The approach unifying spins and charges is offering the mechanism for generating families, predicting the fourth family and the dark matter candidate

N.S. Mankoč Borštnik
University of Ljubljana

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Collaborators in this project, which has started almost 15 years ago: Anamarija Pika Borštnik Bračič, Gregor Bregar, Matjaž Breskvar, Dragan Lukman, Holger Bech Nielsen (first of all), Jože Vrabec, others

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- Others

INTRODUCTION

I am proposing the **approach unifying spins and charges**, which is offering **a new way** beyond the Standard model of the electroweak and colour interactions:

- Spinors carry in $d\ (= 1 + 13)$ only **two kinds of spin**, no charges.
- The **Dirac spin** manifests in $d = 1 + 3$ **the spin and all the charges** of quarks and leptons, the **second kind** of the Clifford algebra object generates families.
- A spinor interacts in $d = 1 + 13$ with the **vielbeins** and **spin connections** (two kinds of).
- **A simple action for a spinor in $d = 1 + 13$ in $d = 1 + 3$ all the properties of the families of quarks and leptons, as assumed by the Standard model. It is a part of the simple starting Lagrange density, which manifests the Yukawa coupling, no Higgs are needed.**

I am looking for

- general proofs that this Approach does lead in the observable energy region (low energy region) to the observable phenomena,
- to which extend can the Approach answer the open questions of the Standard model.

The open questions, which I am answering, together with my collaborators, are:

1. Where do families of quarks and leptons come from?
2. What does determine the strength of the Yukawa couplings and accordingly the weak scale?
3. Why do only the left handed spinors carry the weak charge, while the right handed are weak chargeless?
4. How many families appear at (soon) observable energies?
5. Are among the members of the families the candidates for the dark matter?
6. And several other questions.

The approach is offering the answers to these questions:

- The representation of one Weyl spinor of the group SO(1,13), manifests the left handed weak charged quarks and leptons and the right handed weak chargeless quarks and leptons.
- There are two kinds of the Clifford algebra objects. One kind takes care of the spin and the charges, the other generates families.
- A part of a simple starting Lagrange density for a spinor in $d = 1 + 13$ carrying nothing but two kinds of spins (no charges) and interacting with the gravitational fields only–the vielbeins and spin connections of the two kinds–manifests in d=1+3 the Lagrange density for spinors as assumed by the Standard model before the break of the electroweak symmetry.

- It is a part of a simple starting Lagrange density for a spinor in $d = (1+13)$, which manifests the Yukawa couplings, playing the role of the Higgs field of the Standard model.
- **The way of breaking symmetries determines the charges and the properties of families, as well as the coupling constants of the gauge fields**.
- There are **two times four families** with zero Yukawa matrix elements among the members which do not belong to the same four families group. The three from the lowest four families are the observed ones, the **fourth family** might (due to the first rough estimations) **be seen at LHC**. The lowest among the **decoupled** four families is the **candidate** for forming the **dark matter** clusters.

ACTION

There are **two kinds of the Clifford algebra objects**:

- The **Dirac γ^a operators** (used by Dirac 80 years ago),
- The **second one:** $\tilde{\gamma}^a$,

$$
\begin{aligned}
\{\gamma^a, \gamma^b\}_+ &= 2\eta^{ab} = \{\tilde{\gamma}^a, \tilde{\gamma}^b\}_+ ,\\
\{\gamma^a, \tilde{\gamma}^b\}_+ &= 0,\\
\tilde{\gamma}^a B : &= i(-)^{n_B} B\gamma^a ,
\end{aligned}
$$

$$
\begin{aligned}
&S^{ab} := (i/4)(\gamma^a\gamma^b - \gamma^b\gamma^a),\\
&\tilde{S}^{ab} := (i/4)(\tilde{\gamma}^a\tilde{\gamma}^b - \tilde{\gamma}^b\tilde{\gamma}^a),\\
&\{S^{ab}, \tilde{S}^{cd}\}_- = 0.
\end{aligned}
$$

- **I recognize: γ^a are to describe the spins and the charges, $\tilde{\gamma}^a$ are to describe families**.

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

$$\begin{aligned} S &= \int d^d x \, \mathcal{L} \\ \mathcal{L} &= \frac{1}{2}(E\bar{\psi}\gamma^a p_{0a}\psi) + h.c. \\ p_{0a} &= f^{\alpha}{}_a p_{0\alpha}, \quad p_{0\alpha} = p_\alpha - \frac{1}{2}S^{ab}\omega_{ab\alpha} - \frac{1}{2}\tilde{S}^{ab}\tilde{\omega}_{ab\alpha} \end{aligned}$$

$$\mathcal{L} = \bar{\psi}\gamma^{\mathbf{m}}(\mathbf{p_m} - \sum_{\mathbf{A,i}} \mathbf{g^A} \tau^{\mathbf{Ai}} \mathbf{A^{Ai}_m})\psi + \{\sum_{\mathbf{s=7,8}} \bar{\psi}\gamma^{\mathbf{s}}\mathbf{p_{0s}}\,\psi\} + \text{the rest}$$

$$\tau^{Ai} = \sum_{a,b} c^{Ai}{}_{ab}\, S^{ab}, \quad \{\tau^{Ai}, \tau^{Bj}\}_- = i\delta^{AB} f^{Aijk}\tau^{Ak}$$

$$
\begin{array}{lllll}
A = 1 & U(1) \text{ hyper charge} & i = \{1\} & \text{usual not. } Y, \\
A = 2 & SU(2) \text{ weak charge} & i = \{1,2,3\} & \text{usual not. } \tau^{i}, \\
A = 3 & SU(3) \text{ colour charge} & i = \{1,\cdots,8\} & \text{usual not. } \lambda^{i}/2,
\end{array}
$$

We assume the Einstein action for a free gravitational field, which is linear in the curvature

$$
\begin{aligned}
S &= \int d^d x \, E \, (R + \tilde{R}), \\
R &= f^{\alpha[a} f^{\beta b]} \, (\omega_{ab\alpha,\beta} - \omega_{ca\alpha} \omega^{c}{}_{b\beta}), \\
\tilde{R} &= f^{\alpha[a} f^{\beta b]} \, (\tilde{\omega}_{ab\alpha,\beta} - \tilde{\omega}_{ca\alpha} \tilde{\omega}^{c}{}_{b\beta}).
\end{aligned}
$$

