Supersymmetric contributions to Z' decays

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G.C. and S.Gentile, Nucl.Phys.B886 (2013) 293 and work in progress

U(1)' gauge groups in GUT-inspired models:

$$\mathrm{E}_6 \to \mathrm{SO}(10) \times \mathrm{U}(1)'_\psi \quad , \quad \mathrm{SO}(10) \to \mathrm{SU}(5) \times \mathrm{U}(1)'_\chi$$

$$Z'(\theta) = Z'_\psi \cos\theta - Z'_\chi \sin\theta$$

$$\mathrm{E}_6 \to \mathrm{SM} \times \mathrm{U}(1)'_\eta \quad \theta = \arccos\sqrt{5/8} \;\Rightarrow\; Z'_\eta$$

Orthogonal combination to Z'_η: $\theta = \arccos\sqrt{5/8} - \pi/2 \Rightarrow Z'_I$

Secluded model (singlet S): $\theta = \arctan(\sqrt{15}/9) - \pi/2 \Rightarrow Z'_S$

Representations of E_6, $\mathrm{SO}(10)$ and $\mathrm{SU}(5)$:

$$\mathrm{E}_6 \quad : \quad \mathbf{27} = (Q, u^c, e^c, L, d^c, \nu^c, H, D^c, H^c, D, S^c)_L$$

$$\mathrm{SU}(5) : \mathbf{10} = (Q, u^c, e^c), \bar{\mathbf{5}} = (L, d^c), \mathbf{1} = (\nu^c), \bar{\mathbf{5}} = (H, D^c), \mathbf{5} = (H^c, D), \mathbf{1} = (S^c)$$

$$\text{`Conventional'}\ \mathrm{SO}(10) \ : \mathbf{16} = (Q, u^c, e^c, L, d^c, \nu^c) \ , \ \mathbf{10} = (H, D^c, H^c, D) \ , \ \mathbf{1} = (S^c)$$

$$\text{`Unconventional'}\ \mathrm{SO}(10) \ : \mathbf{16} = (Q, u^c, e^c, H, D^c, \nu^c), \mathbf{10} = (L, d^c, H^c, D) \ , \ \mathbf{1} = (S^c)$$

From conventional to unconventional SO(10) (Nardi–Rizzo '94): $\theta \to \theta + \arctan\sqrt{15}$

U(1)′ models, mixing angles and charges

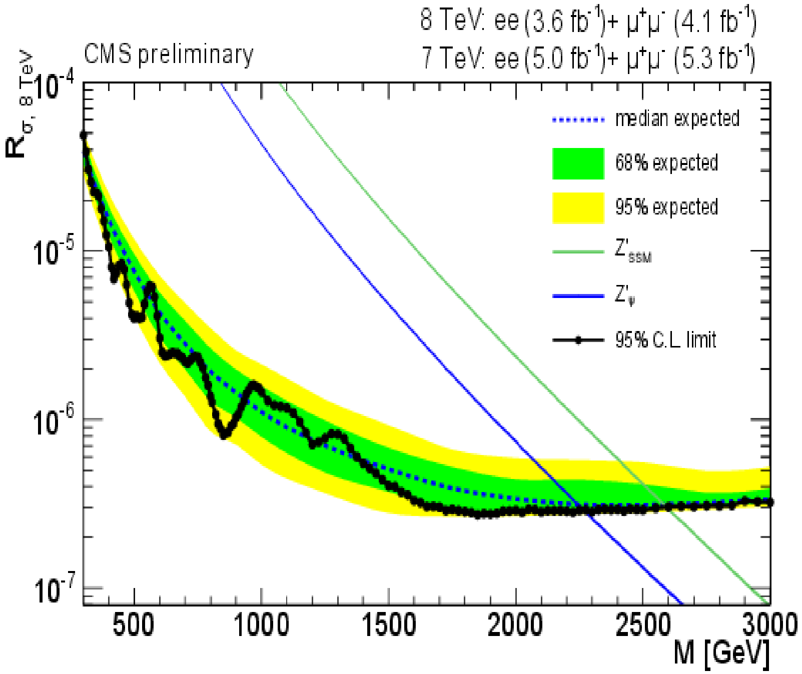
Model	θ
Z'_χ	$-\pi/2$
Z'_ψ	0
Z'_η	$\arccos\sqrt{5/8}$
Z'_I	$\arccos\sqrt{5/8}-\pi/2$
Z'_N	$\arctan\sqrt{15}-\pi/2$
Z'_S	$\arctan(\sqrt{15}/9)-\pi/2$

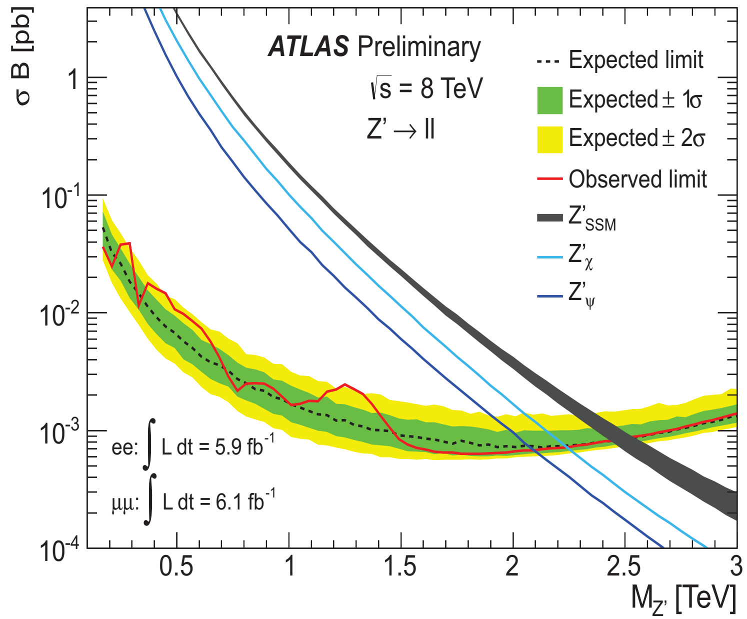
	$2\sqrt{10}\ Q'_\chi$	$2\sqrt{6}\ Q'_\psi$	$2\sqrt{15}\ Q'_\eta$
Q	-1	1	2
u^c	-1	1	2
d^c	3	1	-1
L	3	1	-1
e^c	-1	1	2
ν^c	-5	1	5
H	-2	-2	-1
H^c	2	-2	-4
S^c	0	4	5
D	2	-2	-4
D^c	-2	-2	-1

$$\mathbf{27} = (Q, u^c, e^c, L, d^c, \nu^c, H, D^c, H^c, D, S^c)_L$$

Product $\sigma \times \mathrm{BR}$ to obtain the Z' mass exclusion limits

$$\mathrm{BR} = \mathrm{BR}(\mu^+\mu^-) + \mathrm{BR}(e^+e^-)$$





Intersection of 1σ and 2σ bands with the theory curves yields the exclusion limits

Right: ATLAS $\Rightarrow$ $m(Z'_{\mathrm{SSM}}) > 2.49$ TeV , $m(Z'_{\mathrm{GUT}})$ >2.09-2.24 TeV

