SUSY SO(10)

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- SO(10)
  - Matter sector

$$\mathcal{F} = \mathbf{16} \oplus \overline{\mathbf{16}}$$

$$\mathbf{16} \leftrightarrow \left(\begin{array}{cccccccccccccccc} u_1 & u_2 & u_3 & \nu & u_1^c & u_2^c & u_3^c & \nu^c & d_1 & d_2 & d_3 & e & d_1^c & d_2^c & d_3^c & e^c \end{array} \right).$$

- Yukawa couplings

$$\mathcal{L}_{Yuk} = \mathbf{Y16}_F^T C_L C_{10} (\gamma_i \Phi^i + \gamma_{[i}\gamma_j\gamma_{k]}\Phi^{ijk} + \gamma_{[i}\gamma_j\gamma_k\gamma_l\gamma_{m]}\Phi^{ijklm})\mathbf{16}_F$$

$$\mathbf{16} \otimes \mathbf{16} = \mathbf{10} \oplus \mathbf{120} \oplus \overline{\mathbf{126}}$$

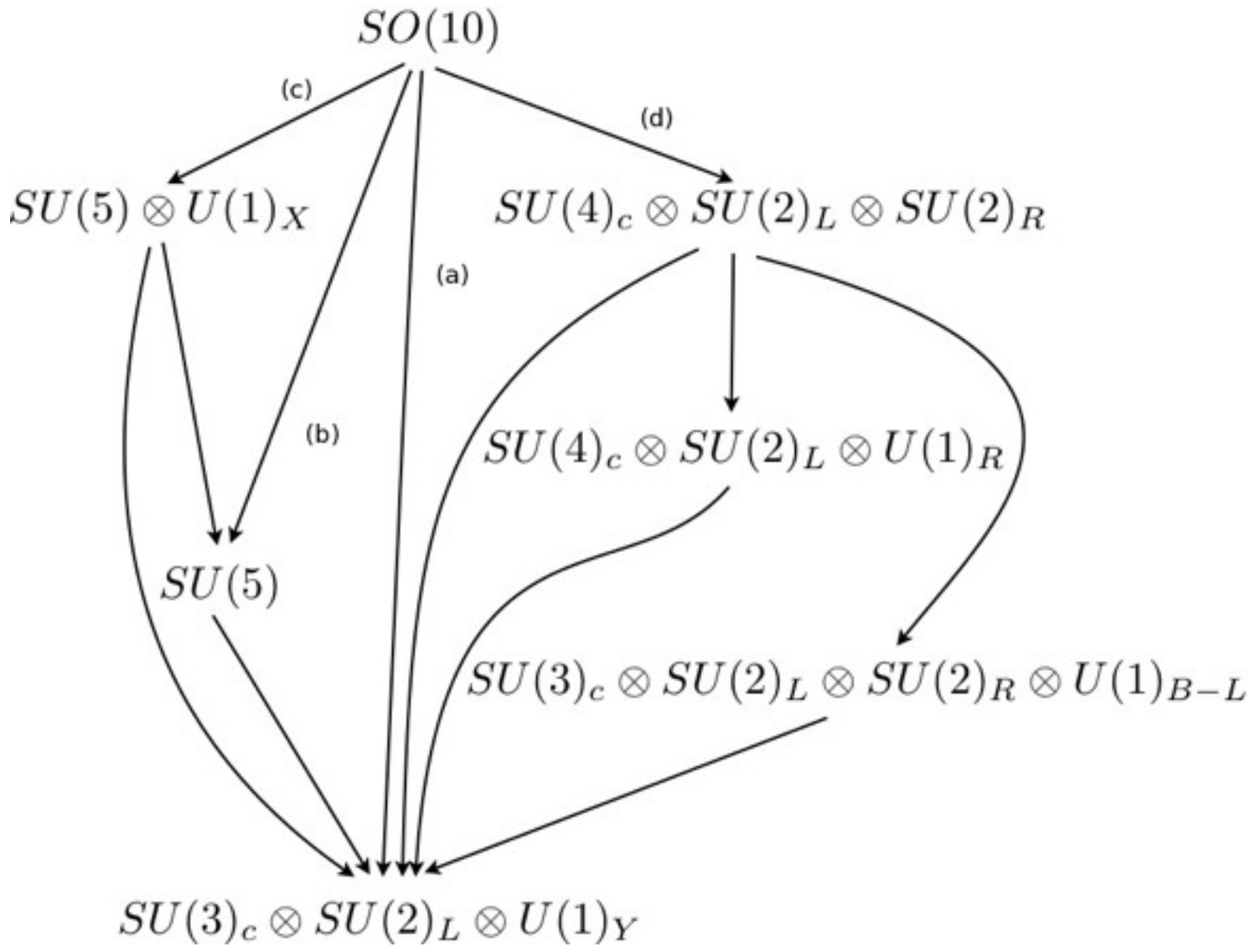
- Symmetry breaking

$a)\mathbf{144}\ldots$

$b)\mathbf{16}\otimes\overline{\mathbf{16}}\ldots$

$c)\mathbf{45}\ldots$

$d)\mathbf{54}\ldots$



- mSUGRA

$$
\begin{aligned}
W &= W_{MSSM} - \frac{1}{M_P}\left(\frac{1}{6}y^{Xijk}X\Phi_i\Phi_j\Phi_k + \frac{1}{2}\mu^{Xij}X\Phi_i\Phi_j\right) + \ldots, \\
