Asymptotically Safe Extensions of the MSSM

[Work in progress in collaboration with Gudrun Hiller and Daniel Litim]

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- The SM can be extended at $\sim \mathcal{O}(\text{TeV})$ to become AS
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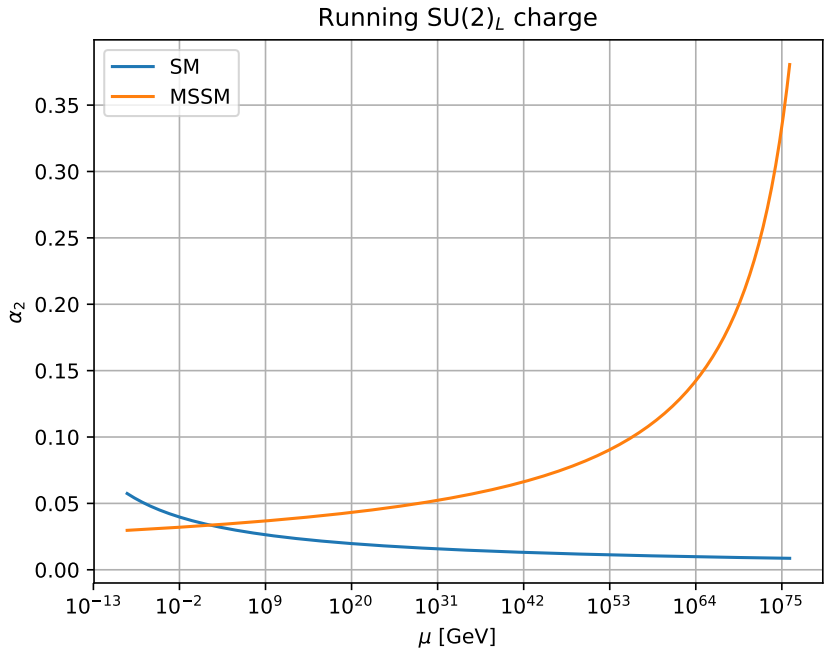
- In the MSSM, even the $\text{SU}(2)_L$ coupling has a Landau pole:



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$\Rightarrow$ Focus on gauge-Yukawa models

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  [S. Martin, M. Vaughn, 1994]
- Fixed point α^* with $\beta_i(\alpha^*) = 0$ physical: $\alpha_i^* \geq 0$

Searching AS MSSM extensions

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Searching models

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Motivated by their model, we consider :

Superfield	$SU(3)_C$	$SU(2)_L$	Multiplicity			
			Model scan	Bond, Litim	MSSM	AS MSSM
Q_L	$\mathbf{3}$	$\mathbf{2}$	q_L	1	3	3+?
Q_R	$\overline{\mathbf{3}}$	$\overline{\mathbf{2}}$	q_R	1	0	0+?
Ψ_L	$\mathbf{3}$	$\mathbf{1}$	n_L	N_F	0	0+?
Ψ_R	$\overline{\mathbf{3}}$	$\mathbf{1}$	n_R	N_F	6	6+?
χ	$\mathbf{1}$	$\mathbf{2}$	m	$2N_F$	5	5+?

$$\text{Superpotential } W = \sum_i y_i \mathrm{Tr}_i \left(\Psi Q_i \chi\right)$$

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Search for models

The three fixed points $(\alpha_3^*, \alpha_2^*, \vec{\alpha}_y^*)$ with non-zero Yukawa components are:

- $\text{FP}_1 = (\alpha_3^*, 0, \vec{\alpha}_y^*)$ $\quad$ $\text{SU}(3)_C$ safe, $\text{SU}(2)_L$ free
- $\text{FP}_2 = (0, \alpha_2^*, \vec{\alpha}_y^*)$ $\quad$ $\text{SU}(3)_C$ free, $\text{SU}(2)_L$ safe
- $\text{FP}_3 = (\alpha_3^*, \alpha_2^*, \vec{\alpha}_y^*)$ $\quad$ fully interacting

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Search for models

Scanning 134.853.755 models with

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within the parameter space (using many different Yukawa superpotentials)

$$0 \leq q_L, q_R \leq 6,$$
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yields:

