





Simplify your life

Towards more model-independent new physics searches

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Outline

- Lessons from the 1st phase of the LHC
- Towards more model-independent searches: effective field theories and simplified models
- Simplified models for BSM Higgs physics

• Summary & conclusion

Lessons from LHC run1: a Higgs boson has been found



Lessons from LHC run1: a Higgs boson has been found

...and it looks like the Standard Model Higgs

Lessons from LHC run1:

the SM has passed most tests with flying colours

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Mass limit

ATLAS SUSY Searches* - 95% CL Lower Limits Status: March 2016

Model

10⁻¹

 e, μ, τ, γ Jets $E_{T}^{miss} \int \mathcal{L} dt [fb^{-1}]$

	ATLAS Preliminar			
\sqrt{s} = 7, 8 TeV \sqrt{s} = 13 TeV	Reference			
1.85 TeV m(<i>q̃</i>)=m(<i>g̃</i>)	1507.05525			

	Inclusive Searches	$ \begin{array}{l} MSUGRA/CMSSM \\ \widetilde{q}\widetilde{q}, \widetilde{q} \rightarrow \widetilde{q}\widetilde{\chi}_{1}^{0} \\ \widetilde{q}\widetilde{q}, \widetilde{q} \rightarrow \widetilde{q}\widetilde{\chi}_{1}^{0} (compressed) \\ \widetilde{q}\widetilde{q}, \widetilde{q} \rightarrow q(\ell\ell/\ell\nu/\nu\nu)\widetilde{\chi}_{1}^{0} \\ \widetilde{g}\widetilde{g}, \widetilde{g} \rightarrow q\widetilde{q}\widetilde{\chi}_{1}^{0} \\ \widetilde{g}\widetilde{g}, \widetilde{g} \rightarrow qq\widetilde{\chi}_{1}^{0} \rightarrow qqW^{\pm}\widetilde{\chi}_{1}^{0} \\ \widetilde{g}\widetilde{g}, \widetilde{g} \rightarrow qq(\ell\ell/\ell\nu/\nu\nu)\widetilde{\chi}_{1}^{0} \\ \widetilde{g}\widetilde{g}, \widetilde{g} \rightarrow qqWZ_{1}^{0} \\ GMSB (\ell NLSP) \\ GGM (bino NLSP) \\ GGM (higgsino-bino NLSP) \\ GGM (higgsino-bino NLSP) \\ GGM (higgsino NLSP) \\ GFavitino LSP \\ \end{array} $	$\begin{array}{c} 0\text{-3} \ e, \mu/1\text{-2} \ \tau \\ 0 \\ \text{mono-jet} \\ 2 \ e, \mu \ (\text{off-}Z \\ 0 \\ 1 \ e, \mu \\ 2 \ e, \mu \\ 0 \\ 1\text{-2} \ \tau + 0\text{-1} \\ 2 \ \gamma \\ \gamma \\ 2 \ e, \mu \ (Z) \\ 0 \end{array}$	2-10 jets/3 b 2-6 jets 1-3 jets 2-6 jets 2-6 jets 2-6 jets 2-6 jets 0-3 jets 7-10 jets ℓ 0-2 jets - 1 b 2 jets 2 jets 2 jets	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	20.3 3.2 3.2 20.3 3.2 3.3 20 3.2 20.3 20.3	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1507.05525 ATLAS-CONF-2015-062 <i>To appear</i> 1503.03290 ATLAS-CONF-2015-062 ATLAS-CONF-2015-076 1501.03555 1602.06194 1407.0603 1507.05493 1507.05493 1507.05493 1507.05493 1503.03290 1502.01518