$f^{\alpha[a} f^{\beta b]} = f^{\alpha a} f^{\beta b} - f^{\alpha b} f^{\beta a}$

The Yukawa couplings

Yukawa couplings

$$
\begin{aligned}
-\mathcal{L}_Y &= \psi^\dagger \gamma^{\mathbf{0}} \gamma^{\mathbf{s}} \mathbf{p_{0s}} \psi \\
&= \psi^\dagger\, \gamma^0 \{ \overset{78}{(+)}\ p_{0+} + \overset{78}{(-)}\ p_{0-} \} \psi,
\end{aligned}
$$

$$
\begin{aligned}
p_{0\pm} &= (p_7 \mp i\ p_8) - \\
& \quad \frac{1}{2} S^{ab} \omega_{ab\pm} - \frac{1}{2} \tilde{S}^{ab} \tilde{\omega}_{ab\pm}, \\
\omega_{ab\pm} &= \omega_{ab7} \mp i\ \omega_{ab8}, \\
\tilde{\omega}_{ab\pm} &= \tilde{\omega}_{ab7} \mp i\ \tilde{\omega}_{ab8}
\end{aligned}
$$

We put $p_7 = p_8 = 0$.

Our technique to represent spinor states

Our technique to represent spinors works elegantly

- *J. of Math. Phys.* **43**, 5782-5803 (2002), hep-th/0111257,
- *J. of Math. Phys.* **44** 4817-4827 (2003), hep-th/0303224, both with H.B. Nielsen.

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

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

$$
\begin{aligned}
S^{ab} \stackrel{ab}{(k)} &= \frac{k}{2} \stackrel{ab}{(k)}, \quad S^{ab} \stackrel{ab}{[k]} = \frac{k}{2} \stackrel{ab}{[k]},\\
\tilde{S}^{ab} \stackrel{ab}{(k)} &= \frac{k}{2} \stackrel{ab}{(k)}, \quad \tilde{S}^{ab} \stackrel{ab}{[k]} = -\frac{k}{2} \stackrel{ab}{[k]}\,.
\end{aligned}
$$

$$
\begin{aligned}
\gamma^{a} \stackrel{ab}{(k)} &= \eta^{aa} \stackrel{ab}{[-k]}, \quad \gamma^{b} \stackrel{ab}{(k)} = -ik \stackrel{ab}{[-k]},\\
\gamma^{a} \stackrel{ab}{[k]} &= \stackrel{ab}{(-k)}, \quad \gamma^{b} \stackrel{ab}{[k]} = -ik\eta^{aa} \stackrel{ab}{(-k)}\\
\tilde{\gamma}^{a} \stackrel{ab}{(k)} &= -i\eta^{aa} \stackrel{ab}{[k]}, \quad \tilde{\gamma}^{b} \stackrel{ab}{(k)} = -k \stackrel{ab}{[k]},\\
\tilde{\gamma}^{a} \stackrel{ab}{[k]} &= i \stackrel{ab}{(k)}, \quad \tilde{\gamma}^{b} \stackrel{ab}{[k]} = -k\eta^{aa} \stackrel{ab}{(k)}\,.
\end{aligned}
$$

γ^a **transform** $\stackrel{ab}{(k)}$ **into** $\stackrel{ab}{[-k]}$**,** $\tilde{\gamma}^a$ **transform** $\stackrel{ab}{(k)}$ **into** $\stackrel{ab}{[k]}$**.**

REPRESENTATION OF SPINORS IN $d = 1 + 13$ ANALYZED IN TERMS OF STANDARD MODEL SYMMETRIES

Cartan subalgebra set of the algebra S^{ab}

$$S^{03}, S^{12}, S^{56}, S^{78}, S^{9\,10}, S^{11\,12}, S^{13\,14}.$$

A left handed ($\Gamma^{(1,13)} = -1$) eigen state of all the members of the Cartan subalgebra represents $u_R^{c_1}$ spin up

$$\stackrel{03}{(+i)}\stackrel{12}{(+)} \mid \stackrel{56}{(+)}\stackrel{78}{(+)} \mid\mid \stackrel{9\,10}{(+)}\stackrel{11\,12}{(-)}\stackrel{13\,14}{(-)} |\psi\rangle =$$

$$\frac{1}{2^7}(\gamma^0 - \gamma^3)(\gamma^1 + i\gamma^2)|(\gamma^5 + i\gamma^6)(\gamma^7 + i\gamma^8)||$$

$$(\gamma^9 + i\gamma^{10})(\gamma^{11} - i\gamma^{12})(\gamma^{13} - i\gamma^{14})|\psi\rangle.$$

The eightplet (the representation of $SO(1,7)$) of quarks of a particular color charge ($\tau^{33} = 1/2$, $\tau^{38} = 1/(2\sqrt{3})$, and $\tau^{41} = 1/6$) generated by S^{ab}.

i		$\vert^a\psi_i>$	$\Gamma^{(1,3)}$	S^{12}	$\Gamma^{(4)}$	τ^{13}	τ^{21}	Y	Y'
		Octet, $\Gamma^{(1,7)} = 1$, $\Gamma^{(6)} = -1$, of quarks							
1	u_R^{c1}	$\overset{03}{(+i)}\overset{12}{(+)} \vert \overset{56}{(+)}\overset{78}{(+)} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	1	$\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{2}{3}$	$-\frac{1}{3}$
2	u_R^{c1}	$\overset{03}{[-i]}\overset{12}{[-]} \vert \overset{56}{(+)}\overset{78}{(+)} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	1	$-\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{2}{3}$	$-\frac{1}{3}$
3	d_R^{c1}	$\overset{03}{(+i)}\overset{12}{(+)} \vert \overset{56}{[-]}\overset{78}{[-]} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	1	$\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{1}{3}$	$\frac{2}{3}$
4	d_R^{c1}	$\overset{03}{[-i]}\overset{12}{[-]} \vert \overset{56}{[-]}\overset{78}{[-]} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	1	$-\frac{1}{2}$	1	0	$-\frac{1}{2}$	$-\frac{1}{3}$	$\frac{2}{3}$
5	d_L^{c1}	$\overset{03}{[-i]}\overset{12}{(+)} \vert \overset{56}{[-]}\overset{78}{(+)} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	-1	$\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
6	d_L^{c1}	$\overset{03}{(+i)}\overset{12}{[-]} \vert \overset{56}{[-]}\overset{78}{(+)} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	-1	$-\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
7	u_L^{c1}	$\overset{03}{[-i]}\overset{12}{(+)} \vert \overset{56}{(+)}\overset{78}{[-]} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	-1	$\frac{1}{2}$	-1	$\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$
8	u_L^{c1}	$\overset{03}{(+i)}\overset{12}{[-]} \vert \overset{56}{(+)}\overset{78}{[-]} \Vert \overset{9\,10}{(+)}\;\overset{11\,12}{(-)}\;\overset{13\,14}{(-)}$	-1	$-\frac{1}{2}$	-1	$\frac{1}{2}$	0	$\frac{1}{6}$	$\frac{1}{6}$