- $\text{FP}_1 = (\alpha_3^*, 0, \vec{\alpha}_y^*)$ $\rightarrow$ Exactly once UV fixed point $\rightarrow$ "AS MSSM" !!
- $\text{FP}_2 = (0, \alpha_2^*, \vec{\alpha}_y^*)$ $\rightarrow$ Always unphysical
- $\text{FP}_3 = (\alpha_3^*, \alpha_2^*, \vec{\alpha}_y^*)$ $\rightarrow$ Always IR

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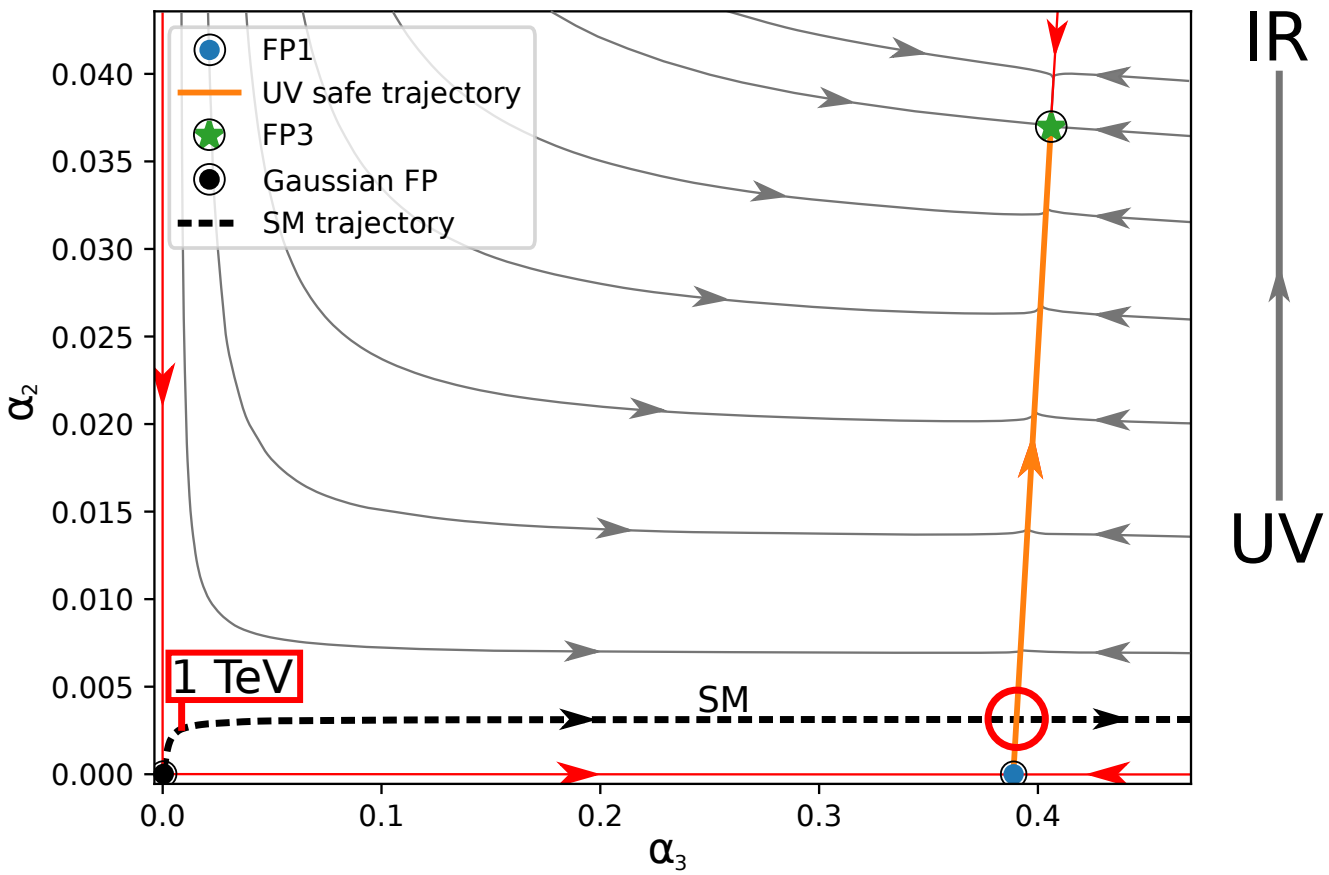
The AS MSSM