K &= \Phi^{*i}\Phi_i + \frac{1}{M_P}(n_i^j X + \bar{n}_i^j X^*)\Phi_P^{*i} h i_j - \frac{1}{M_P^2}k_j^i X X^* \Phi^{*i}\Phi_j + \ldots, \\
f_{ab} &= \frac{\delta_{ab}}{g_a^2}\left(1 - \frac{2}{M_P}f_a X + \ldots\right).
\end{aligned}
$$

$$
m_{1/2} = f\frac{\langle F_X\rangle}{M_P}, \quad m_0^2 = (k+n)^2\frac{|\langle F_X\rangle|^2}{M_P^2},
$$

$$
A_0 = (\alpha + 3n)\frac{\langle F_X\rangle}{M_P}, \quad B_0 = (\beta + 2n)\frac{\langle F_X\rangle}{M_P}
$$

- SUSY SO(10) Lagrangian

$$\mathcal{L}_{SO(10)} = \mathcal{L}^{kin}_{gauge,\mathbf{16}_F,\mathbf{10}_H,\Sigma} + \mathcal{L}_{soft} + \mathbf{Y16}_F\mathbf{10}_H\mathbf{16}_F - V(\mathbf{10}_H,\Sigma)$$

$$m^2_{16_F} = (k_{16} + n^2_{16})\frac{|\langle F_X\rangle|^2}{M_P^2}, \quad m^2_{10_H} = (k_{10} + n^2_{10})\frac{|\langle F_X\rangle|^2}{M_P^2}$$

- D-terms

$$\mathcal{L}_{D-terms} = -\frac{1}{2}g^2_{10}\left(\tilde{\mathbf{16}}^*_F T^a \tilde{\mathbf{16}}_F + \Sigma^*_H T^a \Sigma_H + \mathbf{10}^*_H T^a \mathbf{10}_H\right)^2$$