Left: CMS $\Rightarrow$ $m(Z'_{\mathrm{SSM}}) > 2.59$ TeV , $m(Z'_{\mathrm{GUT}})$ >2.26 TeV

Sfermion masses get D- and F-term corrections (m_0 soft mass at the Z' scale):

$$V(\phi,\phi^*) = F^{*i}F_i + \frac{1}{2}D^a D_a \ , \ D^a = -g^a(\phi^* T^a \phi) \ , \ F_i = \frac{\delta W}{\delta \phi_i}$$

First contribution to D-term (electroweak symmetry breaking):

$$\Delta\tilde{m}_a^2 = (T_{3,a}g_1^2 - Y_a g_2^2)(v_1^2 - v_2^2) = (T_{3,a} - Q_a \sin^2\theta_W)m_Z^2 \cos 2\beta$$

Second contribution driven by the new U(1)' symmetry:

$$\Delta\tilde{m}_a'^2 = \frac{g'^2}{2}Q_a'(Q_1'v_1^2 + Q_2'v_2^2 + Q_3'v_3^2)$$

$$\mathcal{M}_{\tilde{f}}^2 = \begin{pmatrix} (M^{\tilde{f}}_{LL})^2 & (M^{\tilde{f}}_{LR})^2 \\ (M^{\tilde{f}}_{LR})^2 & (M^{\tilde{f}}_{RR})^2 \end{pmatrix}$$

$$\begin{aligned}
(M^{\tilde{u}}_{LL})^2 &= (m^0_{\tilde{u}_L})^2 + m_u^2 + \left(\frac{1}{2} - \frac{2}{3}x_w\right) m_Z^2 \ \cos 2\beta + \Delta\tilde{m}'^2_{\tilde{u}_L} \\
(M^{\tilde{u}}_{RR})^2 &= (m^0_{\tilde{u}_R})^2 + m_u^2 + \left(\frac{1}{2} - \frac{2}{3}x_w\right) m_Z^2 \ \cos 2\beta + \Delta\tilde{m}'^2_{\tilde{u}_R} \\
(M^{\tilde{u}}_{LR})^2 &= m_u \left(A_u - \mu \cot\beta\right) .
\end{aligned}$$

Contributions $\sim m_u^2$ and mixing are inherited by the F-term

Lagrangian for Z' coupling with fermions

$$\mathcal{L}_f = g' \bar{f} \gamma^\mu (v_f - a_f \gamma_5) f Z'_\mu$$

$$v_f = \frac{1}{2}\left[Q'(f_L) + Q'(f_R)\right] = \frac{1}{2}\left[(Q'_\psi(f_L) + Q'_\psi(f_R)) \cos\theta - (Q'_\chi(f_L) + Q'_\chi(f_R)) \sin\theta\right]$$

$$a_f = \frac{1}{2}\left[Q'(f_L) - Q'(f_R)\right] = \frac{1}{2}\left[(Q'_\psi(f_L) - Q'_\psi(f_R)) \cos\theta - (Q'_\chi(f_L) - Q'_\chi(f_R)) \sin\theta\right]$$

Z' rate into fermions:

$$\Gamma(Z' \to f\bar{f}) = C_f \frac{g'^2}{12\pi} m_{Z'} \left[v_f^2 \left(1 + 2\frac{m_f^2}{m_{Z'}^2}\right) + a_f^2 \left(1 - 4\frac{m_f^2}{m_{Z'}^2}\right)\right] \left(1 - 4\frac{m_f^2}{m_{Z'}^2}\right)^{1/2}$$

Lagrangian for Z' coupling with sfermions

$$\mathcal{L}_{\tilde{f}} = g'(v_f \pm a_f)[\tilde{f}^*_{L,R}(\partial_\mu \tilde{f}_{L,R}) - (\partial_\mu \tilde{f}^*_{L,R})\tilde{f}_{L,R}] Z'^\mu$$

Z' rate into sfermions:

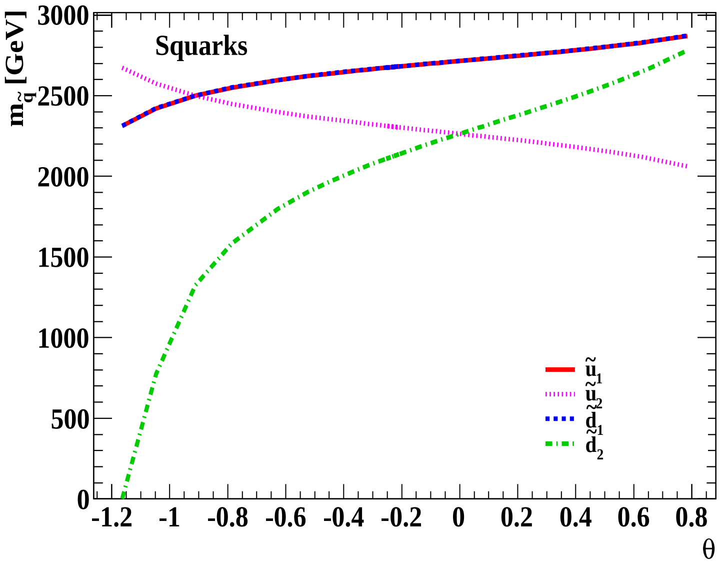
$$\Gamma(Z' \to \tilde{f}_{L,R} \tilde{f}^*_{L,R}) = C_f \frac{g'^2}{48\pi} m_{Z'} (v_f \pm a_f)^2 \left(1 - 4\frac{m_{\tilde{f}}^2}{m_{Z'}^2}\right)^{1/2}$$

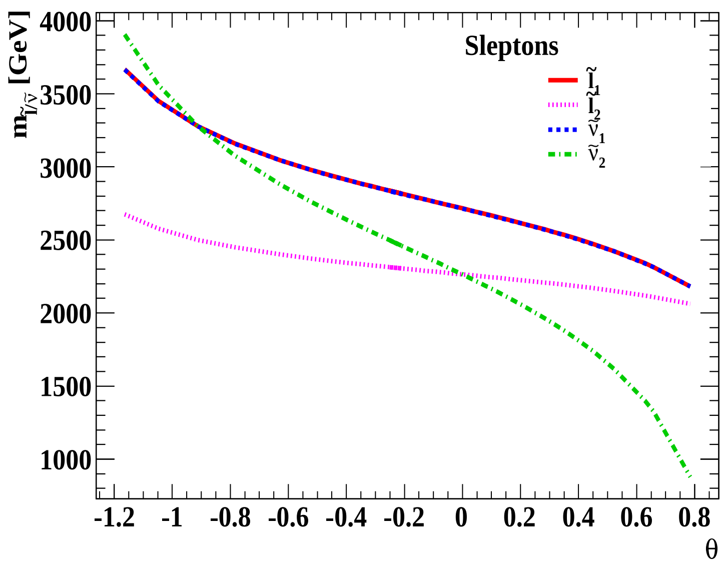
Zero rates into sfermions if $v_f = \pm a_f$, e.g. Z'_N and Z'_I couplings to $\tilde{f}_R \tilde{f}^*_R$

Representative Point:

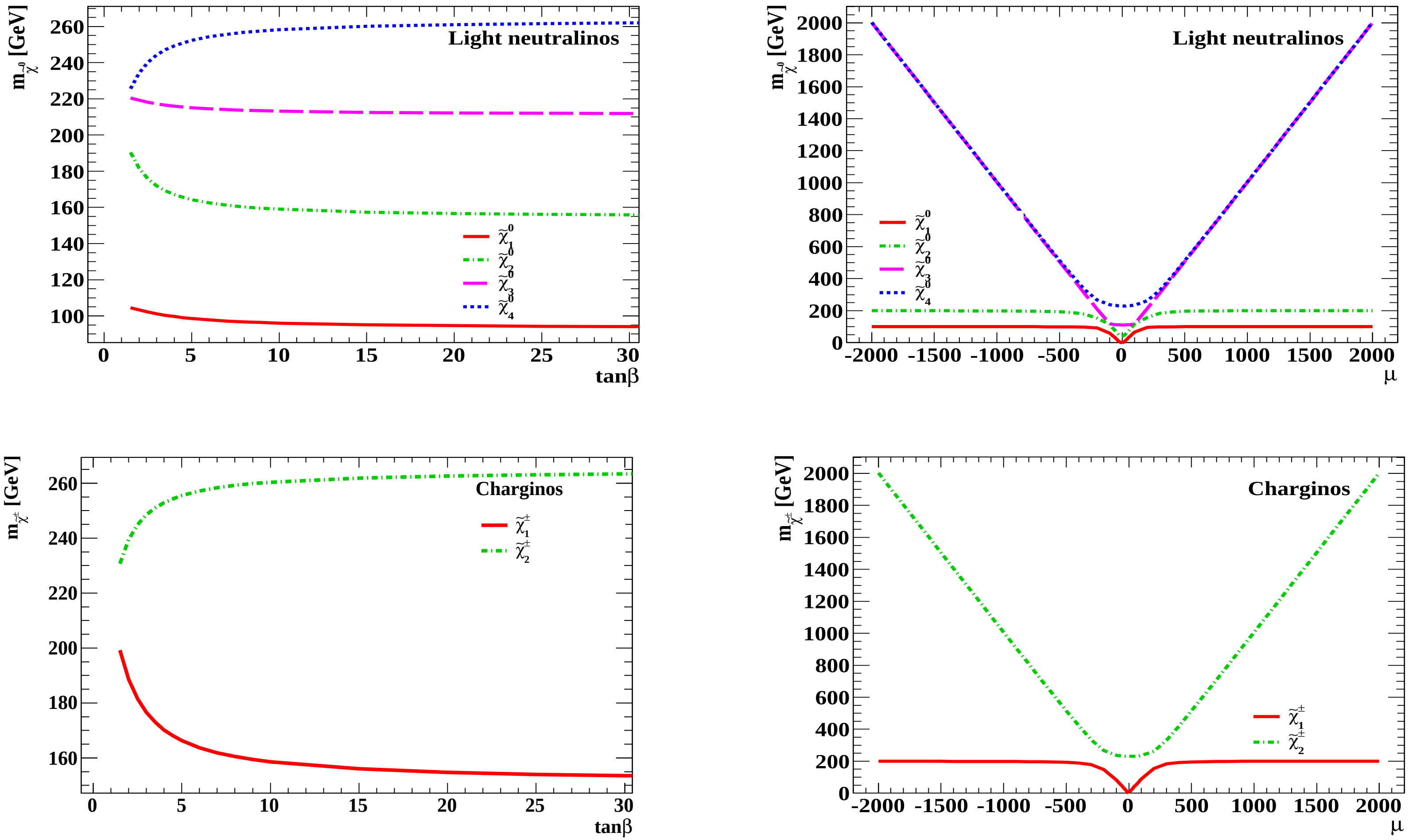
$$m_{Z'} = 3 \text{ TeV} \ , \ \theta = \theta_I = \arccos\sqrt{\frac{5}{8}} - \frac{\pi}{2}$$
$$\mu = 200 \text{ GeV} \ , \ \tan\beta = 20 \ , \ A_q = A_\ell = A_f = 500 \text{ GeV}$$
$$m^0_{\tilde{q}_1} = m^0_{\tilde{q}_2} = m^0_{\tilde{\ell}_1} = m^0_{\tilde{\ell}_2} = m^0_{\tilde{\nu}_1} = m_{\tilde{\nu}_2} = 2.5 \text{ TeV}$$
$$M_1 = 100 \text{ GeV} \ , \ M_2 = 200 \text{ GeV} \ , \ M' = 1 \text{ TeV}$$

$m_{\tilde{u}_1}$	$m_{\tilde{u}_2}$	$m_{\tilde{d}_1}$	$m_{\tilde{d}_2}$	$m_{\tilde{\ell}_1}$	$m_{\tilde{\ell}_2}$	$m_{\tilde{\nu}_1}$	$m_{\tilde{\nu}_2}$
2499.4	2499.7	2500.7	1323.1	3279.0	2500.4	3278.1	3279.1
$m_{\tilde{\chi}^0_1}$	$m_{\tilde{\chi}^0_2}$	$m_{\tilde{\chi}^0_3}$	$m_{\tilde{\chi}^0_4}$	$m_{\tilde{\chi}^0_5}$	$m_{\tilde{\chi}^0_6}$	$m_{\tilde{\chi}^\pm_1}$	$m_{\tilde{\chi}^\mp_2}$
94.6	156.5	212.2	260.9	2541.4	3541.4	154.8	262.1
m_h	m_A	m_H	$m_{H'}$	$m_{H^\pm}$			
90.7	1190.7	1190.7	3000.0	1193.4			





