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Minimal muon anomalous magnetic moment

Based on JHEP 02 (2015) 099
in collaboration with M. Bordone

INVISIBLES15 Workshop
Madrid, 22-26 June 2015

The $(g-2)_\mu$ anomaly

$$a_\mu^{exp} = 116592080(63) \cdot 10^{-11}$$

Brookhaven 2006

$$a_\mu^{SM} = 116591790(65) \cdot 10^{-11}$$

Jegerlehner, Nyffeler 2009
(e+e- annih.)

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- theoretical: bad estimation of hadronic contribution
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adopt this optimistic option :)

Explaining Δa_μ with a single new particle

Assumptions:

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2. consider only fermions and scalars

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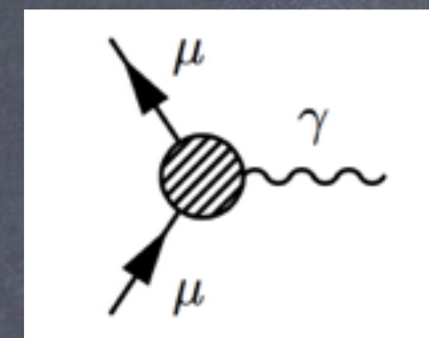

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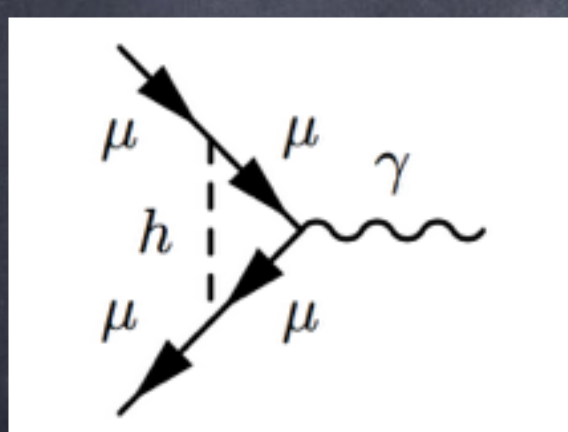

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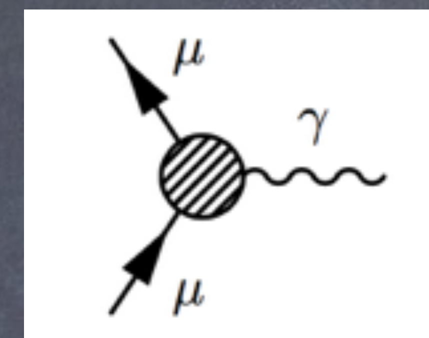

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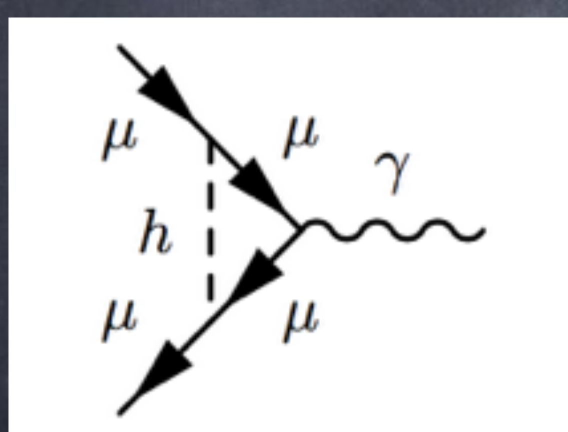