j	3 rd gen. ẽ med.	$ \tilde{g}\tilde{g}, \tilde{g} \rightarrow b \tilde{b} \tilde{\chi}_{1}^{0} $ $ \tilde{g}\tilde{g}, \tilde{g} \rightarrow t \tilde{\chi}_{1}^{0} $ $ \tilde{g}\tilde{g}, \tilde{g} \rightarrow b \tilde{b} \tilde{\chi}_{1}^{-} $	0 0-1 <i>e</i> ,μ 0-1 <i>e</i> ,μ	3 b 3 b 3 b 3 b	Yes Yes Yes	3.3 3.3 20.1	$\begin{array}{c} \vec{s} \\ $	ATLAS-CONF-2015-067 To appear 1407.0600
	3 rd gen. squarks direct production	$ \begin{split} \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow b\tilde{\chi}_{1}^{0} \\ \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow t\tilde{\chi}_{1}^{\pm} \\ \tilde{h}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\tilde{\chi}_{1}^{\pm} \\ \tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\tilde{\chi}_{1}^{\pm} \\ \tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow \tilde{t}_{1}\tilde{\chi}_{1}^{0} \\ \tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow \tilde{\xi}_{1}^{0} \\ \tilde{t}_{1}\tilde{t}_{1} (natural GMSB) \\ \tilde{t}_{2}\tilde{t}_{2}, \tilde{t}_{2} \rightarrow \tilde{t}_{1} + Z \\ \tilde{t}_{2}\tilde{t}_{2}, \tilde{t}_{2} \rightarrow \tilde{t}_{1} + h \end{split} $	$\begin{array}{c} 0 \\ 2 \ e, \mu \ (\text{SS}) \\ 1-2 \ e, \mu \\ 0-2 \ e, \mu \\ 0 \\ 2 \ e, \mu \ (Z) \\ 3 \ e, \mu \ (Z) \\ 1 \ e, \mu \end{array}$	2 b 0-3 b 1-2 b 0-2 jets/1-2 b mono-jet/c-tag 1 b 1 b 6 jets + 2 b	Yes Yes Yes Yes Yes Yes Yes Yes	3.2 3.2 4.7/20.3 20.3 20.3 20.3 20.3 20.3 20.3	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ATLAS-CONF-2015-066 1602.09058 1209.2102, 1407.0583 08616, ATLAS-CONF-2016-007 1407.0608 1403.5222 1403.5222 1506.08616
	EW direct	$ \begin{array}{c} \tilde{\ell}_{L,R} \tilde{\ell}_{L,R}, \tilde{\ell} \rightarrow \ell \tilde{\chi}_{1}^{0} \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow \tilde{\ell} \nu (\ell \tilde{\nu}) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow \tilde{\tau} \nu (\tau \tilde{\nu}) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{2}^{0} \rightarrow \tilde{\ell}_{L} \nu \tilde{\ell}_{L} \ell (\tilde{\nu} \nu), \ell \tilde{\nu} \tilde{\ell}_{L} \ell (\tilde{\nu} \nu) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\chi}_{1}^{0} \lambda \tilde{\chi}_{1}^{0} \\ \tilde{\chi}_{2}^{+} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\chi}_{1}^{0} h \tilde{\chi}_{1}^{1}, h \rightarrow b \bar{b} / W W / \tilde{\chi}_{2}^{0} \tilde{\chi}_{2}^{0}, \tilde{\chi}_{2,3}^{0} \rightarrow \tilde{\ell}_{R} \ell \\ \mathbf{GGM} (\text{wino NLSP}) \text{ weak processing} $	$\begin{array}{c} 2 \ e, \mu \\ 2 \ e, \mu \\ 2 \ \tau \\ 3 \ e, \mu \\ 2 - 3 \ e, \mu \\ 2 - 3 \ e, \mu \\ q + \gamma \\ 4 \ e, \mu \\ 1 \ e, \mu + \gamma \end{array}$	0 0 	Yes Yes Yes Yes Yes Yes Yes	20.3 20.3 20.3 20.3 20.3 20.3 20.3 20.3	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	1403.5294 1403.5294 1407.0350 1402.7029 1403.5294, 1402.7029 1501.07110 1405.5086 1507.05493