Dependence of neutralino and chargino spectra on MSSM parameters



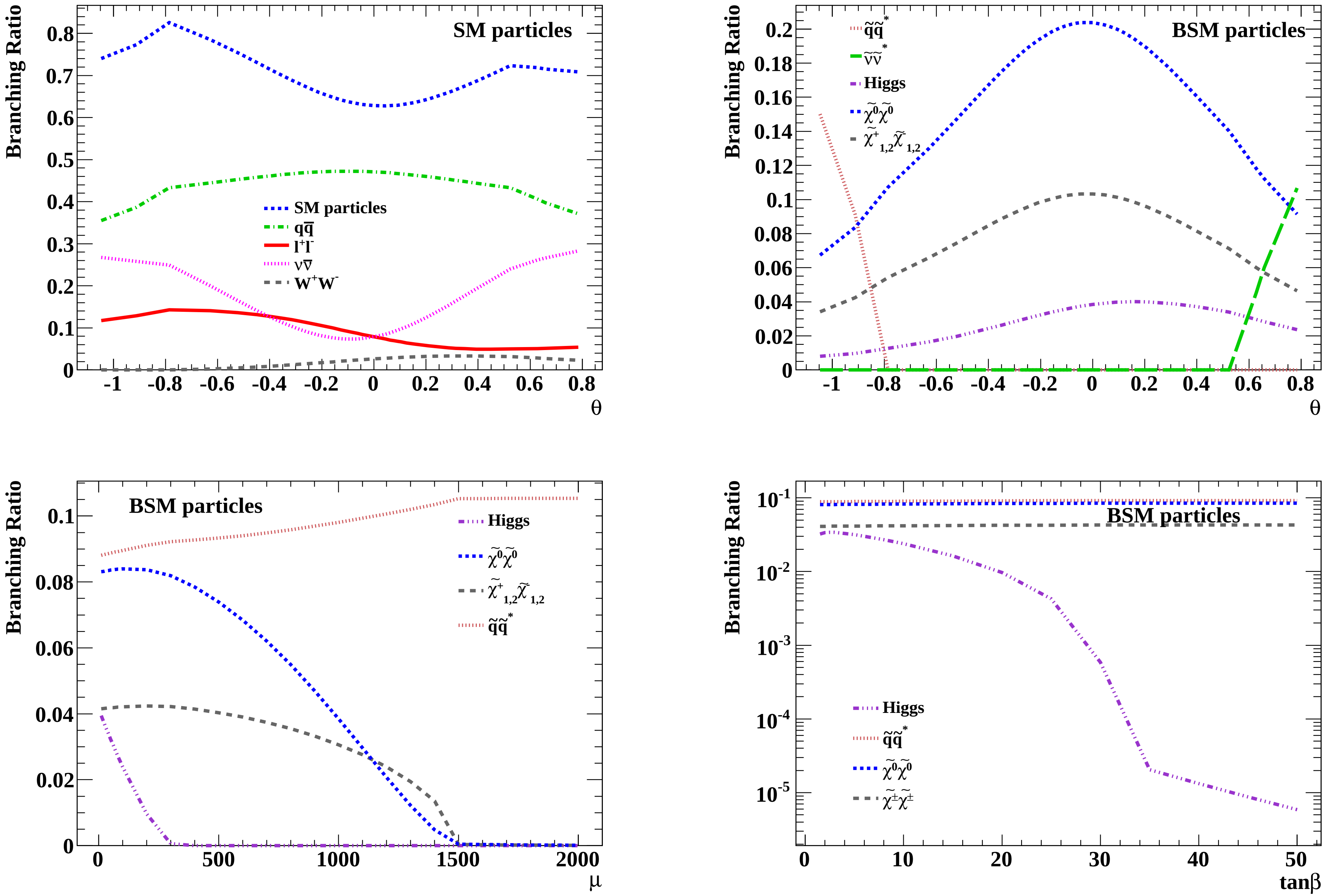
Comparison with ISAJET: good agreement for Representative Point

Model	$m_{\tilde{\chi}_1^0}$	$m_{\tilde{\chi}_2^0}$	$m_{\tilde{\chi}_3^0}$	$m_{\tilde{\chi}_4^0}$	m_h	m_H	m_A	$m_{H\pm}$	$m_{\tilde{\chi}_1^\pm}$	$m_{\tilde{\chi}_2^\pm}$
U(1)'/MSSM	94.6	156.6	212.2	261.0	90.7	1190.0	1190.0	1190.0	155.0	263.0
MSSM	91.3	152.2	210.2	266.7	114.1	1190.0	1197.9	1200.7	147.5	266.8

Branching ratios in the Representative Point

Final state	BR (%)	Final State	BR (%)
$\sum_i u_i \bar{u}_i$	0.00	$\tilde{\chi}_1^0 \tilde{\chi}_1^0$	0.07
$\sum_i d_i \bar{d}_i$	40.67	$\tilde{\chi}_1^0 \tilde{\chi}_2^0$	0.43
$\sum_i \ell_i^+ \ell_i^-$	13.56	$\tilde{\chi}_1^0 \tilde{\chi}_3^0$	0.71
$\sum_i \nu_i \bar{\nu}_i$	27.11	$\tilde{\chi}_1^0 \tilde{\chi}_4^0$	0.27
$\sum_{i,j} \tilde{u}_i \tilde{u}_j^*$	0.00	$\tilde{\chi}_1^0 \tilde{\chi}_5^0$	$\sim 10^{-6}$
$\sum_{i,j} \tilde{d}_i \tilde{d}_j^*$	9.58	$\tilde{\chi}_2^0 \tilde{\chi}_2^0$	0.65
$\sum_{i,j} \tilde{\ell}_i \tilde{\ell}_j^*$	0.00	$\tilde{\chi}_2^0 \tilde{\chi}_3^0$	2.13
$\sum_{i,j} \tilde{\nu}_i \tilde{\nu}_j^*$	0.00	$\tilde{\chi}_2^0 \tilde{\chi}_4^0$	0.80
$H^+ H^-$	0.50	$\tilde{\chi}_3^0 \tilde{\chi}_3^0$	1.75
hA	$\sim 10^{-3}$	$\tilde{\chi}_3^0 \tilde{\chi}_4^0$	1.31
HA	0.51	$\tilde{\chi}_3^0 \tilde{\chi}_5^0$	$\sim 10^{-6}$
ZH	$\sim 10^{-3}$	$\tilde{\chi}_4^0 \tilde{\chi}_4^0$	0.25
ZH'	0.00	$\tilde{\chi}_1^\pm \tilde{\chi}_2^\mp$	1.95
$H'A$	0.00	$\tilde{\chi}_2^\pm \tilde{\chi}_2^\mp$	0.54
$W^\pm H^\mp$	$\sim 10^{-3}$	$\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$	1.76

Branching ratios as a function of the U(1)′ and MSSM parameters



Branching ratios into SM and BSM particles varying the Z' and slepton masses

$\mu = 200\ ,\ \tan\beta = 20\ ,\ A_q = A_\ell = 500\ \mathrm{GeV}\ ,\ m^0_{\tilde{q}} = 5\ \mathrm{TeV}\ ,\ M_1 = 150\ \mathrm{GeV}\ ,\ M_2 = 300\ \mathrm{GeV}\ ,\ M' = 1\ \mathrm{TeV}$

Z'_η ($\theta \simeq 0.66$):

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	B_{WW}	B_{ZH}	$B_{\tilde{\chi}^+\tilde{\chi}^-}$	$B_{\tilde{\chi}^0\tilde{\chi}^0}$	$B_{\tilde{\nu}\tilde{\nu}^*}$	$B_{\rm SM}$	$B_{\rm BSM}$
1.0	0.8	39.45	5.24	27.26	3.01	2.91	4.92	8.64	8.54	71.96	28.04
1.0	0.9	43.14	5.73	29.81	3.30	3.18	5.38	9.45	0.00	78.68	21.32
2.0	1.5	37.97	4.91	25.54	2.66	2.64	5.33	10.33	10.61	68.42	31.58
2.0	1.8	42.47	5.49	28.57	2.98	2.95	5.96	11.56	0.00	76.54	23.46
3.0	2.2	37.60	4.84	25.17	2.59	2.59	5.38	10.61	11.14	67.60	32.40
3.0	2.6	42.31	5.45	28.32	2.92	2.91	6.06	11.94	0.00	76.08	23.92
4.0	2.9	37.41	4.81	25.00	2.56	2.56	5.39	10.70	11.38	67.22	32.78
4.0	3.5	42.22	5.43	28.21	2.89	2.89	6.08	12.07	0.00	75.85	24.15

Z'_ψ ($\theta = 0$) :