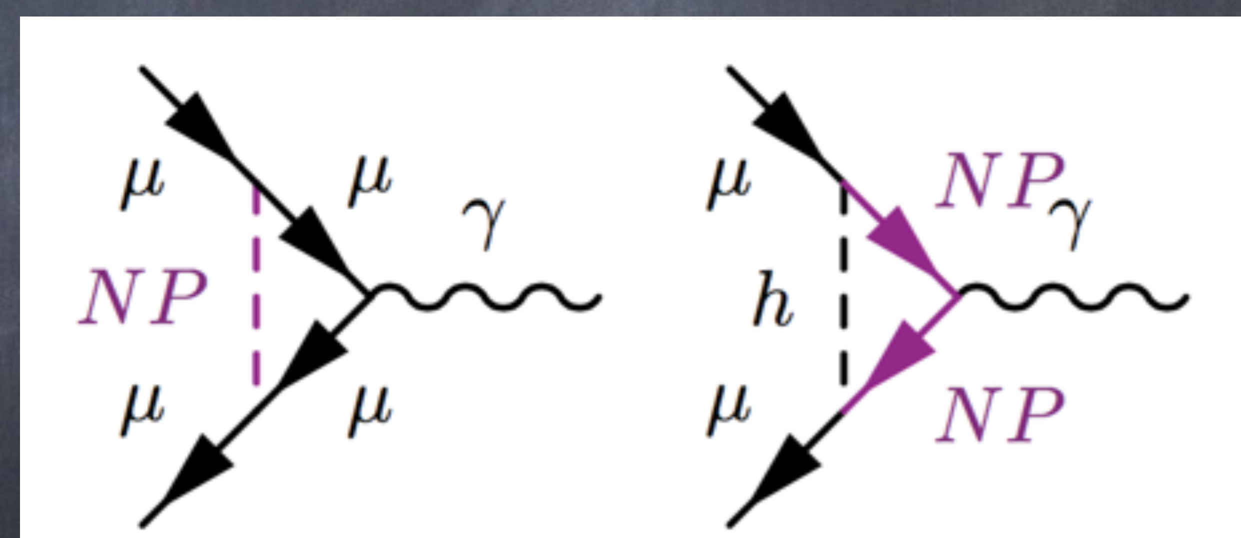

Requirements: 1. Lorentz invariance
2. Gauge invariance
3. Renormalizability

New fermions

All vector-like: masses indep. of EWSB, no anomalies

N_R	$(1,1,0)$	typeI seesaw
Σ_R	$(1,3,1)$	typeIII seesaw
E_4	$(1,1,-1)$	} 4th generation.
L_4	$(1,2,-1/2)$	
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D	$(1,2,-3/2)$	

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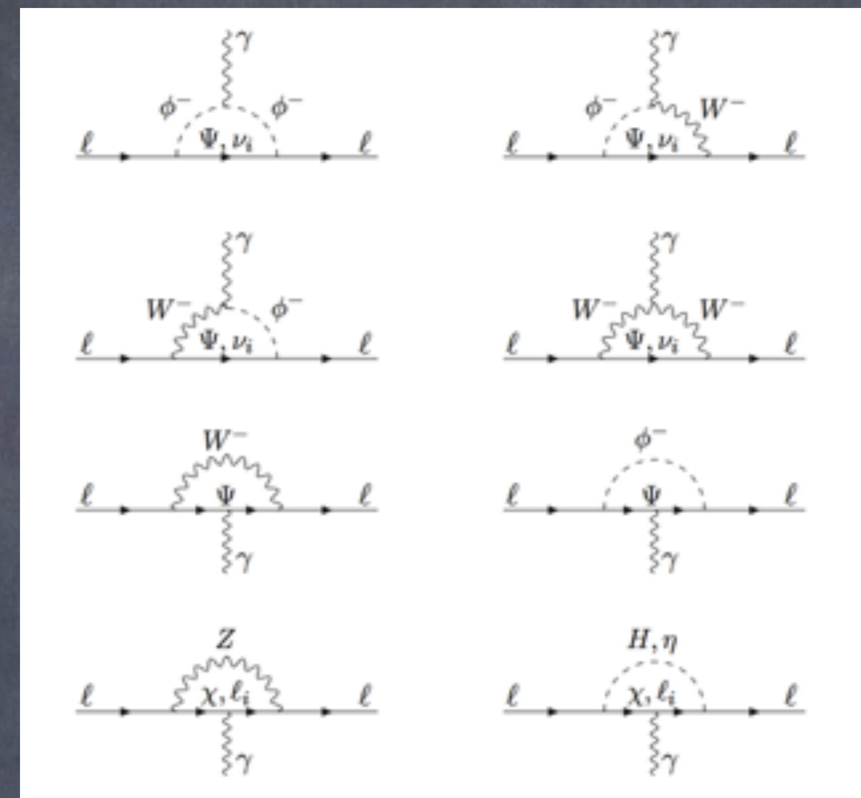
The contribution of D ~ (1,2,-3/2)

$$D = \begin{pmatrix} \chi \\ \Psi \end{pmatrix} \begin{matrix} \rightarrow Q=1 \\ \rightarrow Q=2 \end{matrix}$$



SM

$$a_\mu^{\mathrm{SM}+D} = \frac{m_\mu^2 G_F}{24\sqrt{2}\pi^2}\left\{ \left(3 - 4\cos^2\theta_W\right)^2 + 5 + \frac{v^2\,|\lambda_{D\mu}|^2}{M_D^2}\left[-\frac{11}{4} - 4\cos^2\theta_W + \right.\right.$$
$$\left.\left. + F_{\mathrm{NC}}\left(\frac{M_D^2}{M_Z^2}\right) + F_{\mathrm{h}}\left(\frac{M_D^2}{M_H^2}\right) + F_{\mathrm{CC}}\left(\frac{M_D^2}{M_W^2}\right) \right]\right\},$$