$-\mathcal{L}_Y = \psi^\dagger\, \gamma^0 \{\overset{78}{(+)}\; p_{0+} + \overset{78}{(-)}\; p_{0-}\}\psi$, $\gamma^0\, \overset{78}{(-)}$ transforms u_R of the 1^{st} row into u_L of the 7^{th} row, while $\gamma^0\, \overset{78}{(+)}$ transforms d_R of the 3^{rd} row into d_L of the 5^{th} row, doing what the Higgs and γ^0 do in the Standard model. $\gamma^a\, \overset{ab}{(k)} = \eta^{aa}\, \overset{ab}{[-k]}$, $\overset{ab}{(-k)}\overset{ab}{(k)} = \eta^{aa}\, \overset{ab}{[-k]}$,

$\tilde{S}^{ab}$ **generate families**.

$$\tilde{S}^{03} = \frac{i}{2}[\overset{03}{(\tilde{+}i)}\overset{12}{(\tilde{+})} + \overset{03}{(\tilde{-}i)}\overset{12}{(\tilde{+})} + \overset{03}{(\tilde{+}i)}\overset{12}{(\tilde{-})} + \overset{03}{(\tilde{-}i)}\overset{12}{(\tilde{-})}]$$

Both vectors bellow describe a right handed u-quark of the same colour.

$$\overset{03}{(\tilde{-}i)}\overset{12}{(\tilde{-})} \qquad \overset{03}{(+i)}\overset{12}{(+)} \mid \overset{56}{(+)}\overset{78}{(+)} \mid\mid \overset{9\,10}{(+)}\overset{11\,12}{(-)}\overset{13\,14}{(-)} =$$

$$\overset{03}{[+i]}\overset{12}{[+]} \mid \overset{56}{(+)}\overset{78}{(+)} \mid\mid \overset{9\,10}{(+)}\overset{11\,12}{(-)}\overset{13\,14}{(-)}$$

$$\overset{ab}{(\tilde{\pm}i)} = \frac{1}{2}(\tilde{\gamma}^a \mp \tilde{\gamma}^b), \quad \overset{ab}{(\tilde{\pm}1)} = \frac{1}{2}(\tilde{\gamma}^a \pm i\tilde{\gamma}^b),$$

BREAKING STARTING SYMMETRIES of SO(1,13)

Breaks of symmetries

$$\underbrace{\begin{array}{ccc} & SO(1,13) & \\ & \downarrow & \\ & SO(1,7)\times & SU(3)\times U(1) \\ \swarrow\ ? & ? & \searrow\ ? \\ SO(1,3)\times SO(4)\times U(1) & & SU(3) \\ & SO(1,3)\times SU(2)\times U(1) & SU(3) \end{array}}$$

$$\begin{array}{c} \downarrow \\ ? \\ \downarrow \\ \mathrm{SO}(1,3)\times \mathrm{U}(1)\times \mathrm{SU}(3) \end{array}$$

We assume:

- Breaking symmetries from $SO(1,13)$ to $SO(1,7) \times U(1) \times SU(3)$ occurs at very high energy scale and leave very heavy all the families except one which is left massless.
- There are $2^{8/2-1} = 8$ families (the symmetry $SO(1,7)$ determines them).
- Two ways of breaking from $SO(1,7) \times U(1)$ to $SO(1,3) \times U(1)$ in the $\tilde{S}^{ab}\tilde{\omega}_{ab\pm}$ sector.

The Yukawa couplings are strongly influenced by the way of breaking symmetries. They can be rewritten as follows

$$
\begin{aligned}
\mathcal{L}_Y \quad = \quad & \psi^\dagger \gamma^0 \{ \overset{78}{(+)} \, (\sum_{y=Y,Y'} y A^y_+ + \frac{-1}{2} \sum_{(ab)} \tilde{S}^{ab} \tilde{\omega}_{ab+})) + \\
& \overset{78}{(-)} \, (\sum_{y=Y,Y'} y A^y_- + \frac{-1}{2} \sum_{(ab)} \tilde{S}^{ab} \tilde{\omega}_{ab-}) \\
& \overset{78}{(+)} \sum_{\{(ac)(bd)\},k,l} \overset{ac}{(\tilde{k})} \overset{bd}{(\tilde{l})} \, \tilde{A}^{kl}_+ ((ac),(bd)) \; + \\
& \overset{78}{(-)} \sum_{\{(ac)(bd)\},k,l} \overset{ac}{(\tilde{k})} \overset{bd}{(\tilde{l})} \, \tilde{A}^{kl}_- ((ac),(bd)) \} \psi ,
\end{aligned}
$$

with $k, l = \pm 1$, if $\eta^{aa}\eta^{bb} = 1$ and $\pm i$, if $\eta^{aa}\eta^{bb} = -1$, while $Y = \tau^{21} + \tau^{41}$ and $Y' = -\tau^{21} + \tau^{41}$,

$(ab), (cd), \cdots$ **Cartan only**.

BREAK A.