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	B_{WW}	B_{ZH}	$B_{\tilde{\chi}^+\tilde{\chi}^-}$	$B_{\tilde{\chi}^0\tilde{\chi}^0}$	$B_{\tilde{\nu}\tilde{\nu}^*}$	$B_{\tilde{\ell}\tilde{\ell}^*}$	$B_{\rm SM}$	$B_{\rm BSM}$
1.0	0.4	48.16	8.26	8.26	3.00	2.89	9.13	16.53	1.91	1.90	64.69	35.31
1.0	0.7	50.07	8.59	8.59	3.08	2.99	9.49	17.18	0.00	0.00	67.25	32.75
2.0	0.8	46.30	7.77	7.77	2.62	2.62	9.92	19.37	1.80	1.80	61.85	38.15
2.0	1.3	48.03	8.06	8.06	2.72	2.72	10.29	20.10	0.00	0.00	64.16	35.84
3.0	1.1	45.35	7.58	7.58	2.53	2.54	9.92	19.63	1.86	1.86	60.51	39.49
3.0	1.9	47.10	7.88	7.88	2.62	2.64	10.30	20.39	0.00	0.00	62.85	37.15
4.0	1.5	44.60	7.45	7.45	2.47	2.49	9.82	19.53	1.80	1.80	59.49	40.51
4.0	2.5	46.26	7.72	7.72	2.56	2.58	10.19	20.26	0.00	0.00	61.71	38.29
5.0	1.8	44.16	7.37	7.37	2.44	2.46	9.76	19.44	1.82	1.82	58.89	41.11
5.0	3.1	45.83	7.65	7.65	2.53	2.55	10.13	20.18	0.00	0.00	61.12	38.88

Z'_N $(\theta \simeq -0.25)$:

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	B_{WW}	B_{ZH}	$B_{\tilde{\chi}^+\tilde{\chi}^-}$	$B_{\tilde{\chi}^0\tilde{\chi}^0}$	$B_{\tilde{\ell}\tilde{\ell}}$	B_{SM}	B_{BSM}
1.0	0.4	49.51	11.98	9.59	1.71	1.68	8.71	15.78	1.04	71.08	28.92
1.0	0.6	50.03	12.11	9.69	1.73	1.69	8.80	15.94	0.00	71.83	28.17
2.0	0.7	47.50	11.36	9.08	1.53	1.54	9.44	18.46	1.08	67.94	32.06
2.0	1.2	48.02	11.48	9.18	1.54	1.55	9.55	18.66	0.00	68.68	31.32
3.0	1.0	46.43	11.30	8.86	1.47	1.49	9.43	18.66	1.08	66.36	33.64
3.0	1.8	46.94	11.20	8.96	1.49	1.50	9.53	18.86	0.00	67.09	32.91
4.0	1.3	45.42	10.83	8.66	1.43	1.45	9.29	18.47	1.07	64.91	35.09
4.0	2.4	45.91	10.94	8.75	1.45	1.47	9.39	18.67	0.00	65.61	34.39
5.0	1.6	44.90	10.70	8.56	1.41	1.43	9.21	18.35	1.06	64.15	35.85
5.0	3.1	45.38	10.81	8.65	1.43	1.45	9.31	18.55	0.00	64.84	35.16

Z'_I $(\theta \simeq -0.91)$:

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	$B_{H^+H^-}$	B_{WH}	B_{HA}	$B_{\tilde{\chi}^+\tilde{\chi}^-}$	$B_{\tilde{\chi}^0\tilde{\chi}^0}$	B_{SM}	B_{BSM}
1.0	1.0	44.06	14.69	29.37	0.00	$\mathcal{O}(10^{-3})$	$\mathcal{O}(10^{-4})$	4.31	7.58	88.11	11.89
1.5	1.0	43.39	14.46	28.93	0.00	$\mathcal{O}(10^{-4})$	$\mathcal{O}(10^{-4})$	4.56	8.65	86.78	13.22
2.0	1.0	43.16	14.38	28.77	0.00	$\mathcal{O}(10^{-4})$	$\mathcal{O}(10^{-3})$	4.65	9.03	86.31	13.69
2.5	1.0	42.99	14.33	28.66	0.06	$\mathcal{O}(10^{-3})$	0.07	4.68	9.19	85.98	14.02
3.0	1.0	42.53	14.18	28.36	0.53	$\mathcal{O}(10^{-3})$	0.53	4.66	9.20	85.07	14.93
3.5	1.0	42.16	14.05	28.11	0.91	$\mathcal{O}(10^{-3})$	0.92	4.64	9.19	84.33	15.67
4.0	1.0	41.90	13.96	27.93	1.20	$\mathcal{O}(10^{-3})$	1.21	4.62	9.17	83.79	16.21
4.5	1.0	41.70	13.90	27.80	1.40	$\mathcal{O}(10^{-3})$	1.41	4.61	9.16	83.40	16.60
5.0	1.0	41.56	13.85	27.71	1.56	0.01	1.57	4.60	9.15	83.12	16.88

Z'_S $(\theta \simeq -1.16)$:

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	B_{WW}	B_{ZH}	$B_{\tilde{\chi}^+\tilde{\chi}^-}$	$B_{\tilde{\chi}^0\tilde{\chi}^0}$	$B_{\tilde{\ell}\tilde{\ell}^*}$	$B_{\tilde{q}\tilde{q}^*}$	$B_{\rm SM}$	$B_{\rm BSM}$
1.0	0.2	42.29	13.70	34.57	0.15	0.14	3.33	5.75	0.07	0.00	90.56	9.44
2.0	0.2	41.67	13.48	34.02	0.14	0.14	3.57	6.90	0.08	0.00	89.17	10.82
3.0	0.2	41.25	13.34	33.66	0.14	0.14	3.58	7.06	0.08	0.00	88.25	11.75
4.0	0.2	40.81	13.20	33.30	0.14	0.14	3.56	7.07	0.08	0.00	87.30	12.70
5.0	0.2	37.34	12.07	30.46	0.13	0.13	3.27	6.50	0.07	7.97	79.87	20.12

Z'_χ $(\theta \simeq -1.57)$:

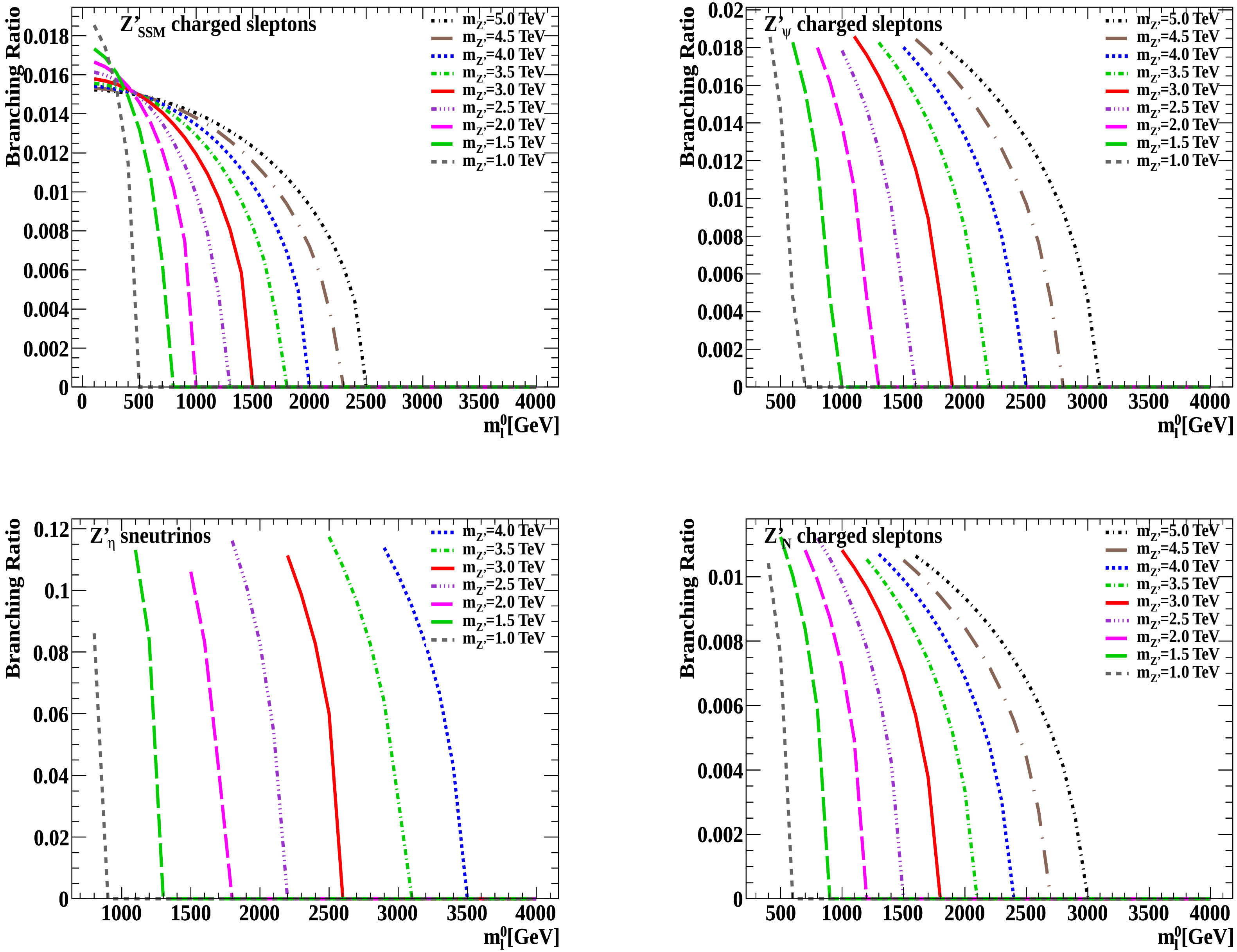
(unphysical sfermion spectrum)

$m_{Z'}$	$B_{q\bar{q}}$	$B_{\ell\ell}$	$B_{\nu\nu}$	B_{WW}	$B_{H^+H^-}$	B_{ZH}	B_{HA}	$B_{\rm SM}$	$B_{\rm BSM}$
1.0	44.35	12.44	42.29	0.90	0.00	0.02	$\mathcal{O}(10^{-3})$	99.08	0.92
2.0	44.32	12.34	41.96	0.84	0.00	0.28	0.26	98.62	1.38
3.0	44.03	12.24	41.63	0.82	0.24	0.53	0.52	97.89	2.11
4.0	43.84	12.18	41.43	0.82	0.46	0.64	0.63	97.45	2.55
5.0	43.74	12.15	41.33	0.81	0.58	0.70	0.69	97.22	2.78

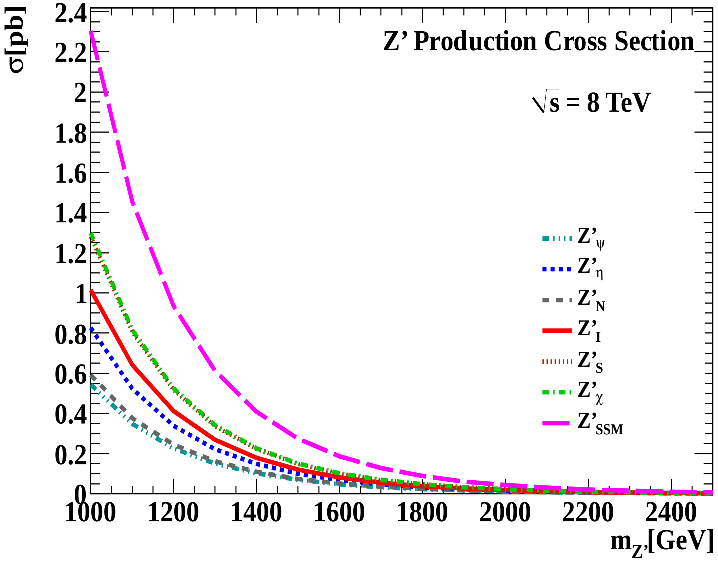
$Z'_{\rm SSM}$: $g' = g_2/(2\cos\theta_W)$

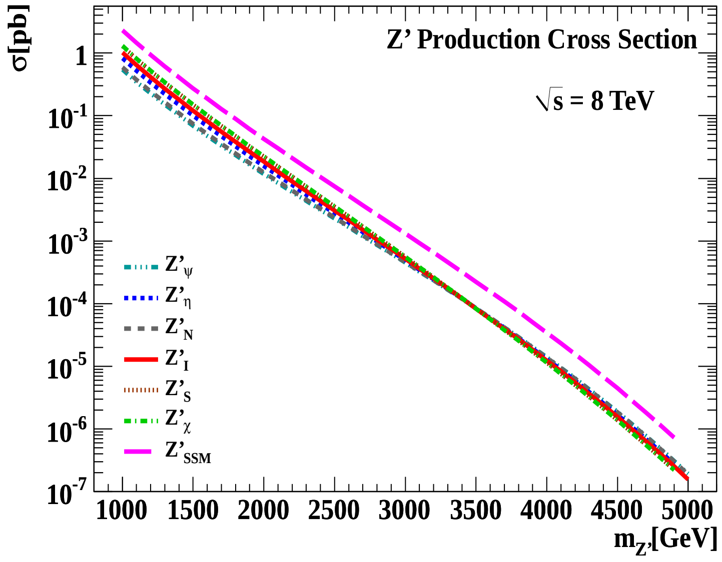
$m_{Z'}$	$m^0_{\tilde\ell}$	B_q	B_ℓ	B_ν	B_{WW}	B_{HH}	B_{Zh}	B_{hA}	$B_{\chi^\pm}$	B_{χ^0}	$B_{\tilde\ell}$	$B_{\tilde\nu}$	$B_{\rm SM}$	$B_{\rm BSM}$
1.0	0.1	29.6	3.9	7.7	5.6	0.0	0.0	0.0	18.3	29.3	1.9	3.8	41.2	58.8
1.0	0.5	31.4	4.1	8.2	5.9	0.0	0.0	0.0	19.4	31.1	0.0	0.0	43.6	56.4
1.5	0.1	27.4	3.5	7.0	4.9	0.9	0.9	0.8	17.8	32.5	1.7	3.5	37.9	62.1
1.5	0.7	28.9	3.7	7.4	5.1	0.0	0.9	0.8	18.8	34.3	0.0	0.0	40.0	60.0
2.0	0.1	26.2	3.4	6.7	4.6	0.0	1.9	1.8	17.4	33.0	1.7	3.3	36.3	63.7
2.0	1.0	27.6	3.5	7.0	4.8	0.0	2.0	1.9	18.3	34.7	0.0	0.0	38.2	61.8
2.5	0.1	25.4	3.3	6.5	4.4	0.9	2.6	2.5	16.9	32.8	1.6	3.2	35.1	64.9
2.5	1.2	26.6	3.4	6.8	4.6	0.9	2.7	2.7	17.8	34.4	0.0	0.0	36.8	63.2
3.0	0.1	24.8	3.2	6.3	4.2	1.7	3.0	2.9	16.6	32.5	1.6	3.1	34.3	65.7
3.0	1.5	26.0	1.7	6.6	4.5	1.8	3.1	3.1	17.4	34.1	0.0	0.0	36.0	64.0
3.5	0.1	24.4	3.1	6.2	4.2	2.3	3.2	3.2	16.4	32.3	1.6	3.1	33.7	66.2
3.5	1.7	25.6	1.4	6.5	4.4	2.4	3.4	3.3	17.2	33.9	0.0	0.0	35.4	64.6
4.0	0.1	24.2	3.1	6.1	4.1	2.6	3.4	3.4	16.3	32.2	1.5	3.1	33.4	66.6
4.0	2.0	25.3	1.2	6.4	4.3	2.8	3.6	3.5	17.1	33.7	0.0	0.0	35.0	65.0
4.5	0.1	24.0	3.1	6.1	4.1	2.9	3.5	3.5	16.2	32.1	1.5	3.0	33.2	66.8
4.5	2.2	25.1	1.1	6.4	4.3	3.0	3.7	3.7	17.0	33.6	0.0	0.0	34.8	65.2
5.0	0.1	23.9	3.0	6.1	4.1	3.1	3.6	3.6	16.1	32.0	1.5	3.0	33.0	67.0
5.0	2.5	25.0	1.0	6.4	4.2	3.3	3.8	3.7	16.9	33.5	0.0	0.0	34.6	65.4