CB, Bordone 14

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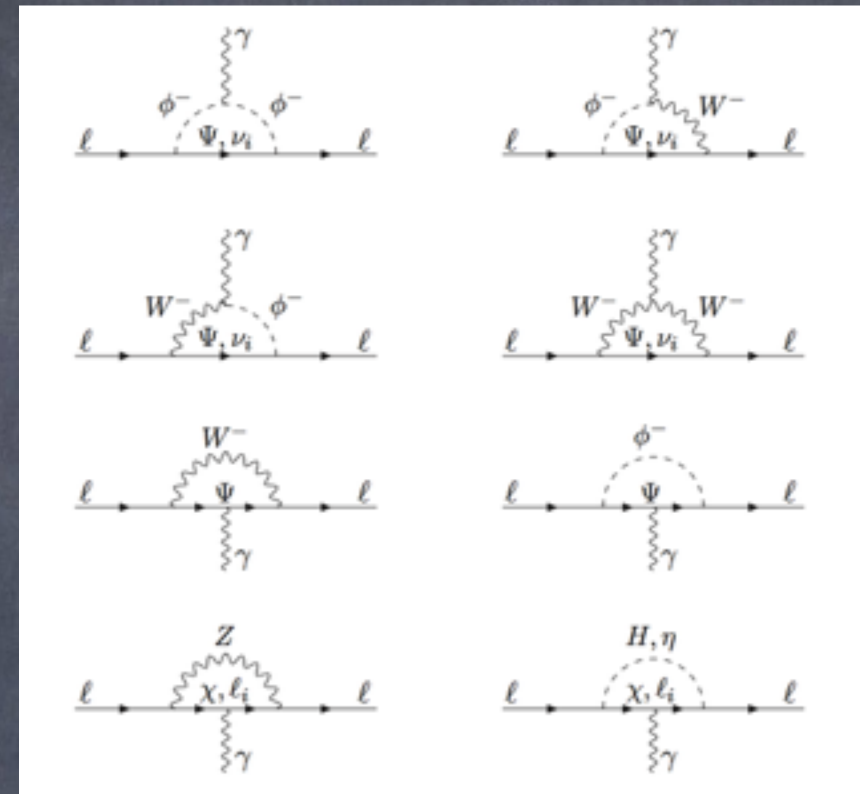

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The new contribution is negative
it cannot explain the discrepancy

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It's not possible to explain the discrepancy adding to the SM a single fermion

New scalars

S_1	$(1,1,1)$	
S_2	$(1,1,2)$	
H_2	$(1,2,1/2)$	II Higgs doublet
Δ	$(1,3,1)$	type II seesaw
$T_c^{1/3}$	$(3,3,-1/3)$	leptoquarks
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Only these because they have both L and R couplings

➢ enhancement with top (charm) mass

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In a particular 2HDM
if lighter than 200 GeV

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The $\tilde{b}_R$ of the Higgsinoless MSSM

Riva, CB, Pomarol 12

It's a SUSY model without R-parity (with $U(1)_R$) where there are NO chiral Higgs superfields:
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In our case $l_\alpha \equiv \mu$, the b_R coupling is fixed to be Y_b

$$a_\mu^{LQ} \propto \frac{v^2 Y_b^2}{M_{LQ}^2}$$

we have a prediction for M_{LQ}

$$M_{\tilde{b}_R} \sim 500\text{GeV}$$

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ATLAS 13

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In our model: $\tilde{b}_R \to$

$b_L \nu_L$

$t_L l_L$

$(b_R \tilde{G})$

($b_L \nu_L$ and $t_L l_L$: same BR)

This possibility is viable, to confirm/exclude it

look for final states with top and charged leptons!!!

Conclusions

- We have considered single particle extensions of the SM (scalar & fermion)
- A single new fermion cannot explain the $(g-2)_\mu$ anomaly
- Only 3 scalars -2 leptoquarks and a second Higgs doublet- can do it
- The $\tilde{b}_R$ of the Higgsinoless MSSM could solve the $(g-2)_\mu$ puzzle and we have a prediction for its mass: $M_{\tilde{b}_R} \sim 500\ GeV$
- Most of these solutions are going to be tested @ LHC13
- Wait for new LHC run and new $(g-2)_\mu$ experiment!

Muchas gracias!