EFT WG Area 5

What are the data telling us?

José Santiago
CAFPE & UGR

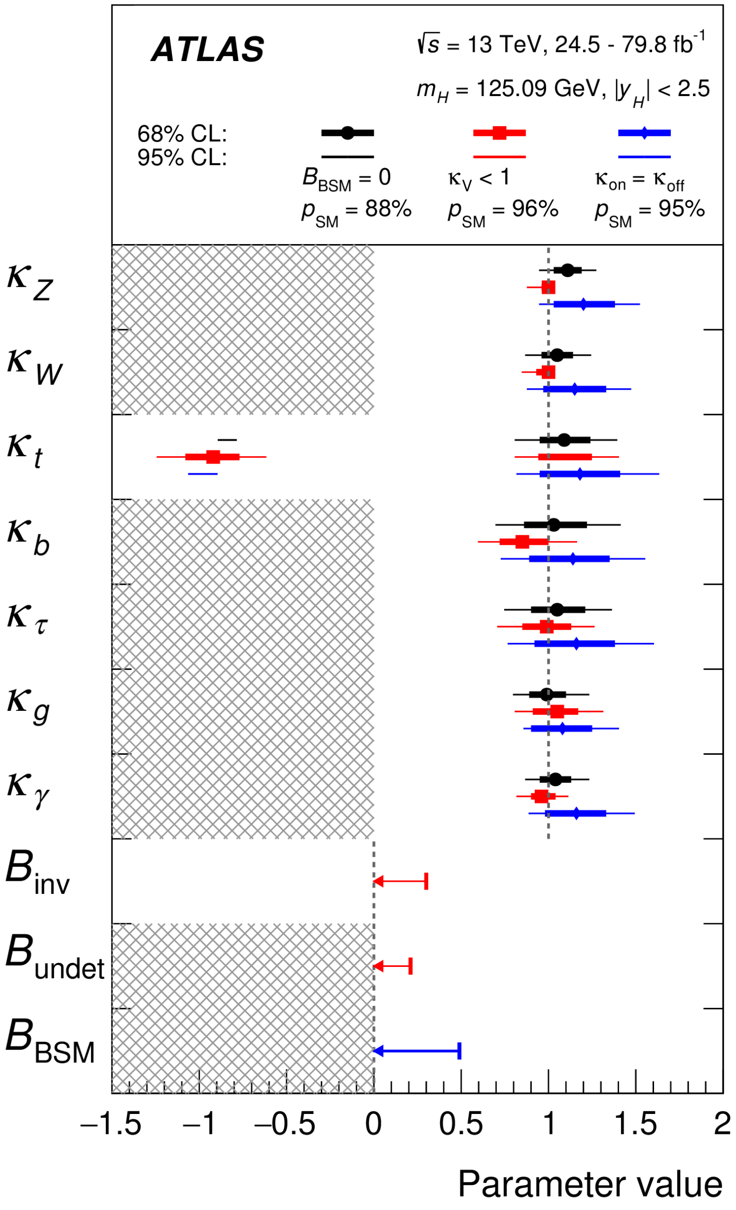
UNIVERSIDAD DE GRANADA

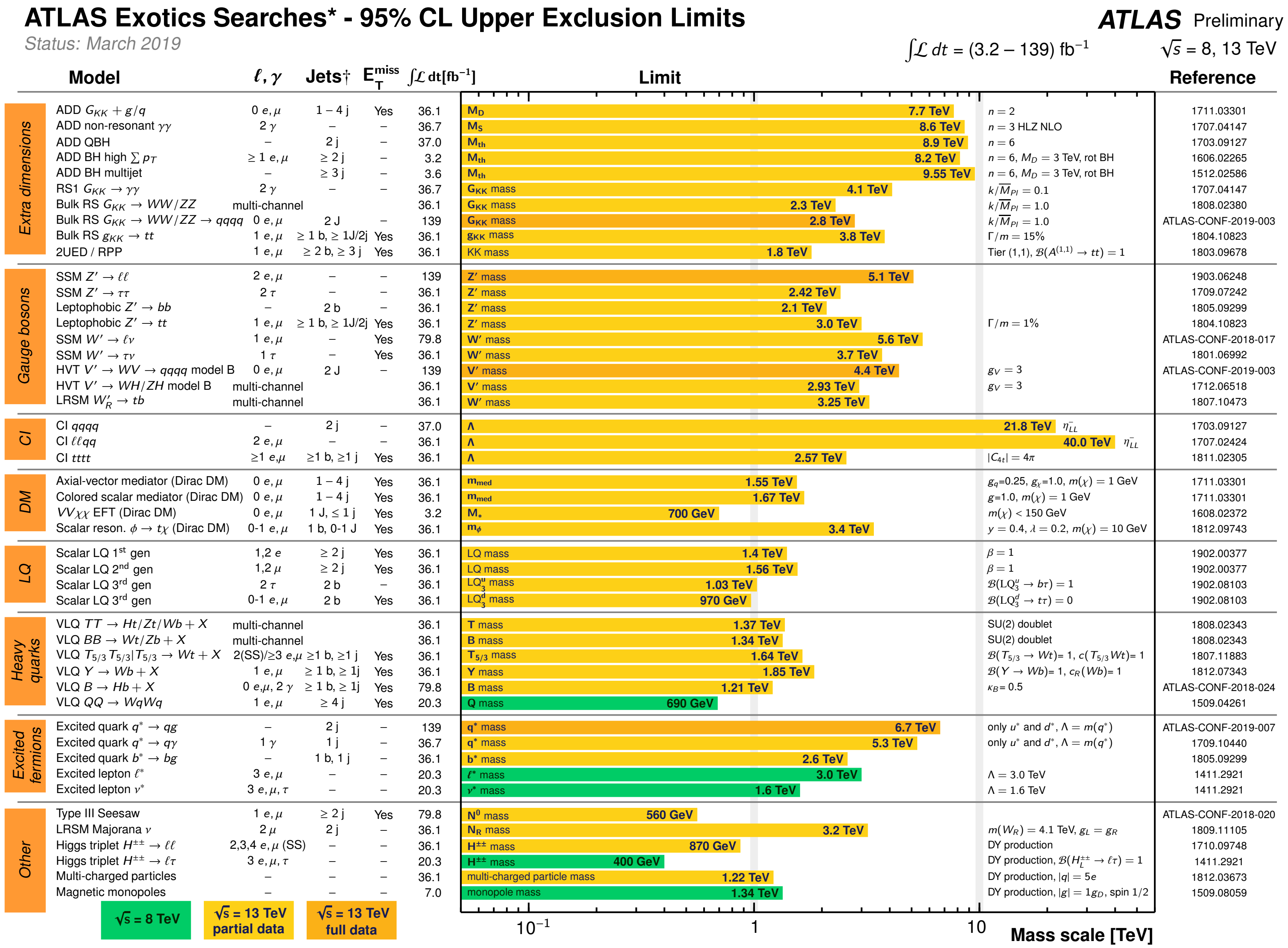
Unidades de Excelencia UGR

In collaboration with J. de Blas, G. Guedes, P. Olgoso

(very preliminary!!!)