We forbid terms in both sectors which would in the ordinary sector ($S^{sa}\omega_{sa\pm}$, $s = 5, 6$ and $a \neq 5, 6$) **not coserve the elm charge**. **Eight families decouple into two times four families**, well separated in masses. We study properties of the lower energy four families with the assumption that mass matrices are real and symmetric (no CP is studied yet).

BREAK B.

First we break in both sectors $SO(1,7) \times U(1)$ into $SO(1,3) \times SO(4) \times U(1)$ (by putting all $\omega_{am\pm}$ and $\tilde{\omega}_{am\pm}, m = 0,1,2,3,\ a = 5,6,7,8$ equal to zero), **eight families decouple into two times four families**.

Then we break $SO(4) \times U(1)$ in two successive breaks first into $SU(2) \times U(1)$ and then to $U(1)$.

The assumption that the first break occurs at much higher energy then the second one (which occurs at the weak scale) makes the two times four families well separated in masses. We then study the properties of the lower four families.

Eight families of quarks and leptons of a right handed quark or lepton with the spin 1/2.
S^{ab}, $a, b \in \{0,1,2,3,5,6,7,8\}$ reach all the members of one family of a particular colour charge.

I_R	$\overset{03}{(+i)}\overset{12}{(+)}\overset{56}{(+)}\overset{78}{(+)}$	I	I
II_R	$\overset{03}{[+i]}\overset{12}{[+]}\overset{56}{(+)}\overset{78}{(+)}$	II	II
III_R	$\overset{03}{(+i)}\overset{12}{(+)}\overset{56}{[+]}\overset{78}{[+]}$		III
IV_R	$\overset{03}{[+i]}\overset{12}{[+]}\overset{56}{[+]}\overset{78}{[+]}$		IV
V_R	$\overset{03}{[+i]}\overset{12}{(+)}\overset{56}{(+)}\overset{78}{[+]}$	V	
VI_R	$\overset{03}{(+i)}\overset{12}{[+]}\overset{56}{[+]}\overset{78}{(+)}$		
VII_R	$\overset{03}{[+i]}\overset{12}{(+)}\overset{56}{[+]}\overset{78}{(+)}$	VII	
$VIII_R$	$\overset{03}{(+i)}\overset{12}{[+]}\overset{56}{(+)}\overset{78}{[+]}$		

The Yukawa couplings for $u-$quarks.

α	I_R	II_R	III_R	IV_R	V_R	VI_R	VII_R	$VIII_R$
I_L	$XXXX$	$-\tilde{A}^{++}_{-}$ $((03),(12))$	$-\tilde{A}^{++}_{-}$ $((56),(78))$	0	$-\tilde{A}^{++}_{-}$ $((03),(78))$	$-\tilde{A}^{++}_{-}$ $((12),(56))$	$\tilde{A}^{++}_{-}$ $((03),(56))$	$\tilde{A}^{++}_{-}$ ((12),(78)
II_L	$-\tilde{A}^{--}_{-}$ $((03),(12))$	$XXXX$	0	$-\tilde{A}^{++}_{-}$ $((56),(78))$	$-\tilde{A}^{-+}_{-}$ $((12),(78))$	$-\tilde{A}^{-+}_{-}$ $((03),(56))$	$\tilde{A}^{-+}_{-}$ $((12),(56))$	$\tilde{A}^{-+}_{-}$ ((03),(78)
III_L	$\tilde{A}^{--}_{-}$ $((56),(78))$	0	$XXXX$	$-\tilde{A}^{++}_{-}$ $((03),(12))$	$\tilde{A}^{+-}_{-}$ $((03),(56))$	$-\tilde{A}^{+-}_{-}$ $((12),(78))$	$\tilde{A}^{+-}_{-}$ $((03),(78))$	$-\tilde{A}^{+-}_{-}$ ((12),(56)
IV_L	0	$\tilde{A}^{--}_{-}$ $((56),(78))$	$-\tilde{A}^{--}_{-}$ $((03),(12))$	$XXXX$	$\tilde{A}^{--}_{-}$ $((12),(56))$	$-\tilde{A}^{--}_{-}$ $((03),(78))$	$\tilde{A}^{--}_{-}$ $((12),(78))$	$-\tilde{A}^{--}_{-}$ ((03),(56)
V_L	$-\tilde{A}^{--}_{-}$ $((03),(78))$	$\tilde{A}^{+-}_{-}$ $((12),(78))$	$\tilde{A}^{-+}_{-}$ $((03),(56))$	$-\tilde{A}^{++}_{-}$ $((12),(56))$	$XXXX$	0	$-\tilde{A}^{+-}_{-}$ $((56),(78))$	$-\tilde{A}^{-+}_{-}$ ((03),(12)
VI_L	$\tilde{A}^{--}_{-}$ $((12),(56))$	$-\tilde{A}^{+-}_{-}$ $((03),(56))$	$\tilde{A}^{-+}_{-}$ $((12),(78))$	$-\tilde{A}^{++}_{-}$ $((03),(78))$	0	$XXXX$	$-\tilde{A}^{+-}_{-}$ $((03),(12))$	$\tilde{A}^{-+}_{-}$ ((56),(78)
VII_L	$\tilde{A}^{--}_{-}$ $((03),(56))$	$-\tilde{A}^{+-}_{-}$ $((12),(56))$	$\tilde{A}^{-+}_{-}$ $((03),(78))$	$-\tilde{A}^{++}_{-}$ $((12),(78))$	$\tilde{A}^{-+}_{-}$ $((56),(78))$	$-\tilde{A}^{-+}_{-}$ $((03),(12))$	$XXXX$	0
$VIII_L$	$-\tilde{A}^{--}_{-}$ $((12),(78))$	$\tilde{A}^{+-}_{-}$ $((03),(78))$	$\tilde{A}^{-+}_{-}$ $((12),(56))$	$-\tilde{A}^{++}_{-}$ $((03),(56))$	$-\tilde{A}^{+-}_{-}$ $((03),(12))$	$-\tilde{A}^{+-}_{-}$ $((56),(78))$	0	$XXXX$

NUMERICAL RESULTS FOR LOWER FOUR FAMILIES

Numerical results for break A.