	Long-lived particles	Direct $\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}$ prod., long-lived Direct $\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}$ prod., long-lived Stable, stopped \tilde{g} R-hadron Metastable \tilde{g} R-hadron GMSB, stable $\tilde{\tau}, \tilde{\chi}_{1}^{0} \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) +$ GMSB, $\tilde{\chi}_{1}^{0} \rightarrow \gamma \tilde{G}$, long-lived $\tilde{\chi}_{1}^{0}$ $\tilde{g}\tilde{g}, \tilde{\chi}_{1}^{0} \rightarrow eev/e\mu\nu/\mu\mu\nu$ GGM $\tilde{g}\tilde{g}, \tilde{\chi}_{1}^{0} \rightarrow Z\tilde{G}$	$ \begin{split} \tilde{\chi}_1^{\pm} & \text{Disapp. trk} \\ \tilde{\chi}_1^{\pm} & \text{dE/dx trk} \\ 0 & \text{dE/dx trk} \\ r(e,\mu) & 1-2 \mu \\ 2 \gamma & \text{displ. } ee/e\mu/ \\ \text{displ. vtx + je} \end{split} $	 1 jet - 1-5 jets - -	Yes Yes - Yes - Yes -	20.3 18.4 27.9 3.2 19.1 20.3 20.3 20.3	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	1310.3675 1506.05332 1310.6584 <i>To appear</i> 1411.6795 1409.5542 1504.05162 1504.05162
	RPV	LFV $pp \rightarrow \tilde{v}_{\tau} + X, \tilde{v}_{\tau} \rightarrow e\mu/e\tau/\mu$ Bilinear RPV CMSSM $\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow W\tilde{\chi}_{1}^{0}, \tilde{\chi}_{1}^{0} \rightarrow ee\tilde{v}_{\mu}, e\mu$ $\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow W\tilde{\chi}_{1}^{0}, \tilde{\chi}_{1}^{0} \rightarrow \tau\tau\tilde{v}_{e}, e\tau$ $\tilde{g}\tilde{s}, \tilde{g} \rightarrow qqq$ $\tilde{g}\tilde{s}, \tilde{g} \rightarrow qq\tilde{\chi}_{1}^{0}, \tilde{\chi}_{1}^{0} \rightarrow qqq$ $\tilde{g}\tilde{s}, \tilde{g} \rightarrow t_{1}t, \tilde{t}_{1} \rightarrow bs$ $\tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\ell$	$ \begin{array}{cccc} \tau & e\mu, e\tau, \mu\tau \\ & 2 \ e, \mu \ (\text{SS}) \\ \tilde{\nu}_e & 4 \ e, \mu \\ \tilde{\nu}_\tau & 3 \ e, \mu + \tau \\ & 0 \\ & 2 \ e, \mu \ (\text{SS}) \\ & 0 \\ & 2 \ e, \mu \end{array} $	- 0-3 b 	- Yes Yes - - Yes -	20.3 20.3 20.3 20.3 20.3 20.3 20.3 20.3	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1503.04430 1404.2500 1405.5086 1405.5086 1502.05686 1502.05686 1404.2500 1601.07453 ATLAS-CONF-2015-015
(<u>Other</u>	Scalar charm, $\tilde{c} \rightarrow c \tilde{\chi}_1^0$	0	2 c	Yes	20.3	<i>č</i> 510 GeV m(<i>X̃</i> ¹)<200 GeV	1501.01325