The LHC is probing the SM and beyond from every imaginable corner (with little success so far)



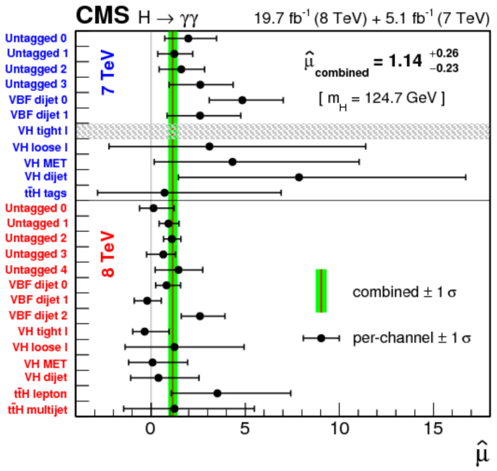

ATLAS Exotics Searches* - 95% CL Upper Exclusion Limits

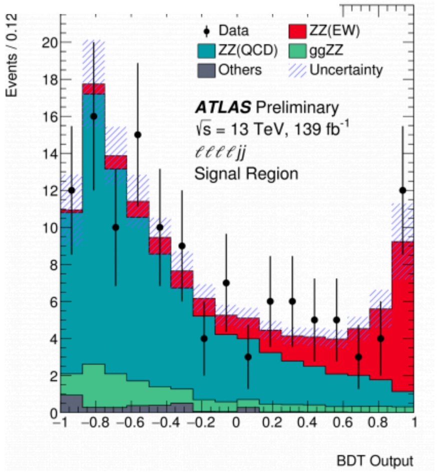
Status: March 2019

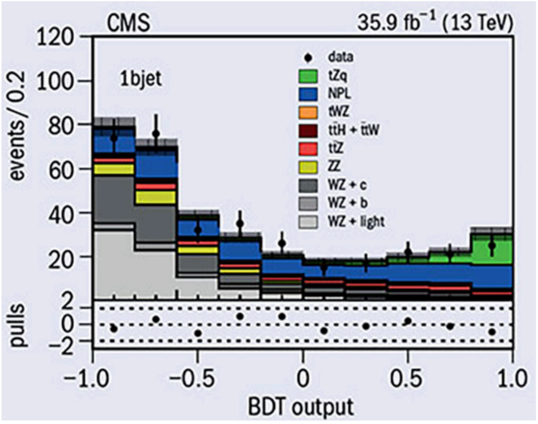
	Model	ℓ, γ	Jets†	E_T^{miss}	$\int\mathcal{L}\,dt[fb^{-1}]$	Limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	0 e, μ	1 – 4 j	Yes	36.1	M_D 7.7 TeV	$n = 2$	1711.03301
	ADD non-resonant $\gamma\gamma$	2 γ	–	–	36.7	M_S 8.6 TeV	$n = 3$ HLZ NLO	1707.04147
	ADD QBH	–	2 j	–	37.0	M_{th} 8.9 TeV	$n = 6$	1703.09127
	ADD BH high $\sum p_T$	≥ 1 e, μ	≥ 2 j	–	3.2	M_{th} 8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1606.02265
	ADD BH multijet	–	≥ 3 j	–	3.6	M_{th} 9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \to \gamma\gamma$	2 γ	–	–	36.7	G_{KK} mass 4.1 TeV	$k/\overline{M}_{Pl} = 0.1$	1707.04147
	Bulk RS $G_{KK} \to WW/ZZ$	multi-channel			36.1	G_{KK} mass 2.3 TeV	$k/\overline{M}_{Pl} = 1.0$	1808.02380
	Bulk RS $G_{KK} \to WW/ZZ \to qqqq$	0 e, μ	2 J	–	139	G_{KK} mass 2.8 TeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2019-003
	Bulk RS $g_{KK} \to tt$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	36.1	g_{KK} mass 3.8 TeV	$\Gamma/m = 15\%$	1804.10823
	2UED / RPP	1 e, μ	≥ 2 b, ≥ 3 j	Yes	36.1	KK mass 1.8 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \to tt) = 1$	1803.09678
Gauge bosons	SSM $Z' \to \ell\ell$	2 e, μ	–	–	139	Z' mass 5.1 TeV		1903.06248
	SSM $Z' \to \tau\tau$	2 τ	–	–	36.1	Z' mass 2.42 TeV		1709.07242
	Leptophobic $Z' \to bb$	–	2 b	–	36.1	Z' mass 2.1 TeV		1805.09299
	Leptophobic $Z' \to tt$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	36.1	Z' mass 3.0 TeV	$\Gamma/m = 1\%$	1804.10823
	SSM $W' \to \ell\nu$	1 e, μ	–	Yes	79.8	W' mass 5.6 TeV		ATLAS-CONF-2018-017
	SSM $W' \to \tau\nu$	1 τ	–	Yes	36.1	W' mass 3.7 TeV		1801.06992
	HVT $V' \to WV \to qqqq$ model B	0 e, μ	2 J	–	139	V' mass 4.4 TeV	$g_V = 3$	ATLAS-CONF-2019-003
	HVT $V' \to WH/ZH$ model B	multi-channel			36.1	V' mass 2.93 TeV	$g_V = 3$	1712.06518
	LRSM $W'_R \to tb$	multi-channel			36.1	W' mass 3.25 TeV		1807.10473
CI	CI $qqqq$	–	2 j	–	37.0	Λ 21.8 TeV	η^-_{LL}	1703.09127
	CI $\ell\ell qq$	2 e, μ	–	–	36.1	Λ 40.0 TeV	η^-_{LL}	1707.02424
	CI $tttt$	≥1 e,μ	≥1 b, ≥1 j	Yes	36.1	Λ 2.57 TeV	$\lvert C_{4t}\rvert = 4\pi$	1811.02305
DM	Axial-vector mediator (Dirac DM)	0 e, μ	1 – 4 j	Yes	36.1	m_{med} 1.55 TeV	g_q=0.25, g_χ=1.0, $m(\chi) = 1$ GeV	1711.03301
	Colored scalar mediator (Dirac DM)	0 e, μ	1 – 4 j	Yes	36.1	m_{med} 1.67 TeV	g=1.0, $m(\chi) = 1$ GeV	1711.03301
	$VV\chi\chi$ EFT (Dirac DM)	0 e, μ	1 J, ≤ 1 j	Yes	3.2	M_* 700 GeV	$m(\chi) < 150$ GeV	1608.02372
	Scalar reson. $\phi \to t\chi$ (Dirac DM)	0-1 e, μ	1 b, 0-1 J	Yes	36.1	m_ϕ 3.4 TeV	$y = 0.4$, $\lambda = 0.2$, $m(\chi) = 10$ GeV	1812.09743
LQ	Scalar LQ 1st gen	1,2 e	≥ 2 j	Yes	36.1	LQ mass 1.4 TeV	$\beta = 1$	1902.00377
	Scalar LQ 2nd gen	1,2 μ	≥ 2 j	Yes	36.1	LQ mass 1.56 TeV	$\beta = 1$	1902.00377
	Scalar LQ 3rd gen	2 τ	2 b	–	36.1	LQ^u_3 mass 1.03 TeV	$\mathcal{B}(LQ^u_3 \to b\tau) = 1$	1902.08103
	Scalar LQ 3rd gen	0-1 e, μ	2 b	Yes	36.1	LQ^d_3 mass 970 GeV	$\mathcal{B}(LQ^d_3 \to t\tau) = 0$	1902.08103
Heavy quarks	VLQ $TT \to Ht/Zt/Wb + X$	multi-channel			36.1	T mass 1.37 TeV	SU(2) doublet	1808.02343
	VLQ $BB \to Wt/Zb + X$	multi-channel			36.1	B mass 1.34 TeV	SU(2) doublet	1808.02343
	VLQ $T_{5/3}T_{5/3}\lvert T_{5/3} \to Wt + X$	2(SS)/≥3 e,μ	≥1 b, ≥1 j	Yes	36.1	$T_{5/3}$ mass 1.64 TeV	$\mathcal{B}(T_{5/3} \to Wt)$= 1, $c(T_{5/3}Wt)$= 1	1807.11883
	VLQ $Y \to Wb + X$	1 e, μ	≥ 1 b, ≥ 1j	Yes	36.1	Y mass 1.85 TeV	$\mathcal{B}(Y \to Wb)$= 1, $c_R(Wb)$= 1	1812.07343
	VLQ $B \to Hb + X$	0 e,μ, 2 γ	≥ 1 b, ≥ 1j	Yes	79.8	B mass 1.21 TeV	κ_B= 0.5	ATLAS-CONF-2018-024
	VLQ $QQ \to WqWq$	1 e, μ	≥ 4 j	Yes	20.3	Q mass 690 GeV		1509.04261
Excited fermions	Excited quark $q^* \to qg$	–	2 j	–	139	q^* mass 6.7 TeV	only u^* and d^*, $\Lambda = m(q^*)$	ATLAS-CONF-2019-007
	Excited quark $q^* \to q\gamma$	1 γ	1 j	–	36.7	q^* mass 5.3 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1709.10440
	Excited quark $b^* \to bg$	–	1 b, 1 j	–	36.1	b^* mass 2.6 TeV		1805.09299
	Excited lepton ℓ^*	3 e, μ	–	–	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0$ TeV	1411.2921
	Excited lepton ν^*	3 e, μ, τ	–	–	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6$ TeV	1411.2921
Other	Type III Seesaw	1 e, μ	≥ 2 j	Yes	79.8	N^0 mass 560 GeV		ATLAS-CONF-2018-020
	LRSM Majorana ν	2 μ	2 j	–	36.1	N_R mass 3.2 TeV	$m(W_R) = 4.1$ TeV, $g_L = g_R$	1809.11105
	Higgs triplet $H^{\pm\pm} \to \ell\ell$	2,3,4 e, μ (SS)	–	–	36.1	$H^{\pm\pm}$ mass 870 GeV	DY production	1710.09748
	Higgs triplet $H^{\pm\pm} \to \ell\tau$	3 e, μ, τ	–	–	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, $\mathcal{B}(H^{\pm\pm}_L \to \ell\tau) = 1$	1411.2921
	Multi-charged particles	–	–	–	36.1	multi-charged particle mass 1.22 TeV	DY production, $\lvert q\rvert = 5e$	1812.03673
	Magnetic monopoles	–	–	–	7.0	monopole mass 1.34 TeV	DY production, $\lvert g\rvert = 1g_D$, spin 1/2	1509.08059

