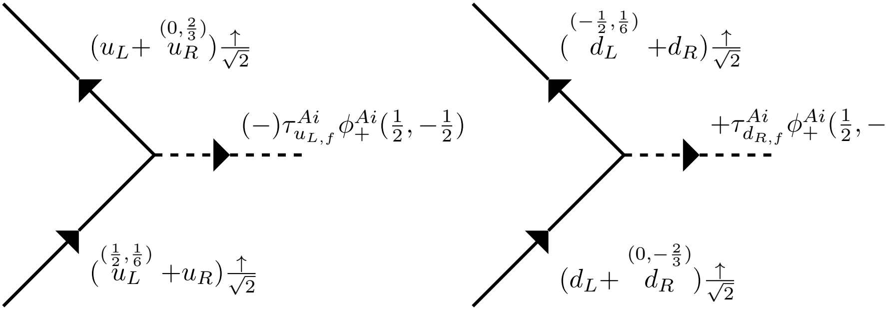
$$(d_R^{l\dagger}\gamma^0 \sum_{A,i,+} \tau^{Ai}\ \stackrel{78}{(-)}\ g^{Ai} A_+^{Ai} d_L^k)^\dagger\}\,.$$

- The Hermiticity is assumed $(A^{Ai}_{\pm})^{\dagger} = A^{Ai}_{\mp}$.
- All the family operators commute with $\gamma^0 \{\stackrel{78}{(\pm)}$:
  $\{\gamma^0 \stackrel{78}{(\pm)}, \tilde{\tau}^{\tilde{A}i}\}_- = 0\,.$
- The family members operators, $\tau^{Ai} = (Q, Q', Y')$, do not,
  $\{(Q, Q', Y'), \gamma^0 \{\stackrel{78}{(\pm)}\}_- \neq 0,$
  however:
  $\gamma^0\; (Q, Q', Y')\; \stackrel{78}{(+)}\; u^k_L = (Q_{Ru}, Q'_{Ru}, Y'_{Ru}\;)\; u^k_R\,,$
  $\gamma^0\; (Q, Q', Y')\; \stackrel{78}{(-)}\; d^k_L = (Q_{Rd}, Q'_{Rd}, Y'_{Rd}\;)\; d^k_R.$

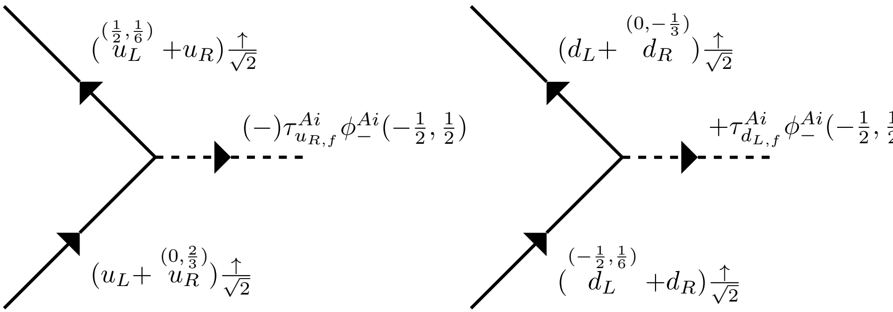
$$A^{Ai}_{\substack{78\\(\pm)}} = v^{Ai}_{\substack{78\\(\pm)}} + \Phi^{Ai}_{\substack{78\\(\pm)}} \,,$$

where $A^{Ai}_{\substack{78\\(\pm)}}$ represents scalars carrying either the family or the family members quantum numbers.

Family members and families



(a) (b)


$(\overset{(\frac{1}{2},\frac{1}{6})}{u_L} + u_R)\frac{\uparrow}{\sqrt{2}}$
$(-)\tau^{Ai}_{u_{R,f}}\phi^{Ai}_{-}(-\frac{1}{2},\frac{1}{2})$
$(u_L + \overset{(0,\frac{2}{3})}{u_R})\frac{\uparrow}{\sqrt{2}}$
$(d_L + \overset{(0,-\frac{1}{3})}{d_R})\frac{\uparrow}{\sqrt{2}}$
$+\tau^{Ai}_{d_{L,f}}\phi^{Ai}_{-}(-\frac{1}{2},$
$(\overset{(-\frac{1}{2},\frac{1}{6})}{d_L} + d_R)\frac{\uparrow}{\sqrt{2}}$

(c) (d)

- One notices on Figs. (a,b,c,d) the opposite signs of the couplings of the scalar fields - the two triplets with the family quantum numbers to u^k with respect to d^k.