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

Mass scale [TeV]

1

CMS Exotica Physics Group Summary – Moriond, 2015

Lessons from the LHC: "Who ordered that?"

Who ordered the di-photon excess?

Who ordered the di-photon excess?

The sociology of ambulance chasing

HINT OF NEW BOSON SPARKS FLOOD OF PAPERS

In just 21 days, physicists have posted 150 papers on the arXiv preprint server about tantalizing results at the Large Hadron Collider.

Key questions for LHC run 2

What is the mechanism of electroweak symmetry breaking?

→ Precision studies of Higgs boson properties

Is there physics beyond the Standard Model at the TeV scale (SUSY, dark matter, ...)?

→ Searches for new particles

BSM models for Higgs physics: top-down

effective field theories

effective field theories

effective field theories

$$\mathcal{L} = \mathcal{L}_{\rm SM} + \frac{g^2}{M_{Z'}^2} (\bar{q}\Gamma q)(\bar{l}\Gamma l) + \dots$$

Buchmüller, Wyler; Grazdkowski et al.

effective field theories

Higgs physics at the LHC:

$$\frac{\sigma \times \mathrm{BR}}{\sigma \times \mathrm{BR}|_{\mathrm{SM}}} - 1 \bigg| \sim \frac{g^2 m_h^2}{\Lambda^2} \gtrsim 0.1$$

effective field theories

Higgs physics at the LHC:

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 $\Leftrightarrow \Lambda \lesssim 500 \, {\rm GeV}$

for perturbative couplings g

effective field theories

Higgs physics at the LHC:

effective field theories

simplified models

effective field theories

simplified models

 $\mathcal{L} = \mathcal{L}_{SM} + \mathcal{L}_6 + \dots$ $\mathcal{L} = \mathcal{L}_{SM} + \mathcal{L}_{T',Z'} + \mathcal{L}_6 + \dots$

Simplified models

- mediate between theory and data
- allow to explore the space of theories and signatures
- connect direct and indirect searches for new physics

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Simplified models have become standard for SUSY and dark matter searches at the LHC. We want to construct simplified models for Higgs physics to

- explore BSM theories that affect the Higgs sector;
- connect measurements of Higgs properties and direct searches for new physics.

Dolan, Hewett, MK, Rizzo (arXiv:1601.07208 [hep-ph])

We take the SM and add

- a scalar singlet S
- a vector-like fermion representation F

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S aquires a vev, S = (s + v_S), and provides mass for the fermion, $m_F = y_F v_S$. The Higgs and new scalar fields mix, $\lambda_{HS} H^+H S^2$, and thus we generate new physics effects in all SM Higgs couplings:

The simplest simplified model with F = T has 5 free and 3 fixed parameters. We choose:

 m_2 , θ , v_s , m_T and θ_L

and set m_1 = 125 GeV, v_H = 246 GeV and m_t = 173 GeV.

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 $\mathbf{m}_2, \theta, \mathbf{v}_s, \mathbf{m}_T \text{ and } \theta_L$

and set m_1 = 125 GeV, v_H = 246 GeV and m_t = 173 GeV.

The parameters are constrained by

- perturbative unitary
- precision EW data: S, T and U
- Higgs cross sections and branching ratios

A fit to the Higgs cross sections and BRs

HiggsSignals/HiggsBounds

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HiggsSignals/HiggsBounds

my hz

Need
$$\sigma(pp \to h_2) \times BR(h_2 \to \gamma\gamma) \sim \mathcal{O}(\text{few fb})$$

With
$$BR(h_2 \to \gamma \gamma) \approx \frac{\Gamma(h_2 \to \gamma \gamma)}{\Gamma(h_2 \to gg)} = \frac{8}{9} \left(\frac{\alpha}{\alpha_s}\right)^2 \approx 0.5\%$$

this corresponds to $\sigma(pp \rightarrow h_2) \approx 1 \, \mathrm{pb}$

and thus
$$y_T = \frac{m_T}{v_S} \gg 1$$

A small $v_s \approx 100$ GeV implies a large $y_T = m_T/v_S$ and a violation of perturbative unitarity.

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A small $v_s \approx 100$ GeV implies a large $y_T = m_T/v_S$ and a violation of perturbative unitarity.

Can restore perturbativity by adding more generations of new fermions.

However, a large width $\Gamma_{h_2} \approx 45 \,\text{GeV}$ as favoured by ATLAS, would most likely imply non-perturbative dynamics. (See e.g. 1512.04933)

Summary

Searches for new physics are increasingly designed and interpreted in terms of simplified models rather than specific top-down models

Simplified models

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Summary

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Simplified models

- mediate between theory and data
- allow to explore the space of theories and signatures
- connect direct and indirect searches for new physics

However

- how do we choose the right simplified model?
- do simplified models provide an explanation?
- how to simplified models connect to theory?