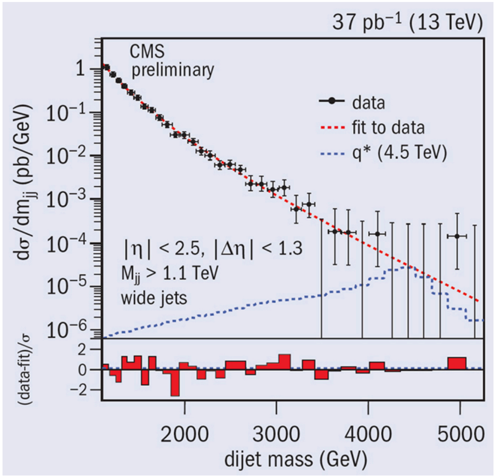
*Only a selection of the available mass limits on new states or phenomena is shown.

†Small-radius (large-radius) jets are denoted by the letter j (J).

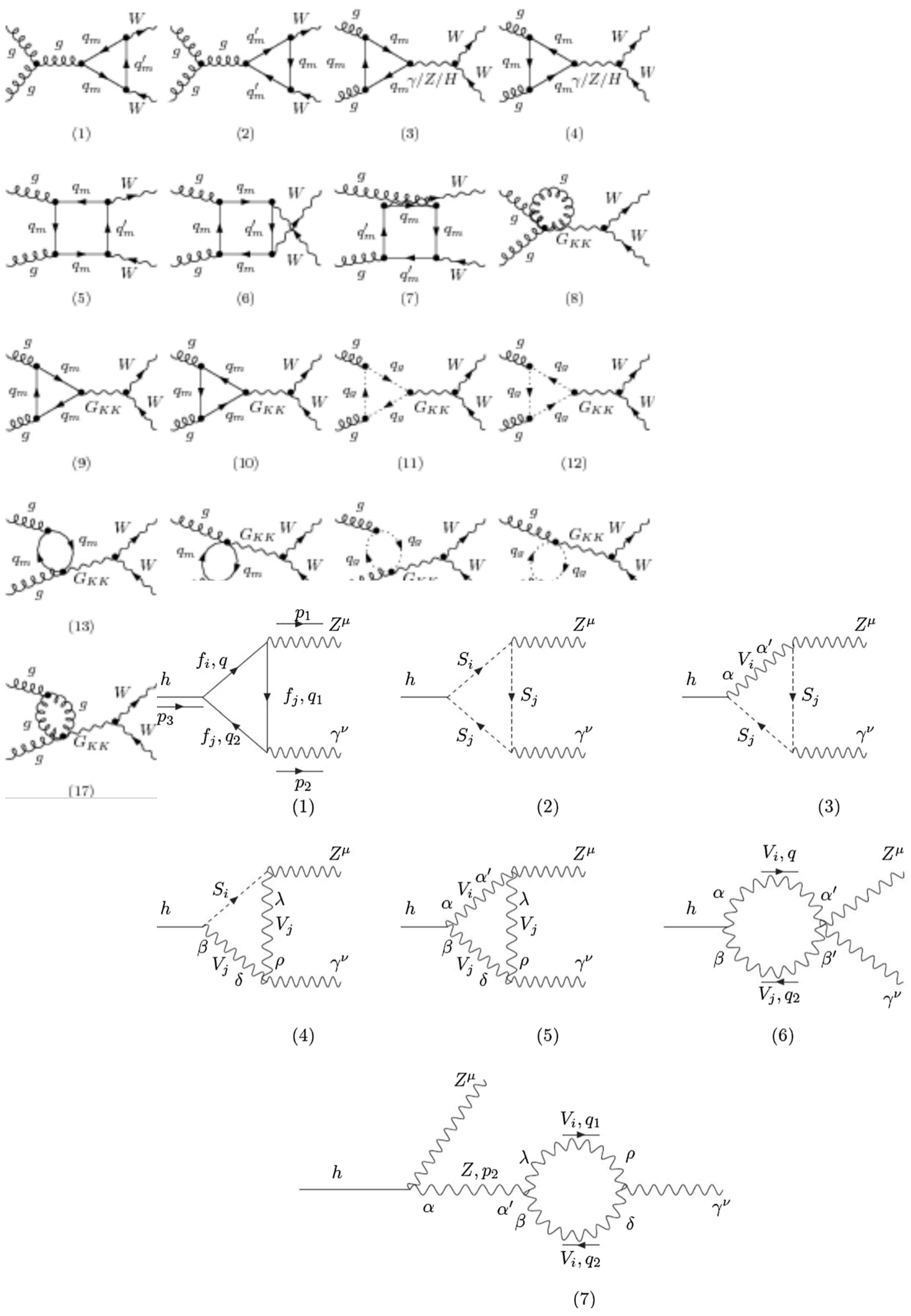


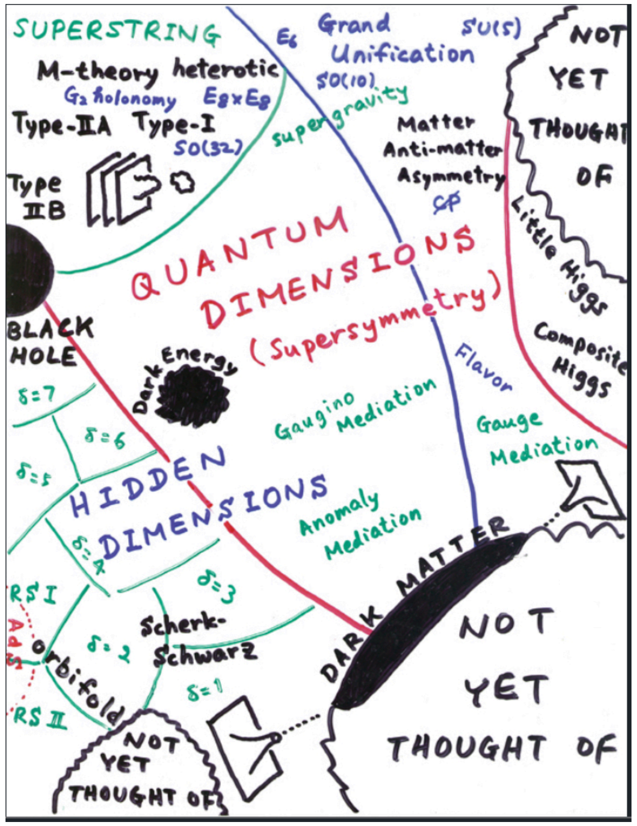






Getting implications of experimental data on new physics models is highly non trivial!





Connect TH and EXP with EFT

EFTs provide an efficient two-step comparison between theory and experiment

Bottom-up approach to EFT: model-independent parameterization of experimental data (global fits)

Top-down approach to EFT: model discrimination

- Has to be done on a model by model basis
- Can be completely classified and automated
- Range of validity of EFT can be checked
- Comparison of direct and indirect limits

But how to use global fits?

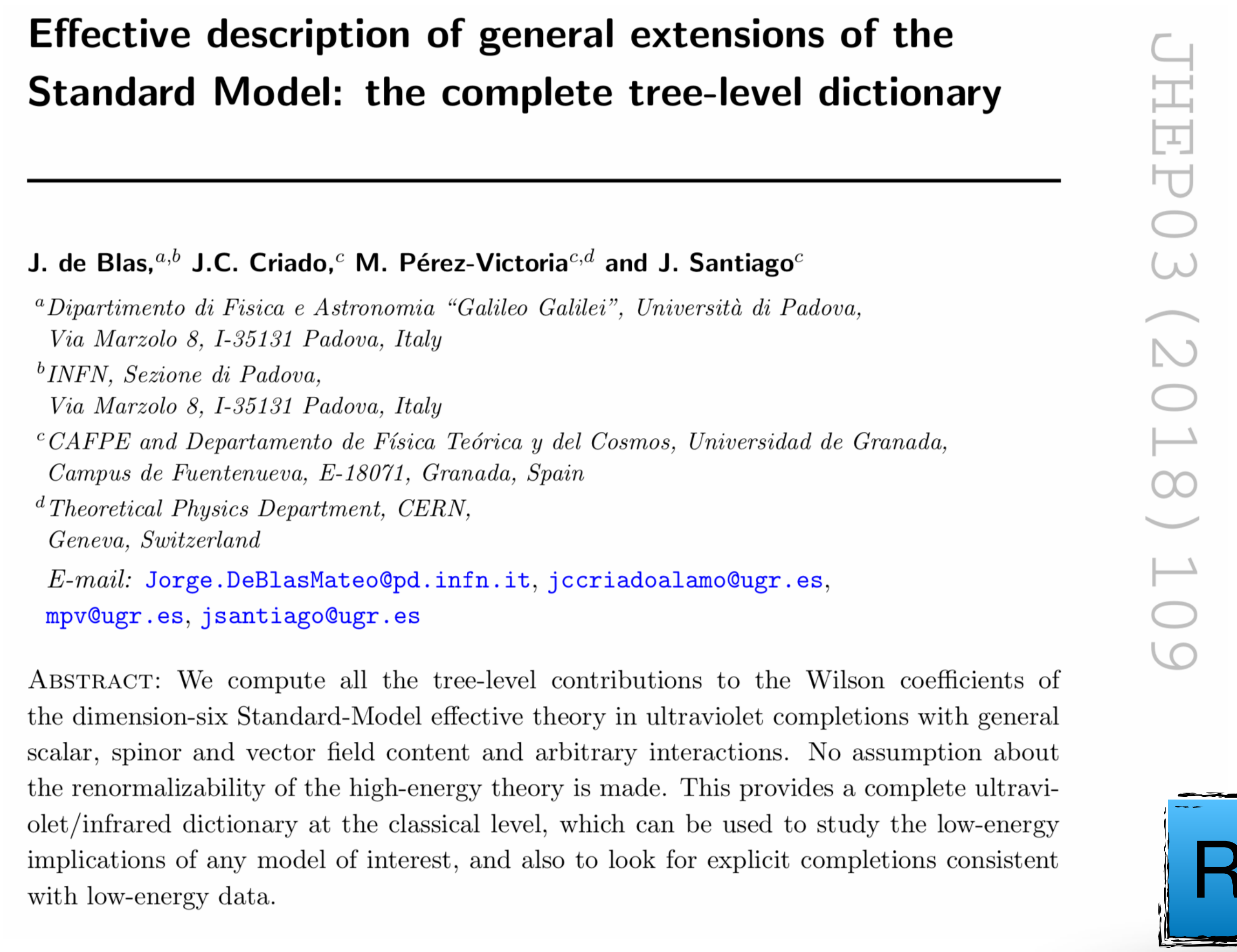
How to use global fits

We can use UV/IR dictionaries to systematically explore implications of experimental data on NP models

- Take the global fit from someone you trust, make sure you understand the results (EFT basis, assumptions, approximations and omissions)
- Do your thing
  - Extract information from the fit on combinations of WCs (interpret the fit)
  - Use dictionary to systematically extract information on new physics models

Tree level UV/IR dictionary