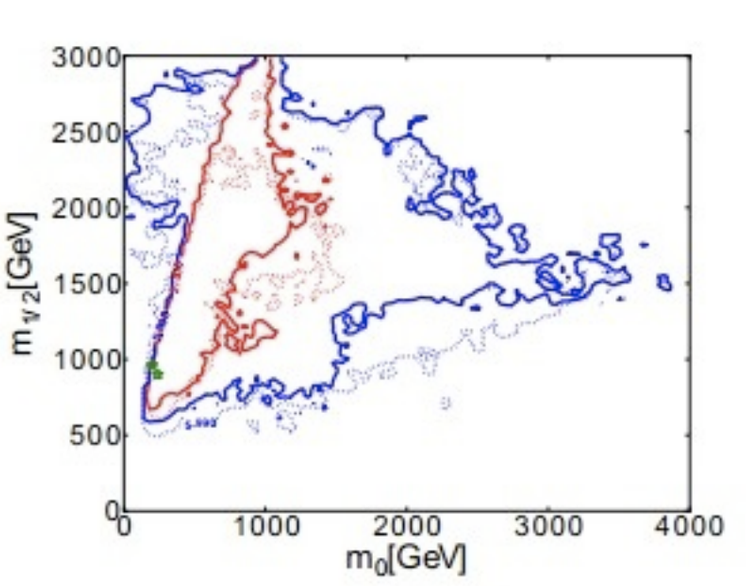
$$m^2_D = \frac{1}{4}g^2_{10}V^2$$

- Boundary conditions

$$
\begin{aligned}
&M_1 = M_2 = M_3 = m_{1/2},\\
&A_u = A_d = A_e = A_0,\\
&\mathbf{m_Q^2} = \mathbf{m_u^2} = \mathbf{m_e^2} = m_{16_F}^2 \mathbf{1} + m_D^2 \mathbf{1},\\
&\mathbf{m_L^2} = \mathbf{m_d^2} = m_{16_F}^2 \mathbf{1} - 3m_D^2 \mathbf{1},\\
&\mathbf{m_\nu^2} = m_{16_F}^2 \mathbf{1} + 5m_D^2 \mathbf{1},\\
&m_{H_d}^2 = m_{10_H}^2 + 2m_D^2,\\
&m_{H_u}^2 = m_{10_H}^2 - 2m_D^2.
\end{aligned}
$$