Break A

Taking into account that experimental data for the known families suggest twice weakly coupled two and two families, we require that mass matrices have the shape

$$\begin{pmatrix} A & B \\ B & C = A + kB \end{pmatrix}. \tag{1}$$

with $k_u = -k_d$, $k_\nu = -k_e$,
$\tilde{\omega}_{abs_{u,\nu}} = b_{abs_{u,\nu}}\, \tilde{\omega}_{abs_{d,e}}$,
for $(abs) = (018)(078)(127)(387)$.
There are 3 angles determining the diagonalization of the mass matrices,
those for u related uniquely to those for d
and those for ν related to those for e,
which lead to

Masses for **quarks**

$$
\begin{aligned}
m_{u_i}/GeV &= (0.0034, 1.15, 176.5, \mathbf{285.2}),\\
m_{d_i}/GeV &= (0.0046, 0.11, 4.4, \mathbf{224.0}),
\end{aligned}
$$

and the corresponding mixing matrix

$$
\begin{pmatrix}
0.974 & 0.223 & 0.004 & \mathbf{0.042}\\
0.223 & 0.974 & 0.042 & \mathbf{0.004}\\
0.004 & 0.042 & 0.921 & \mathbf{0.387}\\
0.042 & 0.004 & 0.387 & \mathbf{0.921}
\end{pmatrix},
$$

Masses for **leptons**

$$
\begin{aligned}
m_{\nu_i}/GeV &= (1\ 10^{-12}, 1\ 10^{-11}, 5\ 10^{-11}, \mathbf{84.0}),\\
m_{e_i}/GeV &= (0.0005, 0.106, 1.8, \mathbf{169.2}),
\end{aligned}
$$

and the corresponding mixing matrix

$$
\begin{pmatrix}
0.697 & 0.486 & 0.177 & \mathbf{0.497}\\
0.486 & 0.697 & 0.497 & \mathbf{0.177}\\
0.177 & 0.497 & 0.817 & \mathbf{0.234}\\
0.497 & 0.177 & 0.234 & \mathbf{0.817}
\end{pmatrix}.
$$

Both in agreement with the references
Phys. Lett. **B 592** (2004)1,
Phys.Scripta **T121** (2005) 72, hep-ph/0410030v1
Phys. Lett. **B 529**(2002) 111, hep-ph/0111028, *Phys.Lett.* **B 476** (2000) 107, hep-ph/9911535v1, *Phys. Atom.Nucl.* **66** (2003) 2169; *Yad.Fiz.* **66** (2003) 2219, hep-ph/0301268v2

Numerical results for break B.

Break B.

α	I_R	II_R	III_R	IV_R	V_R	VI_R	VII_R	$VIII_R$
I_L	$XXXX$	$-\tilde{A}^{++}_{-}$ $((03),(12))$	$-\tilde{A}^{++}_{-}$ $((56),(78))$	0	0	0	0	0
II_L	$-\tilde{A}^{--}_{-}$ $((03),(12))$	$XXXX$	0	$-\tilde{A}^{++}_{-}$ $((56),(78))$	0	0	0	0
III_L	$\tilde{A}^{--}_{-}$ $((56),(78))$	0	$XXXX$	$-\tilde{A}^{++}_{-}$ $((03),(12))$	0	0	0	0
IV_L	0	$\tilde{A}^{--}_{-}$ $((56),(78))$	$-\tilde{A}^{--}_{-}$ $((03),(12))$	$XXXX$	0	0	0	0
V_L	0	0	0	0	$XXXX$	0	$-\tilde{A}^{+-}_{-}$ $((56),(78))$	$-\tilde{A}^{-+}_{-}$ $((03),(12)$
VI_L	0	0	0	0	0	$XXXX$	$-\tilde{A}^{+-}_{-}$ $((03),(12))$	$\tilde{A}^{-+}_{-}$ $((56),(78)$
VII_L	0	0	0	0	$\tilde{A}^{-+}_{-}$ $((56),(78))$	$-\tilde{A}^{-+}_{-}$ $((03),(12))$	$XXXX$	0
$VIII_L$	0	0	0	0	$-\tilde{A}^{+-}_{-}$ $((03),(12))$	$-\tilde{A}^{+-}_{-}$ $((56),(78))$	0	$XXXX$

We let

$SO(1,7)\times U(1)$ **break first to** $SO(1,3)\times SO(4)\times U(1)$ requiring that $\tilde{\omega}_{sm\pm}=0$, with $s=5,6,7,8$; $m=0,1,2,3$.
The **eight families** break into two **decoupled four families**.
At the break $SO(4)\times U(1)$ into $SU(2)\times U(1)$ (at some large scale) new fields $\tilde{A}^{Y}_{\pm}$ and $\tilde{A}^{Y'}_{\pm}$ are formed:

$$\begin{aligned}\tilde{A}^{23}_{\pm} &= \tilde{A}^{Y}_{\pm}\sin\tilde{\theta}_2+\tilde{A}^{Y'}_{\pm}\cos\tilde{\theta}_2,\\ \tilde{A}^{41}_{\pm} &= \tilde{A}^{Y}_{\pm}\cos\tilde{\theta}_2-\tilde{A}^{Y'}_{\pm}\sin\tilde{\theta}_2,\end{aligned} \tag{2}$$

the gauge fields of the new operators:

$$\tilde{Y}=\tilde{\tau}^{41}+\tilde{\tau}^{23},\quad \tilde{Y}\prime=\tilde{\tau}^{23}-\tilde{\tau}^{41}\tan\tilde{\theta}_2,$$

with $\tilde{\tau}^{23}=\frac{1}{2}(\tilde{S}^{56}+\tilde{S}^{78})$, $\quad\tilde{\tau}^{41}=-\frac{1}{3}(\tilde{S}^{9\,10}+\tilde{S}^{11\,12}+\tilde{S}^{13\,14})$.
Small enough $\tilde{\theta}_2$ makes the two four families be well separated in

At the weak scale $SU(2) \times U(1)$ breaks into $U(1)$ in both sectors

.