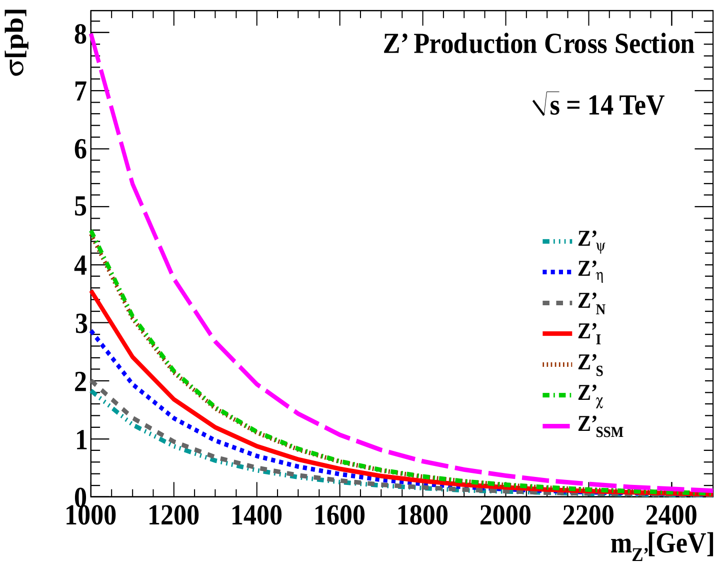
Dependence of branching ratios on Z' and slepton masses

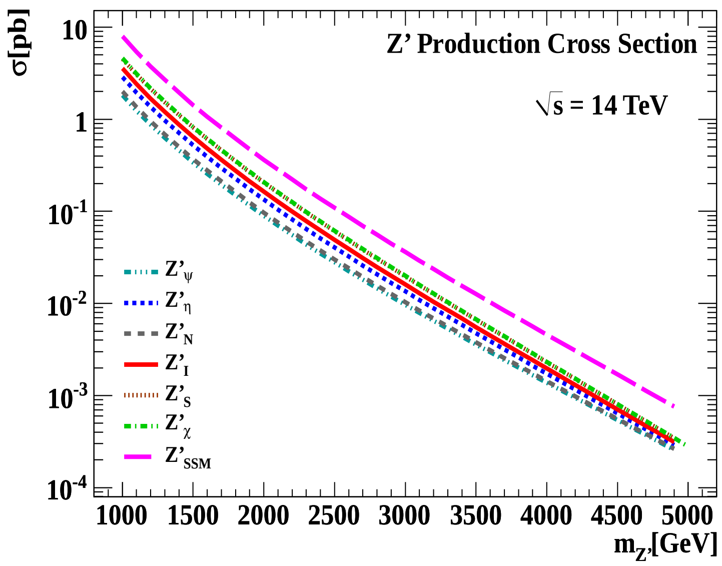


Production cross sections in pp collisions $q\bar{q} \rightarrow Z'$, LO pdf CTEQ6L









Expected event numbers (narrow width approximation):

$$\sigma(pp \to Z' \to f_1 f_2) \simeq \sigma(pp \to Z') \times \mathrm{BR}(Z' \to f_1 f_2)\ ;\ \mathrm{N} = \mathcal{L}\sigma$$

Cascade events: $\mathrm{N_{casc}} = \mathrm{N}(\tilde{\nu}\tilde{\nu}^*) + \mathrm{N}(\tilde{\chi}^+\tilde{\chi}^-) + \mathrm{N}(\tilde{\chi}^0\tilde{\chi}^0)$

Charged-slepton events: $\mathrm{N_{slep}} = \mathrm{N}(\tilde{\ell}^+\tilde{\ell}^-)$