The leading contribution (tree level, dimension 6) in the SMEFT has been recently completed (no spins higher than 1) J. Blas, JC Criado, M Pérez-Victoria, JS ’18



Effective description of general extensions of the Standard Model: the complete tree-level dictionary

J. de Blas,[a,b] J.C. Criado,[c] M. Pérez-Victoria[c,d] and J. Santiago[c]

[a] *Dipartimento di Fisica e Astronomia "Galileo Galilei", Università di Padova, Via Marzolo 8, I-35131 Padova, Italy*

[b] *INFN, Sezione di Padova, Via Marzolo 8, I-35131 Padova, Italy*

[c] *CAFPE and Departamento de Física Teórica y del Cosmos, Universidad de Granada, Campus de Fuentenueva, E-18071, Granada, Spain*

[d] *Theoretical Physics Department, CERN, Geneva, Switzerland*

E-mail: `Jorge.DeBlasMateo@pd.infn.it`, `jccriadoalamo@ugr.es`, `mpv@ugr.es`, `jsantiago@ugr.es`

Abstract: We compute all the tree-level contributions to the Wilson coefficients of the dimension-six Standard-Model effective theory in ultraviolet completions with general scalar, spinor and vector field content and arbitrary interactions. No assumption about the renormalizability of the high-energy theory is made. This provides a complete ultraviolet/infrared dictionary at the classical level, which can be used to study the low-energy implications of any model of interest, and also to look for explicit completions consistent with low-energy data.