In the $\tilde{S}^{ab}$ sector new fields $\tilde{A}_{\pm}, \tilde{Z}_{\pm}$ appear
$\tilde{A}^{13}_{\pm} = \tilde{A}_{\pm} \sin\tilde{\theta}_1 + \tilde{Z}_{\pm} \cos\tilde{\theta}_1,$
$\tilde{A}^{Y}_{\pm} = \tilde{A}_{\pm} \cos\tilde{\theta}_1 - \tilde{Z}_{\pm} \sin\tilde{\theta}_1,$

the gauge fields of
$\tilde{Q} = \tilde{\tau}^{13} + \tilde{Y} = \tilde{S}^{56} + \tilde{\tau}^{41},$
$\tilde{Q}' = -\tilde{Y} \tan^2\tilde{\theta}_1 + \tilde{\tau}^{13},$

with $\tilde{e} = \tilde{g}^{Y} \cos\tilde{\theta}_1, \tilde{g}' = \tilde{g}^{1} \cos\tilde{\theta}_1,\ \tan\tilde{\theta}_1 = \frac{\tilde{g}^{Y}}{\tilde{g}^{1}}.$

Break B.

The new fields determine the mass matrices, which have the form

	I	II	III	IV
I	$a_\pm$	$\frac{\tilde g^m}{\sqrt 2}\tilde A^{+N_+}_\pm$	$-\frac{\tilde g^1}{\sqrt 2}\tilde A^{1+}_\pm$	0
II	$\frac{\tilde g^m}{\sqrt 2}\tilde A^{-N_+}_\pm$	$a_\pm + \frac{1}{2}\tilde g^m(\tilde A^{3N_-}_\pm + \tilde A^{3N_+}_\pm)$	0	$-\frac{\tilde g^1}{\sqrt 2}\tilde A^{1+}_\pm$
III	$\frac{\tilde g^1}{\sqrt 2}\tilde A^{1-}_\pm$	0	$a_\pm + \tilde e \tilde A_\pm + \tilde{g'} \tilde Z_\pm$	$\frac{\tilde g^m}{\sqrt 2}\tilde A^{+N_+}_\pm$
IV	0	$\frac{\tilde g^1}{\sqrt 2}\tilde A^{1-}_\pm$	$\frac{\tilde g^m}{\sqrt 2}\tilde A^{-N_+}_\pm$	$a_\pm + \tilde e \tilde A_\pm + \tilde{g'} \tilde Z_\pm$ $+\frac{1}{2}\tilde g^m(\tilde A^{3N_-}_\pm + \tilde A^{3N_+}_\pm)$

The mass matrix for the lower four families of u-quarks $(-)$ and d-quarks $(+)$ is not assumed to be real and symmetric.
We parameterize

$$\begin{pmatrix} a_\pm & b_\pm & -c_\pm & 0 \\ b_\pm & a_\pm + d_{1\pm} & 0 & -c_\pm \\ c_\pm & 0 & a_\pm + d_{2\pm} & b_\pm \\ 0 & c_\pm & b_\pm & a_\pm + d_{3\pm} \end{pmatrix}$$

Fitting these parameters with the Monte-Carlo program to the experimental data within the known accuracy and to the assumed values for the fourth family masses we get for the u-quarks the mass matrix

$$\begin{pmatrix} (9,22) & (-150,-83) & 0 & (-306,304) \\ (-150,-83) & (1211,1245) & (-306,304) & 0 \\ 0 & (-306,304) & (171600,176400) & (-150,-83) \\ (-306,304) & 0 & (-150,-83) & 200000 \\ \end{pmatrix}$$

and for the d-quarks the mass matrix

$$\begin{pmatrix} (5,11) & (8.2,14.5) & 0 & (174,198) \\ (8.2,14.5) & (83,115) & (174,198) & 0 \\ 0 & (174,198) & (4260,4660) & (8.2,14.5) \\ (174,198) & 0 & (8.2,14.5) & 200000 \\ \end{pmatrix}.$$

This corresponds to the following values for the masses of the u and the d quarks **for the chosen fourth family mass**

$$
\begin{aligned}
m_{u_i}/GeV &= (0.005, 1.220, 171., \mathbf{215}.),\\
m_{d_i}/GeV &= (0.008, 0.100, 4.500, \mathbf{285}.),
\end{aligned}
$$

and the mixing matrix for the quarks

$$
\begin{pmatrix}
-0.974 & -0.226 & -0.00412 & \mathbf{0.00218}\\
0.226 & -0.973 & -0.0421 & \mathbf{-0.000207}\\
0.0055 & -0.0419 & 0.999 & \mathbf{0.00294}\\
0.00215 & 0.000414 & -0.00293 & \mathbf{0.999}
\end{pmatrix}.
$$

FIFTH FAMILY AS A CANDIDATE TO FORM CLUSTERS OF DARK MATTER CONSTITUENTS

- The way **A.** of breaking symmetries leads to the **masses of the fourth family in agreement with the experimental data**, predicting the fourth family to be **possibly measured at LHC**. The three families are weakly coupled to the fourth.
- The way **B.**, although leading to mass matrices with only two off diagonal elements for each member of a family, has still **too many free parameters to predict the masses of the fourth family**. For chosen fourth family masses, the Yukawa couplings follow. Letting the fourth family mass growing, the fourth family very slowly decouples from the first three. The way B. predicts the changed values for $|V_{31}|/|V_{32}| = 0.128 - 0.149$ (since four instead of three families at weak scale contribute to this value).

- **The lowest family among the higher four families is the candidate to form the dark matter clusters.**

The candidate for the dark matter constituents must have the following properties:

- The scattering amplitude of a cluster of constituents with the ordinary matter (made mostly of the fermions of the first family) and among the dark matter clusters must be small enough to be in agreement with the observations (so that no effect of such scattering has been observed up to now).
- Clusters of constituents must be stable in comparison with the age of the Universe and they must form in the evolution the density distribution within a galaxy, which is approximately spherically symmetric and decreases approximately with the second power of the radius of the galaxy. They also spread in the intergalactic space. This density distribution is obviously different from the density distribution of the ordinary matter.

- It then follows that the dark matter clusters obviously have (for many orders of magnitude) different time scale for forming matter in comparison with the ordinary barionic matter (due to different scattering cross section and other properties).
- The dark matter constituents and accordingly also the clusters had to have a chance to be formed during the evolution of our Universe so that they agree with the today observed properties of the Universe.
- The ratio of the dark matter density and the ordinary matter density is 5-7.
- The properties must agree with direct observations (DAMA,CDMS).