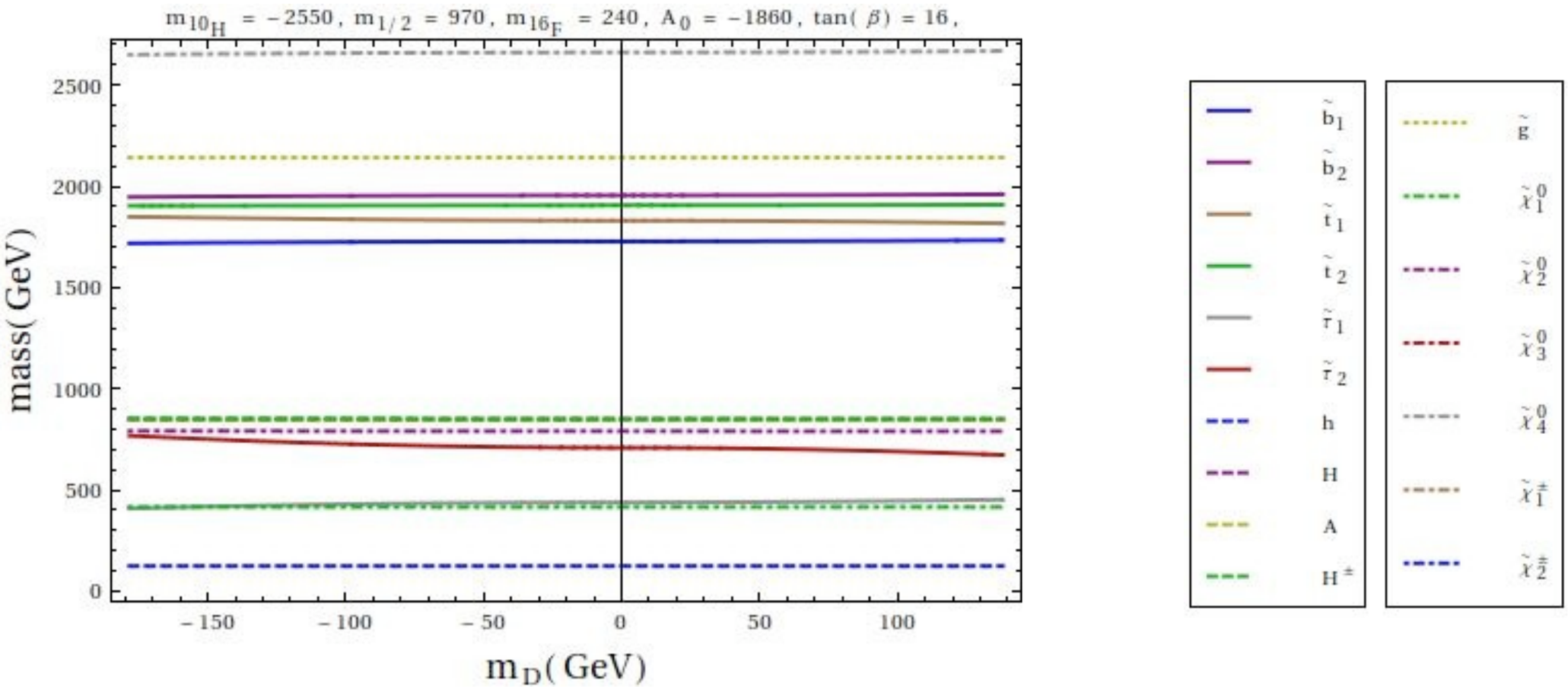
- Benchmark point

$$m_{16_F} = 240 \text{ GeV},$$
$$m^2_{10_H} = -6.5 \times 10^6 \text{ GeV}^2,$$
$$m_{1/2} = 970,$$
$$A_0 = -1860 \text{ GeV},$$
$$\tan\beta = 16.$$