JHEP03(2018)109

Building on previous results

Blas, Chala, Pérez-Victoria, JS ‘14;
Águila, Blas, Pérez-Victoria ‘08, ‘10;
Águila, Pérez-Victoria, JS ‘00

Results given in Warsaw basis

Tree level UV/IR dictionary

The leading contribution (tree level, dimension 6) in the SMEFT has been recently completed (no spins higher than 1) J. Blas, JC Criado, M Pérez-Victoria, JS ’18

19 scalars

Name	$\mathcal{S}$	$\mathcal{S}_1$	$\mathcal{S}_2$	φ	Ξ	Ξ_1	Θ_1	Θ_3
Irrep	$(1,1)_0$	$(1,1)_1$	$(1,1)_2$	$(1,2)_{\frac{1}{2}}$	$(1,3)_0$	$(1,3)_1$	$(1,4)_{\frac{1}{2}}$	$(1,4)_{\frac{3}{2}}$
Name	ω_1	ω_2	ω_4	Π_1	Π_7	ζ		
Irrep	$(3,1)_{-\frac{1}{3}}$	$(3,1)_{\frac{2}{3}}$	$(3,1)_{-\frac{4}{3}}$	$(3,2)_{\frac{1}{6}}$	$(3,2)_{\frac{7}{6}}$	$(3,3)_{-\frac{1}{3}}$		
Name	Ω_1	Ω_2	Ω_4	Υ	Φ			
Irrep	$(6,1)_{\frac{1}{3}}$	$(6,1)_{-\frac{2}{3}}$	$(6,1)_{\frac{4}{3}}$	$(6,3)_{\frac{1}{3}}$	$(8,2)_{\frac{1}{2}}$			

Table 1. New scalar bosons contributing to the dimension-six SMEFT at tree level.

13 fermions

Name	N	E	Δ_1	Δ_3	Σ	Σ_1	
Irrep	$(1,1)_0$	$(1,1)_{-1}$	$(1,2)_{-\frac{1}{2}}$	$(1,2)_{-\frac{3}{2}}$	$(1,3)_0$	$(1,3)_{-1}$	
Name	U	D	Q_1	Q_5	Q_7	T_1	T_2
Irrep	$(3,1)_{\frac{2}{3}}$	$(3,1)_{-\frac{1}{3}}$	$(3,2)_{\frac{1}{6}}$	$(3,2)_{-\frac{5}{6}}$	$(3,2)_{\frac{7}{6}}$	$(3,3)_{-\frac{1}{3}}$	$(3,3)_{\frac{2}{3}}$

Table 2. New vector-like fermions contributing to the dimension-six SMEFT at tree level.

16 vectors

Name	$\mathcal{B}$	$\mathcal{B}_1$	$\mathcal{W}$	$\mathcal{W}_1$	$\mathcal{G}$	$\mathcal{G}_1$	$\mathcal{H}$	$\mathcal{L}_1$
Irrep	$(1,1)_0$	$(1,1)_1$	$(1,3)_0$	$(1,3)_1$	$(8,1)_0$	$(8,1)_1$	$(8,3)_0$	$(1,2)_{\frac{1}{2}}$
Name	$\mathcal{L}_3$	$\mathcal{U}_2$	$\mathcal{U}_5$	$\mathcal{Q}_1$	$\mathcal{Q}_5$	$\mathcal{X}$	$\mathcal{Y}_1$	$\mathcal{Y}_5$
Irrep	$(1,2)_{-\frac{3}{2}}$	$(3,1)_{\frac{2}{3}}$	$(3,1)_{\frac{5}{3}}$	$(3,2)_{\frac{1}{6}}$	$(3,2)_{-\frac{5}{6}}$	$(3,3)_{\frac{2}{3}}$	$(\bar{6},2)_{\frac{1}{6}}$	$(\bar{6},2)_{-\frac{5}{6}}$

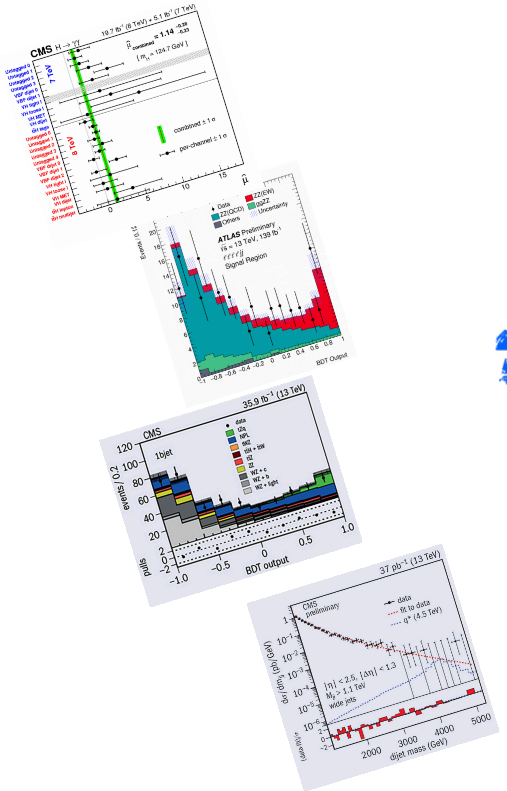
Table 3. New vector bosons contributing to the dimension-six SMEFT at tree level.

