Aspects of Non-minimal SUSY phenomenology.

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Fellow Day '17

Hamburg, 12.12.17





Personal

- > Last Fellow day: 31.10.16
- > Arrival in Hamburg: 01.11.16
- > So, just starting 🙂



Diplom and PhD at TU Dresden with Dominik Stöckinger Floated down the Elbe to DESY

Personal





Diplom and PhD at TU Dresden with Dominik Stöckinger Floated down the Elbe to DESY MSSM is appealing from theory side:

- > Hierarchy problem
- > Gauge coupl. unific.
- > REWSB
- > DM candidate



What about SUSY?

MSSM didn't light up LHC experiments

A.	ATLAS Preliminary								
	Model	ε, μ, τ, γ	Jets	E_T^{min}	' ∫ζ ejn	"I Mass limit	$\sqrt{T} = 7$	TeV Vot 13 TeV	Reference
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Full model

- > Look into non-minimal models for spectrum of alternative predictions
- > Containing features maybe missing in simplified models



Full model

- > Look into non-minimal models for spectrum of alternative predictions
- > Containing features maybe missing in simplified models
- > For my PhD: R-Symmetry
 - Includes solution to flavor problem of the MSSM
 - Dirac gauginos (esp. gluino) might explain SUSY non-discovery
 - Extended Higgs sector, different predictions than (N)MSSM



- > Go calculate all interesting things!
- > Community has decades of experience studying BSM physics
- > In the last years, big efforts to generalize codes and availability see e.g. hepforge.org 1
- > Straight-forward application to full models?

¹FlexibleSUSY, SARAH/SPheno, HiggsBounds, HiggsSignals, micrOMEGAs. Herwig++. CheckMATE. GoSam. Madgraph aMC



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- > Straight-forward application to full models?
- > Yes, if MSSM. Otherwise a bit work required.



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R-symmetry

- > Additional symmetry allowed by SUSY algebra described in "Haag-Łopuszański-Sohnius-Theorem"
- > For N = 1 SUSY it is a global $U(1)_{\mathsf{R}}$ symmetry \rightarrow charged Spinor coordinates: $Q_{\mathsf{R}}(\theta) = 1$, $Q_{\mathsf{R}}(\bar{\theta}) = -1$; $(\theta \rightarrow e^{i\alpha}\theta, \bar{\theta} \rightarrow e^{-i\alpha}\bar{\theta})$
- > Lagrangian has to be invariant
- > SM fields have $Q_{R} = 0$
- > SUSY partners carry charge (MRSSM Kribs et.al. (Phys.Rev. D78 (2008) 055010))
- > Forbids Majorana mass terms and A terms

Assume R-symmetry to be unbroken.



Adding to the MSSM

		$SU(3)_C$	$SU(2)_L$	$U(1)_{Y}$	$U(1)_{R}$
Singlet	Ŝ	1	1	0	0
Triplet	Ť	1	3	0	0
Octet	Ô	8	1	0	0
R-Higgses	\hat{R}_u	1	2	-1/2	2
	\hat{R}_d	1	2	1/2	2



Particles of the MRSSM





Mass spectrum



Aspect one: 125 GeV Higgs boson

Known from MSSM: Loop contributions important

$$m_h^2 = m_Z^2 \cos^2 2\beta + \frac{6v_u^2}{16\pi^2} \left[Y_t^4 \log \frac{m_{\tilde{t}_1}m_{\tilde{t}_2}}{m_t^2} \right]$$



Aspect one: 125 GeV Higgs boson

Known from MSSM: Loop contributions important



 $\Lambda_{\rm m}$



> Extended Higgs sector: What about a lighter Higgs boson?





- > Extended Higgs sector: What about a lighter Higgs boson?
- > Dark matter candidate in model





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Model parameter space non-trivially constrained but still allowed regions



- > How do MRSSM squarks and gluinos do at the LHC?
- > Using G_{μ} as model input, M_W is a prediction of a model Low uncertainty on measurement and SM prediction \Rightarrow Add BSM (not only MRSSM) correctly and with low uncertainty



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Thanks for the attention!