  The two triplet scalars carrying the family quantum numbers do not distinguish between u^k and d^k.
- The three singlets carrying the family members quantum numbers do distinguish between u^k and d^k.
- Correspondingly the u^4 and d^4, if having comparable masses, would contribute (very) little to either the quark-gluon fusion production of any scalar or to the decay to any scalar into two photons, which is consistent with the observations.

- **However, u^4 and d^4, having very little mixing matrix elements to the lower three families, if of not completely equal masses, do contribute to the quark-gluon fusion production of scalars carrying the family quantum numbers, as well as to the decay of such scalars into two photons.**
- **If the 750 GeV event on the LHC is the real one, could then a superpositions of scalars of the mass of ≈ 750 GeV be the first direct confirmation that there are several scalar fields, as predicted by the *spin-charge-family* theory?.**

- **Since the decay of this scalar would go stronger to two (W^+, W^-) and (Z^0, Z^0), what experiments have not observed, the two photons events then can not belong to the decay of this scalar.**
- **More probable is the decay of this scalar to two bosons - (W^+, W^-) and (Z^0, Z^0) (and also to two photons) – at the energy of about 1.8 TeV, if this observation is a real one. This would then be the first direct observation of the second scalar, among those, predicted by the** *spin-charge-family* **theory.**
  The indirect signal of the existence of several scalars are the Yukawa couplings.

- **Even if the phases of u^4 and d^4 can be washed away, still the existence of the fourth family is not so far in contradiction with the experiments.**
  The fourth family quarks would in any case contribute very little to the production of the observed higgs in the quark-gluon fusion, since they mainly couple to the superposition of scalars with the family quantum numbers.

- **I predict: There is the fourth family, with the weak mixing matrix elements to the lower four families.**

- **Let us have a look on the explanations of the assumptions of the** *standard model* **and on predictions of the** *spin-charge-family* **theory to be able to notice whether Nature might be elegant and transparent in laws** (in system with many degrees of freedom symmetries simplify effective laws).

- **In the standard model** the **family members**, the **families**, the **gauge vector fields**, the **scalar Higgs**, the **Yukawa couplings**, exist by the **assumption**.
- ** In the **spin-charge-family theory all these properties follow from the simple starting action** with **two kinds of spins** and with **gravity only** .

  ** The theory offers the explanation for the **dark matter**, the stable of the upper four families does this.

  ** The theory offers the explanation for the **matter-antimatter asymmetry**, the condensate, breaking CP symmetry together with the massive triplet scalars do that.

  ** All the **scalar** and all the **vector** gauge fields are **directly or indirectly observable**.

Concrete predictions:

- **There are several scalar fields;**
  O two triplets , O three singlets ,
  explaining higgss and Yukawa couplings,
  some of these scalars will be observed at the LHC,
  or one of these scalars might have 750 GeV, if the event is real.
  JMP 6 (2015) 2244,
  Phys. Rev. D 91 (2015) 6, 065004.
- **There is the fourth family, (weakly) coupled to the observed three, which will be observed at the LHC,**
  New J. of Phys. 10 (2008) 093002.

- **There is the dark matter, with the predicted properties**, **Phys. Rev. D** (**2009**) 80.083534.
- **There is the ordinary matter/antimatter asymmetry explained and the proton decay predicted**, **Phys. Rev. D 91** (**2015**) 6, 065004.

With **G. Bregar we made calculations, treating quarks and leptons in equivalent way, as required by the "spin-charge-family" theory**.