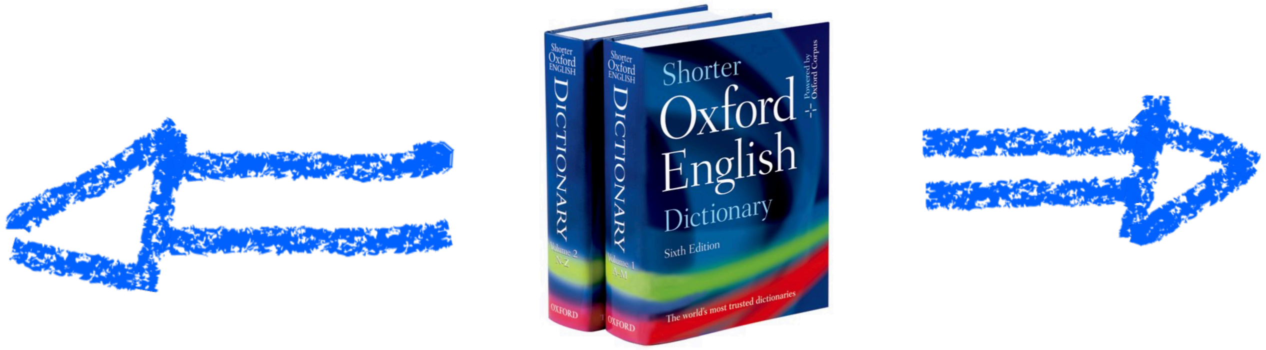
48 new fields

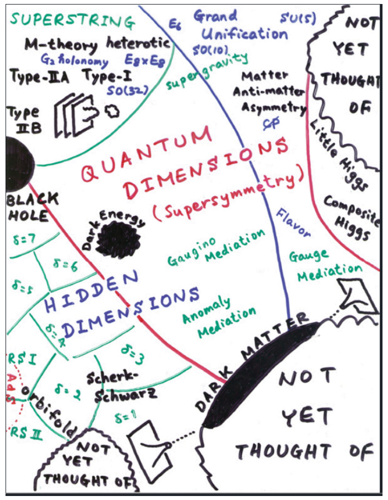
Tree level UV/IR dictionary

The leading contribution (tree level, dimension 6) in the SMEFT has been recently completed (no spins higher than 1) J. Blas, JC Criado, M Pérez-Victoria, JS ’18

Using this dictionary we can systematically explore the implications of experimental data (via global fits) on arbitrary models of new physics







let's get to it!

What do the data say?

For the sake of this talk I’ll take an in-house partial global fit including only Higgs and EW precision data

We first interpret the fit:

- Include only tree-level generated WC
- Find principal components (uncorrelated directions)
- Set to zero small contributions (0.1 x WC)
- Set to zero (or central value if significantly different from zero) directions with small error (0.1 TeV^{-2})
- Find largest deviations compatible with constraint

What do the data say?

Solving for the vanishing of the small directions we get 5 equations for 5 WCs.

		Pull
$-17.9823\, C_{\phi D} + 4.56153\, C_{\phi d,33} - 43.6536\, (C^{(1)}_{\phi q,33} + C^{(3)}_{\phi q,33})$	0.00 ± 0.12	-0.0772397
$-18.7374\, C_{\phi D} + 1.42227\, C_{\phi d,33} - 22.1533\, (C^{(1)}_{\phi q,33} + C^{(3)}_{\phi q,33})$	0.70 ± 0.27	2.56747
$0.25281\, C_{u\phi,33} - 139.611\, C_{\phi D} + 17.7137\, C_{\phi d,33} - 0.421769\, C_{\phi \Box} - 161.034\, (C^{(1)}_{\phi q,33} + C^{(3)}_{\phi q,33})$	0.0 ± 0.5	0.179559
$0.575892\, C_{u\phi,33} + 75.7649\, C_{\phi D} - 9.70501\, C_{\phi d,33} - 0.654222\, C_{\phi \Box} + 88.8911\, (C^{(1)}_{\phi q,33} + C^{(3)}_{\phi q,33})$	0.3 ± 0.5	0.497911
$-0.777018\, C_{u\phi,33} - 0.623948\, C_{\phi \Box}$	-0.6 ± 0.8	-0.719065

We simplify further (for the moment) by requiring custodial symmetry and no corrections to top Yukawa

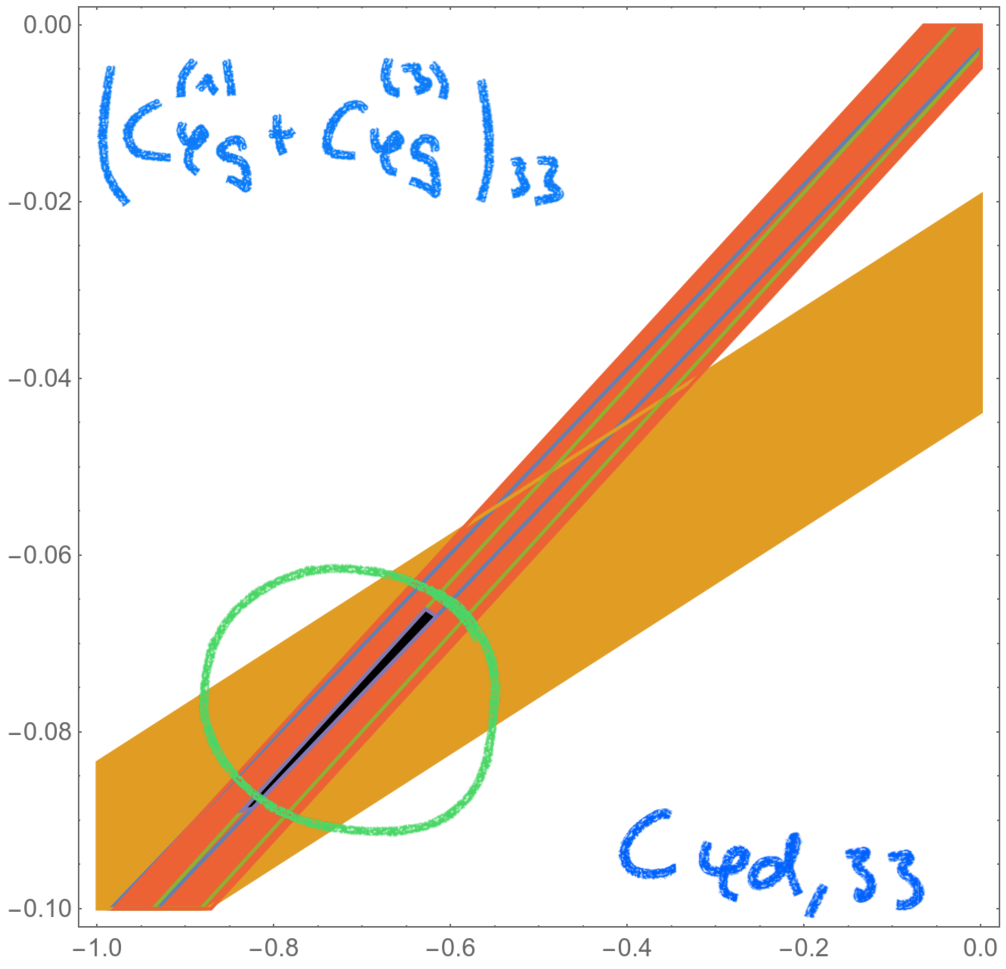
$$C_{\phi D} = 0$$ custodial symm.

$$C_{u\phi,33} = 0$$ Interplay with loops.

What do the data say?

We are left with 5 equations for 3 WCs

$C_{\varphi\Box} \sim [-0.35, 0.45]$



$C_{\varphi d,33} \simeq -0.65\ \mathrm{TeV}^{-2}$

$C_{\varphi\Box} \simeq 0.4\ \mathrm{TeV}^{-2}$

$(C_{\varphi q}^{(1)} + C_{\varphi q}^{(3)})_{33} \simeq -0.08\ \mathrm{TeV}^{-2}$

Implications for NP models

What are the implications for new physics?