Conclusions

The Higgs boson mass and profile, and the limits from direct searches tend to push the new physics scale beyond TeV.

New physics is either natural and somewhat elaborate, or simple and unnatural.

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The Higgs boson mass and profile, and the limits from direct searches tend to push the new physics scale beyond TeV.

New physics is either natural and somewhat elaborate, or simple and unnatural.

For the LHC-13 we need to

- explore a wider range of BSM models
- move towards more model-independent searches: effective field theories, simplified models.

Should new physics be natural, simple, beautiful, perturbative,...?

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Don't expect too much guidance from theory...

Thank you!

Backup

Different representations for the new fermion result in different patterns for Higgs cross sections and branching ratios.

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Consider the Higgs gauge boson coupling ~ h $V_{\mu\nu}V^{\mu\nu}$

$\gamma\gamma$: $\epsilon_{\rm M} \frac{\alpha}{2} \frac{1}{2} \left(\frac{\lambda_{\rm HS} v^2}{2} \right)$	F	ϵ_γ	ϵ_g	ϵ_B	ϵ_W
$G_{a}G^{a}: \epsilon_{a}\frac{\alpha_{s}}{\epsilon_{s}}\frac{1}{\epsilon_{s}}\left(\frac{\lambda_{\rm HS}v^{2}}{2}\right)$	$\left(\begin{array}{c}T'\\B'\end{array}\right)_{L+R}$	$\frac{5}{18}$	$-\frac{1}{6}$	$\frac{1}{144}$	$\frac{1}{16}$
$a'^2 1 \left(\lambda_{\rm HS} v^2\right)$	Q_{L+R}	$\frac{1}{2}Q^2$	$-\frac{1}{12}$	$\frac{1}{8}Q^2$	0
$BB: \epsilon_B \frac{s}{\pi^2} \frac{1}{v} \left(\frac{\lambda_{\rm HS} v}{m_S^2} \right)$	$\left(\begin{array}{c} N\\ E\end{array}\right)_{L+R}$	$\frac{1}{6}$	0	$\frac{1}{48}$	$\frac{1}{48}$
$W_i W^i$: $\epsilon_W \frac{g}{\pi^2} \frac{1}{v} \left(\frac{m_S v}{m_S^2}\right)$	L_{L+R}	$\frac{1}{16}Q^2$	0	$\frac{1}{24}$	0

$$\mathcal{L} \supset \mathcal{L}_{\text{Yukawa}} + \mathcal{L}_{\text{gauge}} - V(H, S)$$

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We chose $\mathbf{F} = \mathbf{T}$, colour-triplet, SU(2) singlet, Q = 2/3:

 $\mathcal{L}_{\text{Yukawa}} = y_T S \overline{T}_L^{\text{int}} T_R^{\text{int}} + y_t \overline{Q}_L^{\text{int}} \widetilde{H} t_R^{\text{int}} + y_b \overline{Q}_L^{\text{int}} H b_R + \lambda_T \overline{Q}_L^{\text{int}} \widetilde{H} T_R^{\text{int}}$

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After SSB the SM top quark **t**^{int} and the vector quark **T**^{int} mix to form the mass eigenstates **t** and **T**:

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After SSB the SM top quark **t**^{int} and the vector quark **T**^{int} mix to form the mass eigenstates **t** and **T**:

$$m_t^2 = \frac{1}{2} v_H^2 y_t^2 \left(1 - \frac{\lambda_T^2}{2y_T^2} \frac{v_H^2}{v_S^2} \right) \quad m_T^2 = v_S^2 y_T^2 \left(1 + \frac{\lambda_T^2}{2y_T^2} \frac{v_H^2}{v_S^2} \right)$$
$$\tan(2\theta_L) = \frac{2}{\sqrt{2}} \frac{\lambda_T}{y_T} \frac{v_H}{v_S}$$

$$\mathcal{L} \supset \mathcal{L}_{\text{Yukawa}} + \mathcal{L}_{\text{gauge}} - V(H, S)$$