FP1
UV safe trajectory
FP3
Gaussian FP
SM trajectory
1 TeV
SM
IR
UV
α_2
α_3
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
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0.1
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0.4

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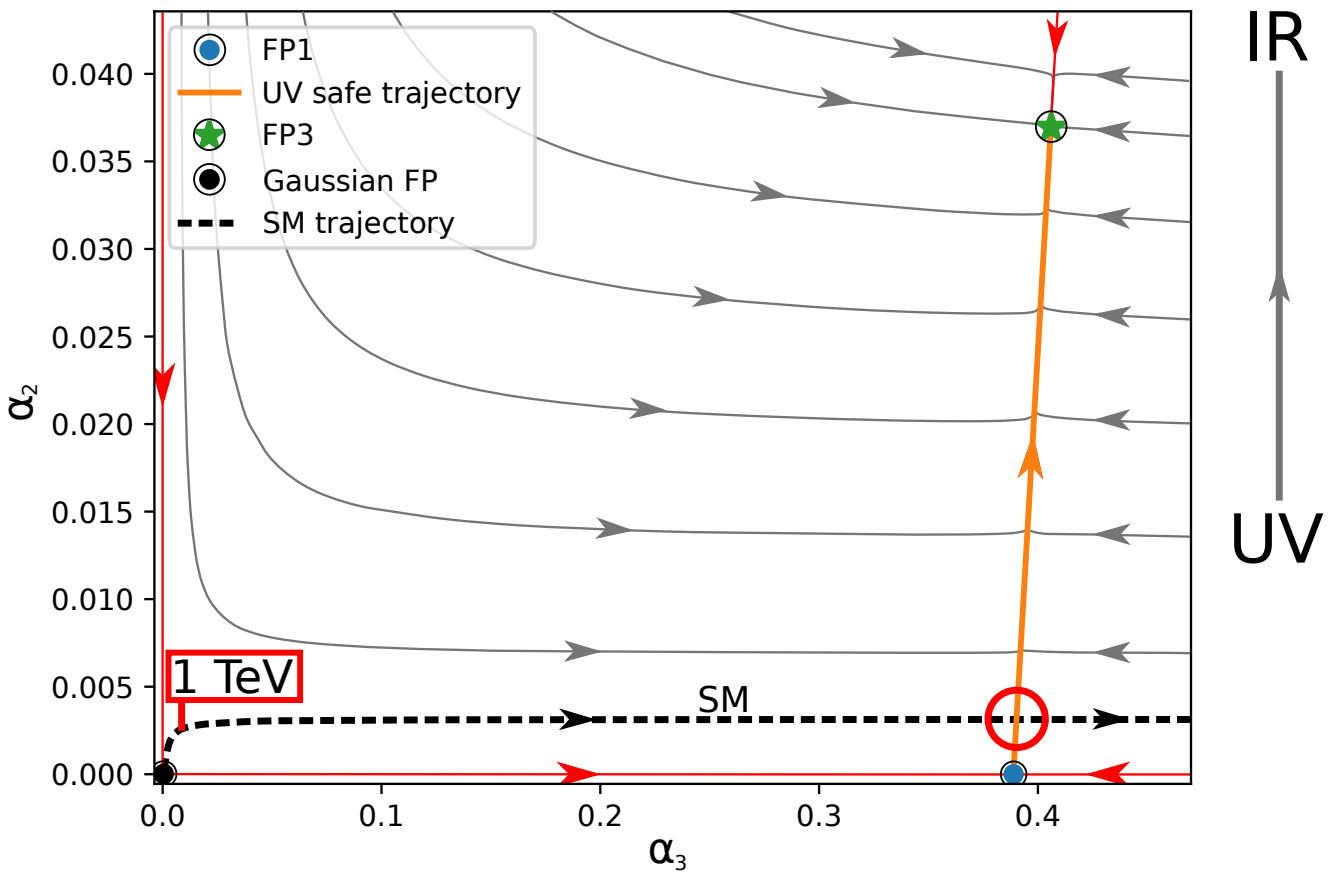