Assume a single multiplet

$c_{\varphi d} \leq 0$ only 2 multiplets: $Q_5 \sim (3,2)_{-\frac{5}{6}}$

$B_\mu \sim (1,1)_0$

$c_{\varphi\Box}$ large
$c_{\varphi D} \sim 0$ only 2 multiplets: B_μ

$W_\mu \sim (1,3)_0$

Implications for NP models

What are the implications for new physics?

Assume a single multiplet

Let's try Q_5: $\mathcal{L} = -\lambda' \bar{Q}_{5L} \tilde{\varphi} b_R + \dots$

$$C_{\varphi b} = -\frac{|\lambda'|^2}{2M^2}, \quad C_{b\varphi} = \frac{y_b |\lambda'|^2}{2M^2}$$

redo the fit

$$\frac{\lambda'}{M} = -0.67 \pm 0.15 \text{ TeV}^{-1}$$

$$\chi^2/_{dof} = 1.32 \quad \left(\chi^2_{SM}/_{dof} \simeq 1.34\right)$$

Beautiful mirrors
Choudhury, Tait, Wagner '02

Implications for NP models

What are the implications for new physics?

Assume a single multiplet B_μ

Some couplings set to 0

$$\mathcal{L} = -g_b B_\mu \bar{b}_R \gamma^\mu b_R - \{ g_\varphi B^\mu \varphi^\dagger i D_\mu \varphi + h.c. \} + \dots$$

$$C_{\varphi b} = -\frac{\mathrm{Re}(g_\varphi) g_b}{M^2}, \quad C_{\varphi \Box} = -\frac{\mathrm{Re}(g_\varphi^2)}{2M^2}, \quad C_{\varphi D} = -\frac{2(\mathrm{Re}\, g_\varphi)^2}{M^2}$$

redo fit ($M = 1\,\mathrm{TeV}$)

$\mathrm{Re}\, g_\varphi = 0.08 \pm 0.02$

$\mathrm{Im}\, g_\varphi = -0.4 \pm 0.6$

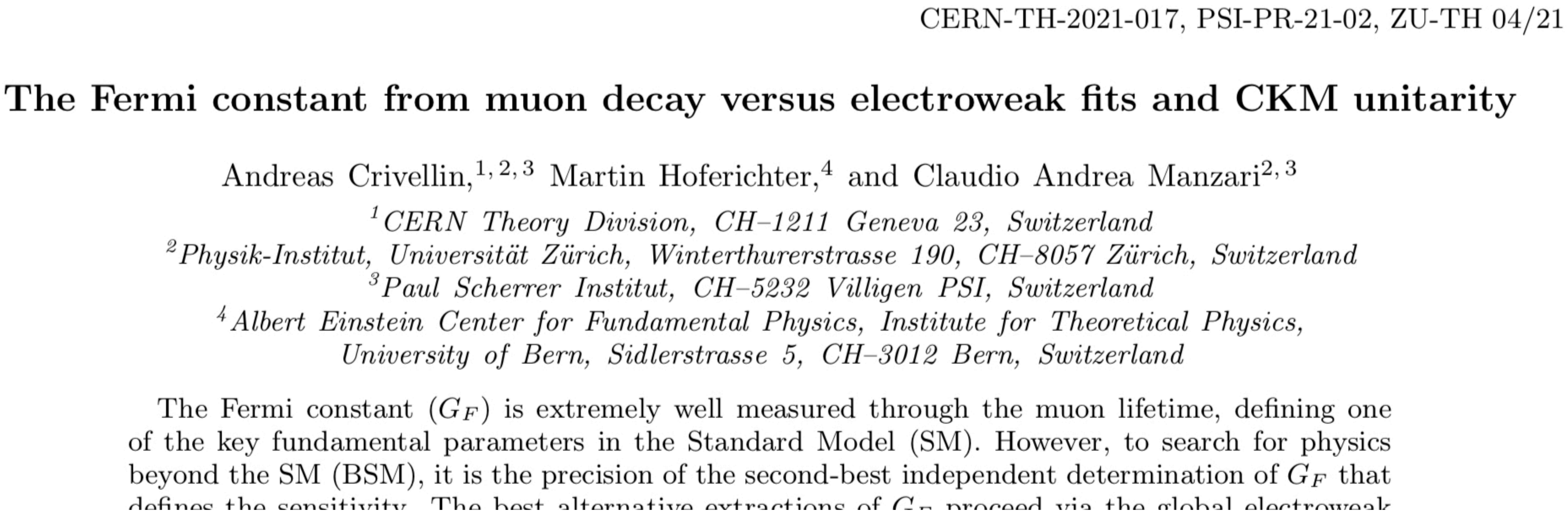
$g_b = 2.6 \pm 1.5$

$$\rho \sim \begin{pmatrix} 1 & & \\ -0.03 & 1 & \\ -0.5 & 0.02 & 1 \end{pmatrix}$$

$$\chi^2/\mathrm{dof} = 1.31$$

Implications for NP models

Let’s see another (brand new) example



CERN-TH-2021-017, PSI-PR-21-02, ZU-TH 04/21

The Fermi constant from muon decay versus electroweak fits and CKM unitarity

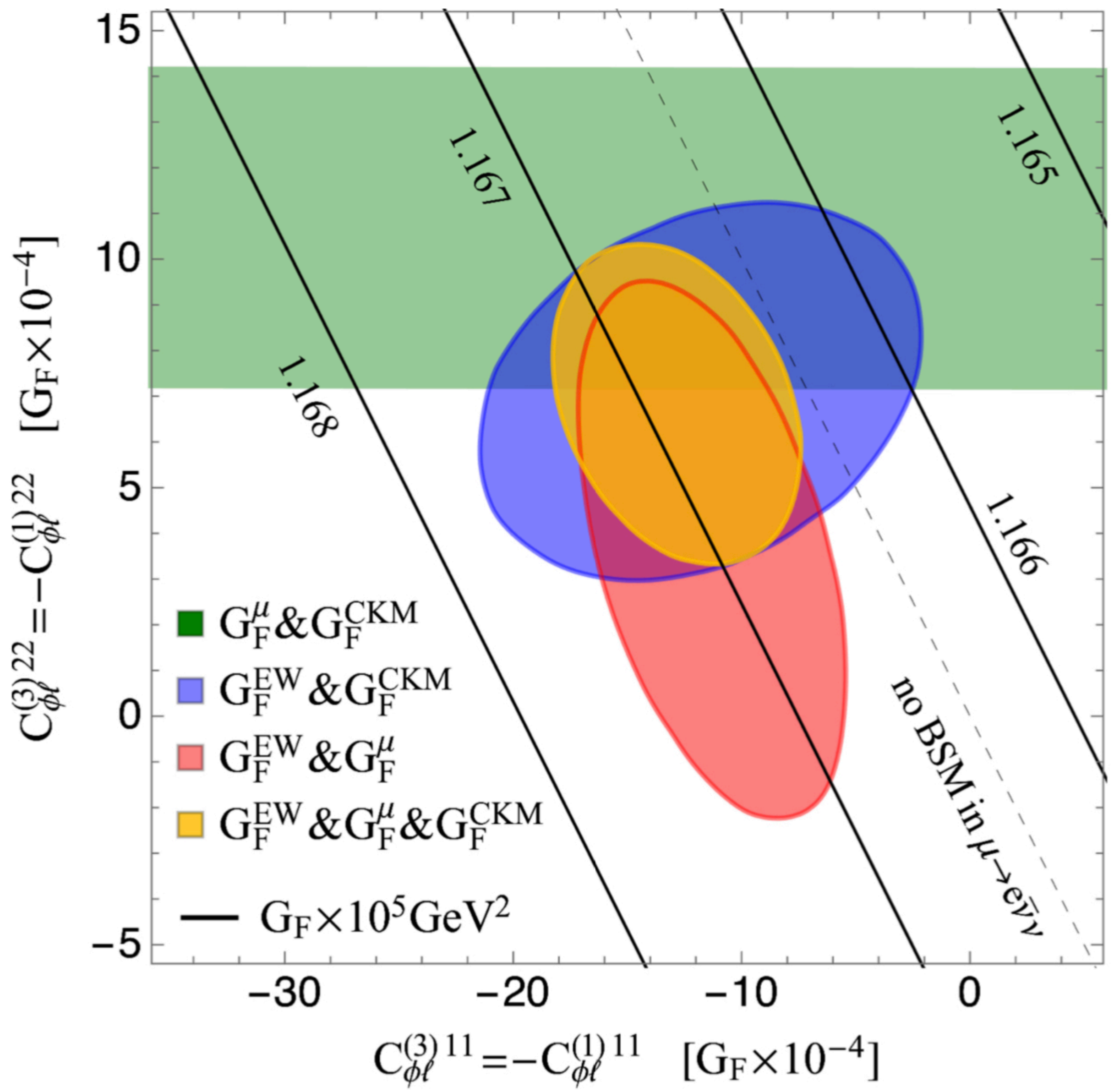
Andreas Crivellin,[1, 2, 3] Martin Hoferichter,[4] and Claudio Andrea Manzari[2, 3]
[1] *CERN Theory Division, CH–1211 Geneva 23, Switzerland*
[2] *Physik-Institut, Universität Zürich, Winterthurerstrasse 190, CH–8057 Zürich, Switzerland*
[3] *Paul Scherrer Institut, CH–5232 Villigen PSI, Switzerland*
[4] *Albert Einstein Center for Fundamental Physics, Institute for Theoretical Physics,*
University of Bern, Sidlerstrasse 5, CH–3012 Bern, Switzerland