- Any **(n-1)x (n-1)** submatrix of an unitary **n x n** matrix determines the **nxn** matrix for **n** $\geq$ **4** uniquely.
- The **measured mixing matrix elements** of the **3 x 3** submatrix **are not accurate enough even for quarks to predict the masses** m_4 **of the fourth family members**.

  O We can say only, if taking into account only mixing matrices and measured masses, that m_4 **quark masses might be any in the interval (**$300 < m_4 < 1000$**) GeV or even above**.

- **Assuming masses m_4 we can predict mixing matrices.**

We recognize that:

- The **last data for mixing matrix of quarks are in better agreement with our prediction for the** 3×3 **submatrix elements of the** 4×4 **mixing matrix than the previous ones**.
- Our **fit to the last data predicts how will** the 3×3 **submatrix elements change** in the **next more accurate measurements**.

Results are presented for two choices of $m_{u_4} = m_{d_4}$, [arxiv:1412.5866]:

- 1. $m_{u_4} = 700$ GeV, $m_{d_4} =$ **700** GeV.....new_1
- 2. $m_{u_4} = 1\,200$ GeV, $m_{d_4} =$ **1 200** GeV.....new_2

$|V_{(ud)}| =$

exp_n	0.97425 ± 0.00022	0.2253 ± 0.0008	0.00413 ± 0.00049	
new_1	0.97423(4)	0.22539(7)	0.00299	**0.00776(1)**
new_2	0.97423[5]	0.22538[42]	0.00299	**0.00793[466]**
exp_n	0.225 ± 0.008	0.986 ± 0.016	0.0411 ± 0.0013	
new_1	0.22534(3)	0.97335	0.04245(6)	**0.00349(60)**
new_2	0.22531[5]	0.97336[5]	0.04248	**0.00002[216]**
exp_n	0.0084 ± 0.0006	0.0400 ± 0.0027	1.021 ± 0.032	
new_1	0.00667(6)	0.04203(4)	0.99909	**0.00038**
new_2	0.00667	0.04206[5]	0.99909	**0.00024[21]**
new_1	**0.00677(60)**	**0.00517(26)**	**0.00020**	**0.99996**
new_2	**0.00773**	**0.00178**	**0.00022**	**0.99997[9]**

.

O The **matrix elements V_{CKM} depend strongly on the accuracy** of the experimental **3 x 3 submatrix**.

O Calculated 3 x 3 submatrix of 4 x 4 $\mathbf{V_{CKM}}$ depends on the m_{4th} family masses, but not much.

O V_{4i}, V_{i4} do not depend strongly on the m_{4th} **family masses**.

O $V_{u_i d_4}$ and of $V_{d_i u_4}$ are obviously very small.

Predictions from the calculated quark mixing matrix:

- $|V_{ud}|$ **will stay or will slightly decrease**.
- $|V_{us}|$ **will continue slightly increasing**.
- $|V_{cd}|$ **will very slightly increase back towards** exp_o.
- $|V_{cb}|$ **will still increase**.
- $|V_{ts}|$ **will very slightly increase back towards** exp_o.
- $|V_{ub}|$ **will still decrease**.
- $|V_{cs}|$ **will still decrease**.
- $|V_{td}|$ **will decrease**.
- $|V_{tb}|$ **will decrease, approaching 1 from below**.

- The higher are the fourth family members masses, the closer are the mass matrices to the **democratic matrices** for either quarks or leptons, as expected.
- **Mass matrices for quarks:**

$$
\begin{aligned}
\mathbf{M^u_d}/MeV/c^2 &= (1.25, 620.1, 172\,000., 700\,000.)\,,\\
\mathbf{M^d_d}/MeV/c^2 &= (2.92, 54.8, 2\,899., 700\,000.)\,,
\end{aligned}
$$

Mass matrices of quarks:

$m_{u_4} = 700$ GeV and $m_{d_4} = 700$ GeV.