Let us assume for our candidate for the dark matter constituents:

- There is a **stable**—decoupled in the Yukawa couplings from the lower families—**heavy family of quarks and leptons** (the fifth family as predicted by the approach unifying spins and charges).
- It has masses several orders of magnitude greater than the known three families.
- **All the charges are those of the known families** and so are accordingly also the couplings to the gauge fields.
- Families distinguish among themselves only in the family index and due to the Yukawa couplings also in their masses.

- We **make a rough estimation of properties of clusters** of the members of the stable heavy family (u_5, d_5, ν_5, e_5), with all the properties of the observed families: having the same family members and interacting with the same gauge fields.
- We **estimate conditions, under which the fifth family members form the barions in the evolution of the universe** (so that do not contradict the observed phenomena).
- We **estimate the behaviour** of our clusters when (if) they trigger:
  i. the DAMA/NaI and DAMA-LIBRA experiments and
  ii. the CDMS experiments.

Baryons of heavy stable family in Bohr-like model

The Bohr-like model for two heavy enough quarks gives for the binding energy and the radius

$$
\begin{aligned}
E_{q_5\, n} &= -\frac{1}{2n^2} m_5 c^2 3\alpha_c^2, \\
< r >_{q_5\, n} &= n^2 \frac{\hbar}{3\alpha_c m_5 c}. \\
\alpha_c(E^2) &= \frac{\alpha_c(M^2)}{1 + \frac{\alpha_c(M^2)}{4\pi}(11 - \frac{2N_F}{3})\ln(\frac{E^2}{M^2})} \\
\alpha_c((91\ \mathrm{GeV})^2) &= 0.1176(20),
\end{aligned}
$$

In table 1_{dm} we present the binding energy, the radius and the cross section for three different choices of the mass of the quark m_5. The meaning of ε ($\varepsilon = \varepsilon_v \cdot \varepsilon_{\rho_{dm}} \cdot \varepsilon_{\sigma_5}$) will be explained latter

$\frac{m_5 c^2}{\mathrm{TeV}}$	α_c	$\frac{E_b}{\mathrm{TeV}}$	$\frac{r_{c5}}{10^{-4}\mathrm{fm}}$	$\frac{\pi r_{c5}^2}{10^{-8}\mathrm{fm}^2}$	ε
5.94	0.1119	0.17	1.97	12.2	1
66.0	0.0958	1.4	0.21	0.14	1000
0.527	0.134	0.02	18.6	1087.0	1/1000

nb$= 10^{-10} fm^2$. We can notice: The binding energy is of the two orders of magnitude smaller than the mass of a cluster at $m_5 \approx 1$ TeV to 100 TeV. The energy difference between the ground and the first excited state is of the same order of magnitude as the binding energy.

If a cluster of heavy quarks and of ordinary (the lightest) quarks is made, then, since light quarks dictate the radius and the excitation energies of a cluster, its properties are not far from the properties of the ordinary hadrons, except that such a cluster has the mass dictated by heavy quarks. Similarly also the ordinary electron in an atom with nucleus made out of the fifth family has the electromagnetic properties of the ordinary atoms and the mass determined by the fifth family quarks.

Dynamics of a heavy family clusters in our galaxy

One of many possible models for the assumed spherically symmetric dark matter density distribution:

$$\rho = \rho_{center}\,, \qquad r < r_0,$$
$$\rho = \rho_{center}\left(\frac{r_0}{r}\right)^2, \qquad r_0 < r < R_0$$
$$\rho = \rho_{center}\,\frac{r_0^2 R_0}{r^3}\,, \qquad r > R_0.$$

With the assumption that the dark matter clusters rotate with a constant velocity v_0, the above density distribution is trivially reproduced. We showed (G. Bregar) that the same density distribution can be as well obtained under the assumption that all the dark matter clusters just oscillate through the center of the galaxy or make a choice of any spheroidal-like path from the oscillatory one through the center to the rotations around the center. One can even weight the corresponding velocities with some (any) Maxwellian distribution to still obtain the same density distribution.

The flux on the Earth is changing annually due to the rotation of the Earth around the Sun.

Let ε_v, $0.5 < \varepsilon_v < 5$, takes care of the uncertainty of the velocity of the dark matter clusters hitting the Earth and $\varepsilon_{\rho_{dm}}$, $1/3 < \varepsilon_{\rho_{dm}} < 3$, of the density uncertainly (Table 1_{dm}).

$$\propto \frac{\rho_{dm}}{m_{c5}} v_0 \varepsilon_v \varepsilon_{\rho_{dm}} \left(1 + \frac{v_{ES}}{v_0} \cos\theta_{ES} \sin\omega t\right),$$

ρ_{dm}... the density of the Dark matter at the Earth location,
m_{c5}... the mass of a cluster made out of the fifth family members
v_0... the velocity of the Sun,
v_{ES} the velocity of the Earth around the Sun,
$\theta_{ES} = 60^0$... the angle of the plane of the Earth rotation with respect to the Sun velocity v_0.

Then the difference between the maximal and the minimal flux of the dark matter clusters, hitting the Earth, is proportional to

$$\propto \; 2\frac{\rho_{dm}}{m_{c5}}\varepsilon_{v}\varepsilon_{\rho_{dm}}\, v_{ES} \cos\theta_{ES}$$

Evolution of abundance of heavy family clusters

Evolution of abundance of heavy family clusters

There are several questions which we should answer before we can estimate the evolution of our heavy family in the expanding Universe. Two of them are:

- What is the particle-antiparticle asymmetry for the fifth and for the first family? (The approach unifying spins and charges does offer the mechanism for the CP symmetry breaking, but we are not yet able to estimate the above asymmetry.)
- What are the masses of the fifth family members? (We are not yet able to answer this question.)