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$$V(H, S) = -\mu^2 H^{\dagger} H + \lambda (H^{\dagger} H)^2 + \frac{a_1}{2} H^{\dagger} H S$$

$$+ \frac{a_2}{2} H^{\dagger} H S^2 + b_1 S + \frac{b_2}{2} S^2 + \frac{b_3}{3} S^3 + \frac{b_4}{4} S^4$$
with
$$H = \begin{pmatrix} i\phi^+ \\ \frac{1}{\sqrt{2}}(h + v_H + i\phi^0) \end{pmatrix} \text{ and } S = (s + v_S)$$

For simplicity, we assume a Z_2 -symmetry and set $a_1 = b_1 = b_3 = 0$.

$$\mathcal{L} \supset \mathcal{L}_{\text{Yukawa}} + \mathcal{L}_{\text{gauge}} - V(H, S)$$
$$V(H, S) = -\mu^2 H^{\dagger} H + \lambda (H^{\dagger} H)^2 + \frac{a_1}{2} H^{\dagger} H S$$
$$+ \frac{a_2}{2} H^{\dagger} H S^2 + b_1 S + \frac{b_2}{2} S^2 + \frac{b_3}{3} S^3 + \frac{b_4}{4} S^4$$

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 and $S = (s+v_S)$

For simplicity, we assume a Z_2 -symmetry and set $a_1 = b_1 = b_3 = 0$.

H and **S** mix, to form mass eigenstates **h**₁ and **h**₂:

$$m_1^2 = 2\lambda v_H^2 \left(1 - \frac{a_2^2}{4\lambda b_4} \right) \quad m_2^2 = 2b_4 v_S^2 \left(1 + \frac{a_2^2}{4b_4^2} \frac{v_H^2}{v_S^2} \right)$$
$$\tan(2\theta) = \frac{a_2}{b_4} \frac{v_H}{v_S}$$

It is straightforward to calculate the couplings of the 125-Higgs to SM particles:

$$\kappa_W = \kappa_Z = \kappa_b = \kappa_\tau = \cos\theta$$
 and $\kappa_t = c_L^2 c_\theta - s_L^2 s_\theta \frac{v_H}{v_S}$

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For the loop-induced couplings one has

$$g_{hgg} = \frac{g_s^2}{4\pi^2} \left(\sum_f \frac{g_{hff}}{m_f} A_{1/2}(\tau_f) + \frac{g_{hTT}}{m_T} A_{1/2}(\tau_T) \right) \approx g_{hgg}^{SM} \left(c_\theta - s_\theta \frac{v_H}{v_S} \right)$$
$$g_{h\gamma\gamma} = \frac{e^2}{4\pi^2} \left(\frac{g_{hWW}}{m_W^2} A_1(\tau_W) + \sum_f 2N_C^f Q_f^2 \frac{g_{hff}}{m_f} A_{1/2}(\tau_f) + \frac{8}{3} \frac{g_{hTT}}{m_T} A_{1/2}(\tau_T) \right)$$

The Higgs P_T distribution

One can try to resolve the heavy new fermion in the loop through Higgs + jet production:

The Higgs P_T distribution

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Madgraph5@NLO

Higgs pair production

One can try to learn something about the new scalar sector through Higgs pair production:

$$\mathcal{L} \supset g_{tty}^{\mathrm{SM}} \left(\bar{t}th_1 + \frac{m_T}{m_t} \frac{v_H}{v_S} \bar{T}Th_2 \right) \qquad \text{for } \sin\theta = \sin\theta_{\mathrm{L}} = 0$$

Higgs pair production

One can try to learn something about the new scalar sector through Higgs pair production:

 $\sin\theta = \sin\theta_{\rm L} = 0.15$

Madgraph5@NLO

Straightforward test: di-jet searches

Direct searches for S and T

Direct searches for S and T

Direct searches for S and T