- $$M^u = \begin{pmatrix} 227623. & 131877. & 132239. & 217653. \\ 131877. & 222116. & 217653. & 132239. \\ 132239. & 217653. & 214195. & 131877. \\ 217653. & 132239. & 131877. & 208687. \end{pmatrix},$$

- $$M^d = \begin{pmatrix} 175797. & 174263. & 174288. & 175710. \\ 174263. & 175666. & 175710. & 174288. \\ 174288. & 175710. & 175813. & 174263. \\ 175710. & 174288. & 174263. & 175682. \end{pmatrix},$$

- **Mass matrices for $m_4 \geq$ 1 TeV are closer to a democratic matrix, like M^d at 700 GeV.**
- **From values of the calculated mass matrix elements we try to extract some properties of the two triplet and three singlet scalar fields with the weak and the hyper charge of higgs: $(\mp\frac{1}{2}, \pm\frac{1}{2})$.**

- **The upper four families are decoupled from the lower four families.**
- **The stable family of the upper four families group is the candidate to form the Dark Matter.**

- **Their masses are influenced by:**
  O **the** $\widetilde{SU}(2)_{II\,\widetilde{SO}(3,1)} \times \widetilde{SU}(2)_{II\,\widetilde{SO}(4)}$ **scalar fields with the corresponding family quantum numbers,**
  O **the scalars** ($A^{Q}_{\substack{78\\(\mp)}}$, $A^{Q'}_{\substack{78\\(\mp)}}$, $A^{Y'}_{\substack{78\\(\mp)}}$), and
  O **the condensate of the two** ν_R **of the upper four families.**
- With **G. Bregar we investigate this possibility carefully**.

hep-ph/0711.4681, p.189-194; *Phys. Rev.* **D 80, 083534 (2009)**.

- **Masses** of the **fifth family** **lie** **much above** **the known three and the** **predicted fourth family** **masses**.
- **Baryons** **of the** **fifth family** **are heavy, forming small enough clusters with small enough scattering amplitude among themselves and with the ordinary matter to be the candidate for the** **dark matter**.
- **We make a rough estimation (with a Bohr like model) of properties of clusters of** (u_5, d_5, ν_5, e_5), which **interact with the same vectors gauge fields as the lower four family, here with** **one gluon** **(one weak and one hyper charge) exchange**.

We estimate:

- **The behavior of such clusters in the evolution of the Universe.**
- **The behavior of such clusters when hitting our Earth, and in particular direct measurements - DAMA/NaI and DAMA-LIBRA and others.**
- **The elm. neutral fifth family baryons (neutrinos also contribute) form the dark matter.**
- **Direct measurements and cosmological evolution limit my fifth family masses** to

$$10 \text{ TeV} < m_{q_5} c^2 < 10^4 \text{ TeV}.$$

- **Dark matter baryons are opening an interesting new "fifth family nuclear" dynamics.**

- The **spin-charge-family theory is offering an explanation for** the **hierarchy problem**:
  The mass matrices of the two four families groups are almost democratic, causing spreading of the fermion masses from 10^{16} GeV to 10^{-8} MeV.

To Summarize:

- The spin-charge-family theory offers the explanation for:
  O the origin of charges,
  O the origin of families,
  O the origin and properties of scalar fields,
  O the origin and properties of vector fields,
  O the properties of families,
  O the the hierarchy,
- The spin-charge-family theory offers the explanation for:
  O the origin of "ordinary" matter-antimatter asymmetry and the proton decay,
  O the origin of the dark matter.

The spin-charge-family theory predicts:

- **New families:**
  - O **the fourth family will be observed at the LHC,**
  - O **the fifth one forms the dark matter.**
- **New scalar fields, one of them might be already observed at the LHC.**
- **The $SU(2)_{II}$ vector gauge fields, too heavy to be directly observed.**
- **New kind of the "nuclear force" within the stable heavy family members.**
- **The direction in which the V_{CKM} will change.**

- **o Fermionization in any dimension might help to understand better if and why the *spin-charge-family* theory is a possible next step beyond the *standard model*.**
- **o The spin-charge-family theory is expected to have many a thing in common with other proposed theories, models, ideas.**
- **o More than I am working on the spin-charge-family theory more phenomenological, directly or indirectly observed, properties appear to be describable within this project.**