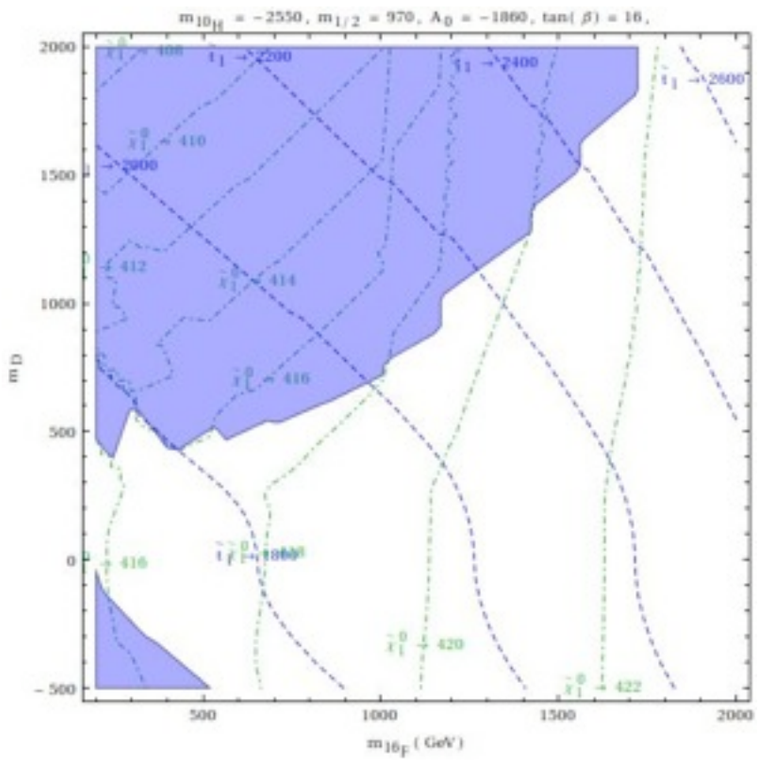


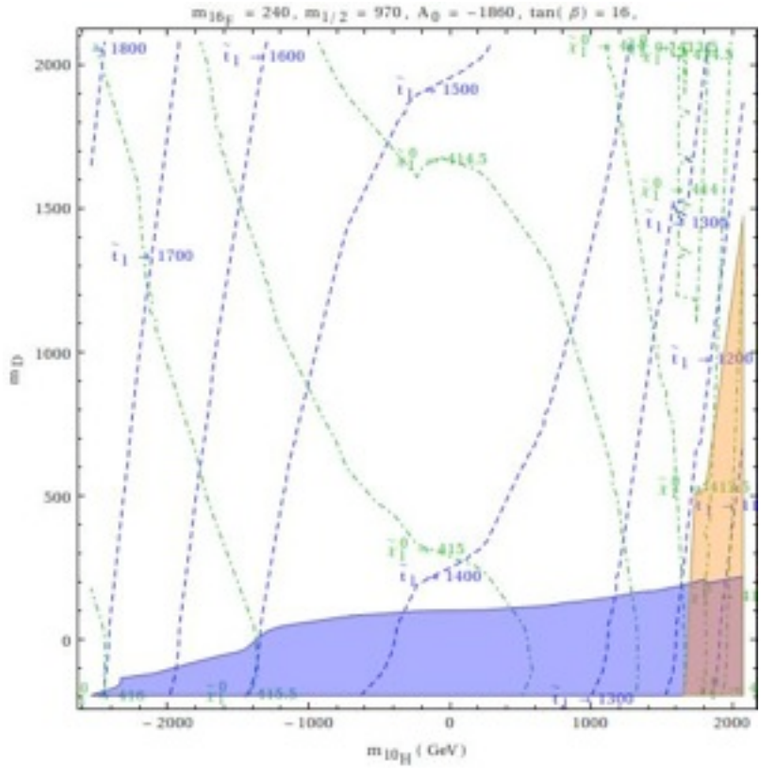
O. Buchmueller et al., arXiv:1207.7315 [hep-ph]

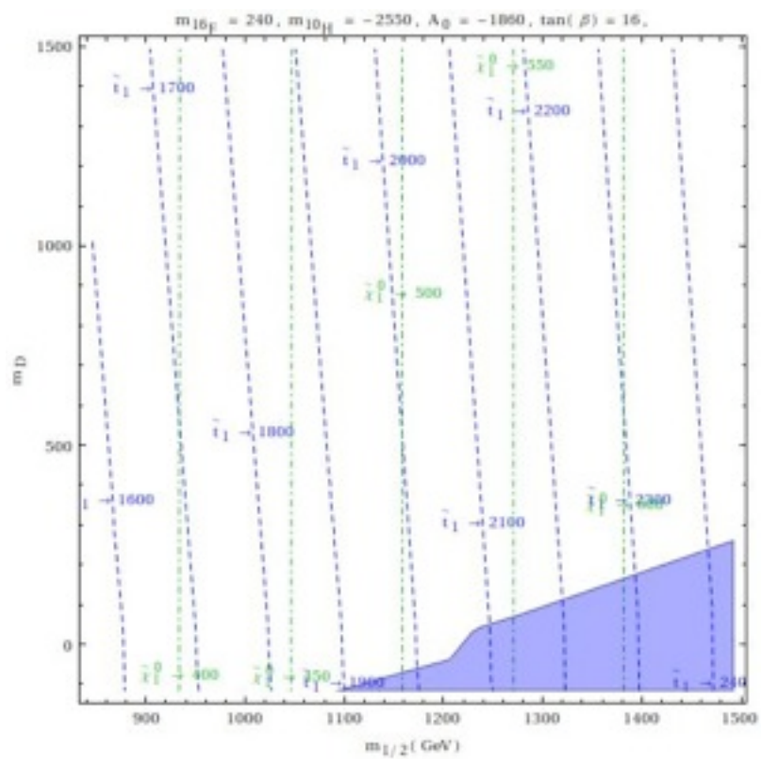
- Results


$m_{10_H} = -2550,\ m_{1/2} = 970,\ m_{16_F} = 240,\ A_0 = -1860,\ \tan(\beta) = 16,$
mass(GeV)
2500
2000
1500
1000
500
0
−150
−100
−50
0
50
100
m_D(GeV)
$\tilde{b}_1$
$\tilde{b}_2$
$\tilde{t}_1$
$\tilde{t}_2$
$\tilde{\tau}_1$
$\tilde{\tau}_2$
h
H
A
$H^{\pm}$
$\tilde{g}$
$\tilde{\chi}_1^0$
$\tilde{\chi}_2^0$
$\tilde{\chi}_3^0$
$\tilde{\chi}_4^0$
$\tilde{\chi}_1^{\pm}$
$\tilde{\chi}_2^{\pm}$

- Results







$$\mathrm{LSP}, m_H, b \to s\gamma, B_s \to \mu^+\mu^-, B^+ \to \tau^+\nu_\tau, a_\mu$$