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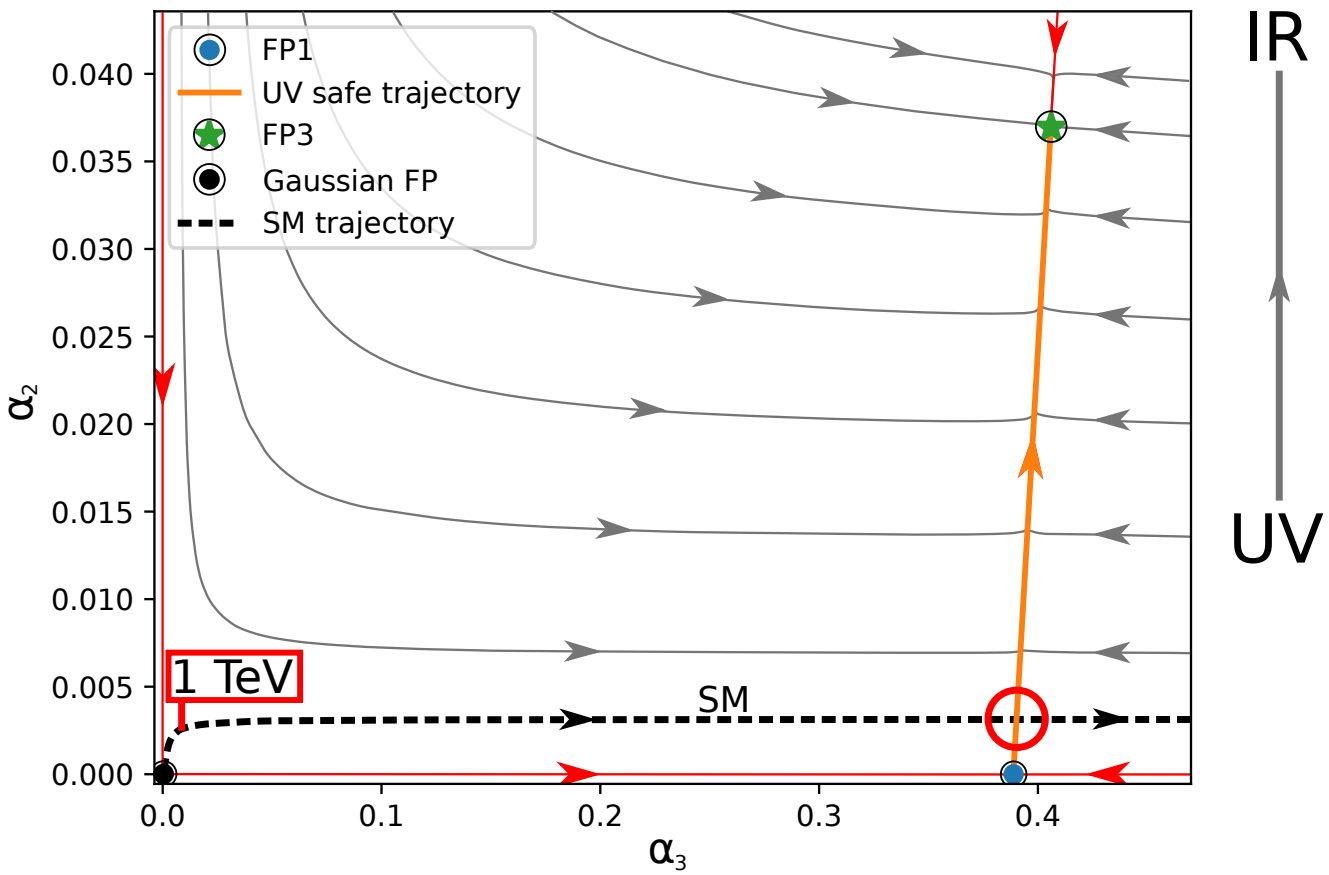

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Not viable!

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$$a = a(R)$$

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Hand-waving: In FP_3 one more non-zero component

$\Rightarrow$ one more constraint on R $\Rightarrow$ smaller maxima

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Thanks for your attention!

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