The Fermi constant (G_F) is extremely well measured through the muon lifetime, defining one of the key fundamental parameters in the Standard Model (SM). However, to search for physics beyond the SM (BSM), it is the precision of the second-best independent determination of G_F that defines the sensitivity. The best alternative extractions of G_F proceed via the global electroweak

2102.02825

Implications for NP models

Let’s see another (brand new) example



$C^{(3)}_{\varphi\ell_{11}} = -C^{(1)}_{\varphi\ell_{11}} \sim [-0.02, -0.009]$

$C^{(3)}_{\varphi\ell_{22}} = -C^{(1)}_{\varphi\ell_{22}} \sim [0.0035, 0.012]$

(TeV^{-2})

Implications for NP models

Let's see another (brand new) example

$C^{(3)}_{\varphi \ell_{11}} = -C^{(1)}_{\varphi \ell_{11}} \sim [-0.02, -0.009]$

$C^{(3)}_{\varphi \ell_{22}} = -C^{(1)}_{\varphi \ell_{22}} \sim [0.0035, 0.012]$

$$\left(C^{(1)}_{\phi l}\right)_{ij} = \boxed{\frac{(\lambda_N)^*_{ri}(\lambda_N)_{rj}}{4M^2_{N_r}}} - \cancel{\frac{(\lambda_E)_{rj}(\lambda_E)^*_{ri}}{4M^2_{E_r}}} + \cancel{\frac{3(\lambda_\Sigma)^*_{ri}(\lambda_\Sigma)_{rj}}{16M^2_{\Sigma_r}}} - \cancel{\frac{3(\lambda_{\Sigma_1})_{rj}(\lambda_{\Sigma_1})^*_{ri}}{16M^2_{\Sigma_{1r}}}}$$

$$- \frac{\mathrm{Re}\left((\hat{g}^\phi_{\mathcal{B}})_r\right)(g^l_{\mathcal{B}})_{rij}}{M^2_{\mathcal{B}_r}} - \frac{g_1 \delta_{ij} (g^B_{\mathcal{L}_1})_{rs} (\gamma_{\mathcal{L}_1})^*_r (\gamma_{\mathcal{L}_1})_s}{4M^2_{\mathcal{L}_{1r}} M^2_{\mathcal{L}_{1s}}}$$

$$\left(C^{(3)}_{\phi l}\right)_{ij} = \boxed{-\frac{(\lambda_N)^*_{ri}(\lambda_N)_{rj}}{4M^2_{N_r}}} - \cancel{\frac{(\lambda_E)_{rj}(\lambda_E)^*_{ri}}{4M^2_{E_r}}} + \cancel{\frac{(\lambda_\Sigma)^*_{ri}(\lambda_\Sigma)_{rj}}{16M^2_{\Sigma_r}}} + \cancel{\frac{(\lambda_{\Sigma_1})_{rj}(\lambda_{\Sigma_1})^*_{ri}}{16M^2_{\Sigma_{1r}}}}$$

$$- \frac{\mathrm{Re}\left((\hat{g}^\phi_{\mathcal{W}})_r\right)(g^l_{\mathcal{W}})_{rij}}{4M^2_{\mathcal{W}_r}} + \frac{g_2 \delta_{ij} (g^W_{\mathcal{L}_1})_{rs} (\gamma_{\mathcal{L}_1})^*_r (\gamma_{\mathcal{L}_1})_s}{4M^2_{\mathcal{L}_{1r}} M^2_{\mathcal{L}_{1s}}}$$

Implications for NP models

We can increase complexity

- Consider several multiplets
- Relax notion of “small”
- Add data to global fit (including anomalies to explain)
- Add leading-log one-loop effects via RGEs

The dictionary allows for a systematic and complete classification

Finite loop effects and higher-dimension contributions can be important: it is crucial to extend the dictionaries to 1 loop and dimension 8, also to other EFTs beyond the SMEFT (νSMEFT, ALPs, ...)

Dawson, Homiller, Lane [2007.01296]

Corbett, Helset, Martin, Trott [2102.02819]

Automating 1-loop matching

1-loop matching has received a lot of attention recently thanks to the development of new functional methods

Henning, Lu, Murayama ‘14-‘16
Drozd, Ellis, Quevillon, You, Zhang ‘15-‘17
Aguila, Kunszt, JS ‘16
Fuentes-Martin, Portoles, Ruiz-Femenia ‘16
Das Bakshi, Chakrabortty, Kumar Patra ‘18
...
Cohen, Lu, Zhang ‘20
Fuentes-Martin, Köning, Pagès, Thomson, Wilsch ‘20

We are developing an alternative approach based on diagrammatic methods: MatchMaker

Anastasiou, Carmona, Lazopoulos, Olgoso, JS

Summary

- EFTs allow for an efficient 2-step comparison between theory and experiment
- Matching is necessary to get physics info on the UV
- UV/IR dictionary (currently tree level) allows for a complete, systematic calculation of the implications on experimental data on models of new physics
- Important efforts are being made towards automation of 1-loop matching calculations
- The final goal is to obtain the 1-loop dim 6, and tree level dim 8 UV/IR dictionaries