Let us assume that there is a negligible matter-antimatter asymmetry

$$\Omega_5 \;=\; \frac{H(m_5)(k_b T_0)^3}{3.30\alpha(m_5 c^2) < \sigma_5 v_5/c > (k_b T_1) c\rho_{cr}},$$

$H(m_5) = \sqrt{\frac{8\pi^3 G(m_5c^2)^4 g(m_5)}{3.30c^2(\hbar c)^3}}$, $g(m_5) = \sum_{i_b} g_{i_b} + \sum_{i_f} g_{i_f}$,
$< \sigma_5 v_5/c >$ is the cross section at $k_b T = m_5 c^2$, g_{i_b} and g_{i_f} are the number of bosonic and fermionic fields contributing to plasma, ($\frac{1}{\alpha}$ takes care of the contributions to the plasma temperature of the lighter particle-antiparticle pairs after the 'freeze-out' temperature T_1.)
It follows then approximately that the fifth quark mass should be in the region

$$\mathrm{few TeV} < m_5 < \mathrm{few 100 TeV},$$

Heavy family clusters and direct measurements

A.

We study how do our fifth family clusters trigger the experiments of DAMA/NaI, DAMA/LIBRA, (Riv. N. Cim. 26 n. 1 (2003), 1-73) which **clearly** measure the annual changing of the signal. We assume that the probability for the scattering on one NaI atom is proportional to $\pi (r_{c5})^2 \; \times \varepsilon_{\sigma_5}$

We assume also that each of the nuclei is pushed by our heavy cluster with the velocity $\varepsilon_v v_0$, achieving the energy $m_{Na} (\varepsilon_v v_0)^2/2 (\approx 5$ KeV) and $m_I v_0^2/2 (\approx 30$ KeV).

The amplitude

$$\Delta R = \frac{\rho_{dm}}{m_{c5}} \, N \, \sigma_{c5} \;\, v_{ES} \cos 60,$$

To compare the above evaluations with the data from DAMA/NaI and DAMA-LIBRA we use their results

- 2-4 keV: $(2.15 \pm 0.3) \cdot 10^{-2}$ cpd/kg/keV
- 2-5 keV: $(1.7 \pm 0.2) \cdot 10^{-2}$ cpd/kg/keV
- 2-6 keV: $(1.3 \pm 0.15) \cdot 10^{-2}$ cpd/kg/keV

and recognize that in order to derive the recoil energy for Na and I one has to account for the measured **quenching factors** values. (A kind of averaging gives 0.3 for Na and 0.09 for I. A I nucleus of 30 keV recoil energy can give $\approx$ 3 KeV electron equivalent if fully quenched, up to 30 keV if fully channeled).

If taking into account these effects and table 1_{dm}, we recognize the agreement of the above results and table 1_{dm} for $\varepsilon \approx 1000$.

B.
The CDMS has measured, measuring the energy of the dark matter clusters in coincidence with the recoil energy of the clusters, **no events at all**.

If our fifth family clusters, or any heavy family cluster, are the right candidates for the dark matter constituents, they should measure 50 of them.
It is no reason not to trust either the CDMS experiments or DAMA experiments.

There are accordingly the following possibilities

- CDMS, when cleaning up the noise, do clean up the fifth family clusters.
- The mechanism how our the fifth family clusters trigger both experiments—DAMA and CDMS—is much more complicated than assumed.
- Our assumptions of how do the fifth family clusters evolve in the history of our Universe are not the correct assumptions (we assumed that all the fifth family particles and antiparticles after decoupling form neutrons and anti-neutron in the first recombination).
- Our fifth family clusters are not the right answer to the dark matter problem.

If a simple model of a heavy stable family clusters are not the right answer to the dark matter problem, that is,

if much more complicated models are needed to explain the events, which DAMA measures, while DCMS does not,

then there are so many possible answers, that it will be extremely difficult to see the right one among them.

The hope is (a small chance), that CDMS cuts away the clusters of the heavy family.

CONCLUDING REMARKS

- We started with a simple Lagrange density suggested by **the approach unifying spins and charges** with one Weyl spinor in $d = 1 + 13$, which carries only the spin (no charges) and interacts with only the gravity through vielbeins and the two kinds of the spin connection fields, which are the gauge fields of S^{ab} and $\tilde{S}^{ab}$, respectively.
- There are S^{ab}, which determine in $d = (1 + 3)$ the spin and all the charges. One Weyl spinor representation includes (if analyzed with respect to the Standard model groups) the left handed weak charged quarks and leptons and the right handed weak chargeless quarks and leptons.
- The second kind of the Clifford algebra objects $\tilde{S}^{ab}$ generate an even number of families.

- It is a **part of a simple starting action** which manifests as Yukawa couplings of the Standard model $\psi^\dagger \gamma^0 \gamma^s p_{0s} \psi,\ s = 7, 8$, with $p_{0s} = -\frac{1}{2} S^{ab} \omega_{abs} - \frac{1}{2} \tilde{S}^{ab} \tilde{\omega}_{abs}$ contributing to diagonal and off diagonal elements of mass matrices.
- Making assumptions about possible ways of breaking symmetries, each of the two assumed ways leads at "low energy sector" to four times four mass matrices for four families of quarks and leptons, two by two weakly coupled and all three also weakly coupled to the fourth one.

- The way **A**. of breaking symmetries leads to the masses of the fourth family in agreement with the experimental data, predicting that the fourth family appears at low enough energies **to be measured at LHC**.
- The way **B**. predicts **the Yukawa couplings** in our rough estimation. Letting the fourth family mass growing, it very slowly decouples from the first three. The way B. also predicts, for example, the changed values for $|V_{31}|/|V_{32}| = 0.128 - 0.149$, acceptable since four instead of three families at weak scale contribute to this value.

- **The stable** one of **the higher four families is the candidate to form the dark matter constituents** in both proposed ways, if the CDMS will confirm the DAMA results.
- Which one of the two studied ways (if any of these two) is the right way? To answer this question we should go beyond the tree level.

- Is the Approach unifying spins and charges the right way to understand the Yukawa couplings and accordingly going beyond the Standard model?
- Since there are two kinds of the Clifford algebra objects (the Dirac one and mine)—one kind defining spins and charges and the other defining equivalent representations with respect to the first one—and since there are families and since the interplay of both is needed in the Yukawa couplings, the Approach might show the right way beyond the Standard Model.
- If the Approach way is the right one to describe families, than there must be more than three observed families. Then it is the fourth to be possibly seen at THC and there must be the fifth one also and it has a chance to form the dark matter.