$\sqrt{s} = 8$ TeV $\mathcal{L} = 20\ \mathrm{fb}^{-1}$

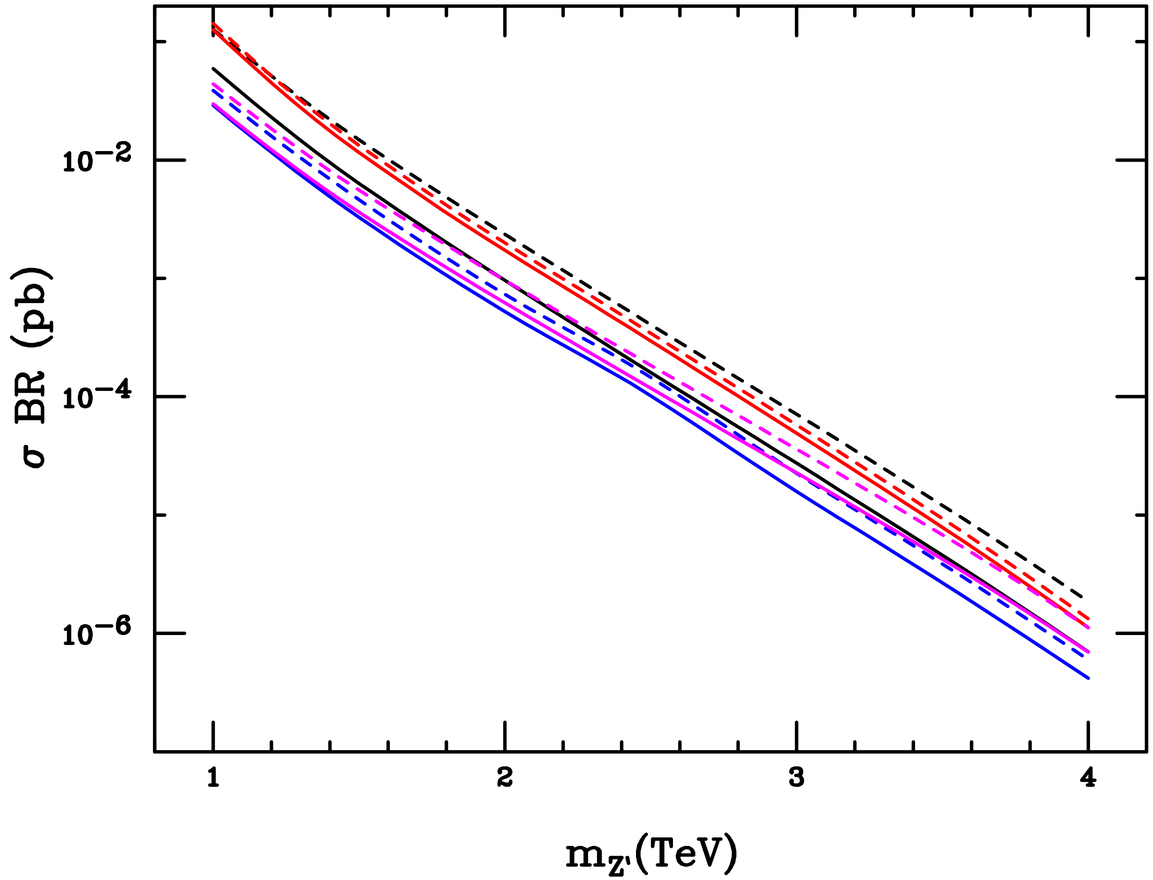
Model	$m_{Z'}$ (TeV)	$\mathrm{N_{casc}}$	$\mathrm{N_{slep}}$
Z'_η	1.5	523	–
Z'_η	2.0	55	–
Z'_ψ	1.5	599	36
Z'_ψ	2.0	73	4
Z'_N	1.5	400	17
Z'_N	2.0	70	3
Z'_I	1.5	317	–
Z'_I	2.0	50	–
Z'_S	1.5	30	–
Z'_S	2.0	46	–
Z'_SSM	1.5	2968	95
Z'_SSM	2.0	462	14

$\sqrt{s} = 14$ TeV $\mathcal{L} = 100\ \mathrm{fb}^{-1}$

Model	$m_{Z'}$ (TeV)	$\mathrm{N_{casc}}$	$\mathrm{N_{slep}}$
Z'_η	1.5	13650	–
Z'_η	2.0	2344	–
Z'_ψ	1.5	10241	622
Z'_ψ	2.0	2784	162
Z'_N	1.5	9979	414
Z'_N	2.0	2705	104
Z'_I	1.5	8507	–
Z'_I	2.0	2230	–
Z'_S	1.5	8242	65
Z'_S	2.0	2146	16
Z'_SSM	1.5	775715	24774
Z'_SSM	2.0	19570	606

Impact of BSM decays on the $\sigma\mathrm{BR}$ product

G.C., arXiv:1207.5424, Proceedings of Blois2012

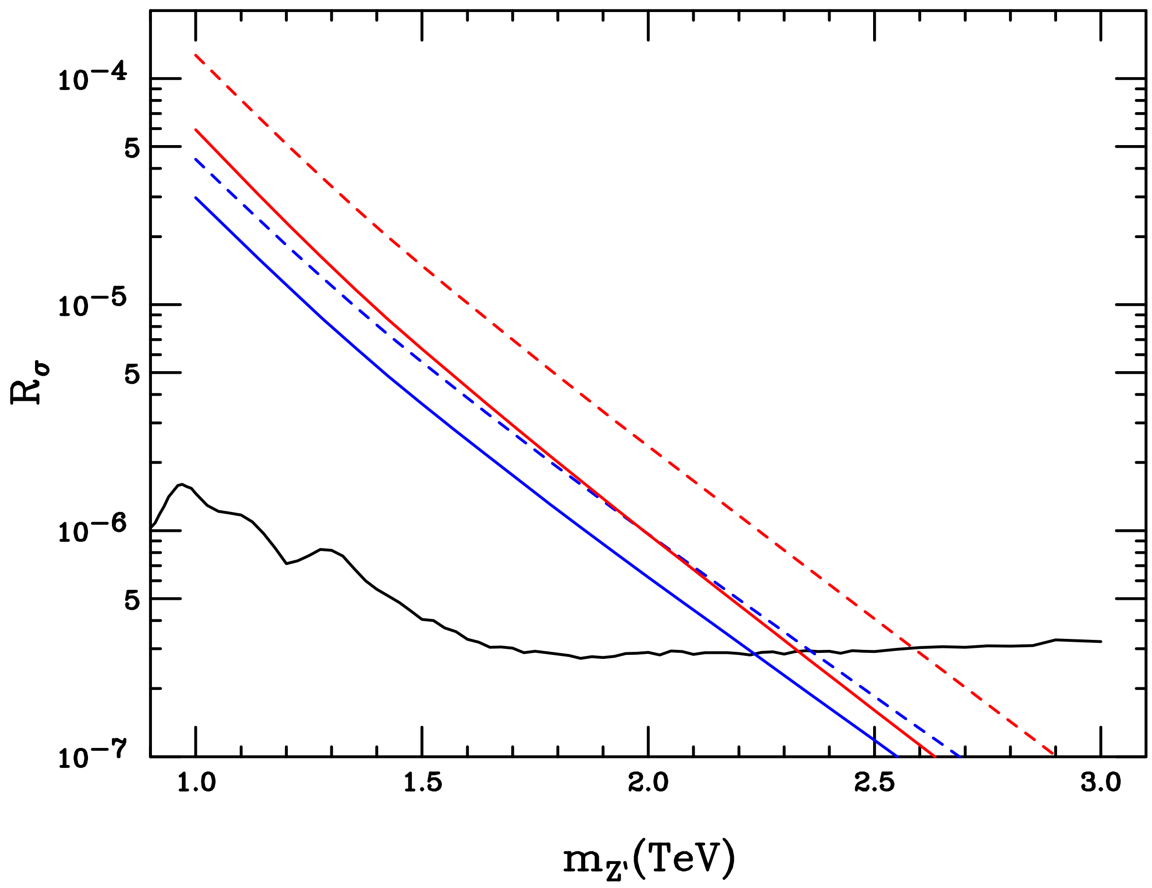


Solid: SM+BSM decays ; Dashes: only SM decays

Black: Z'_{SSM}; Blue: Z'_{η}; Red: Z'_{I}; Magenta: Z'_{ψ}

Impact of inclusion of SUSY decays: Z'_{SSM} 60%; Z'_{η}: 30% ; Z'_{I}: 13% ; Z'_{ψ}: 40%

Preliminary results on mass exclusion limit in the SUSY reference point:



Solid: SM+BSM decays ; Dashes: only SM decays

Black: CMS 95% C.L. limit; Red: $Z'_{\rm SSM}$; Blue: Z'_ψ

Excluded-mass shift: $Z'_{\rm SSM}$: $\Delta m \simeq 300$ GeV ; Z'_ψ: $\Delta m \simeq 100$ MeV

Product acceptance × efficiency for a spin-1 particle (CMS)