On the sparticle spectrum in gaugino-gauge mediation

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Based on arXiv:1009.1714, 1011.1664 with Amit Giveon

Introduction: Gauge Mediation

The SUSY breakdown is transmitted to known particles by interactions of the SM $SU(3) \times SU(2) \times U(1)$ gauge boson and their superpartners. It is assumed that some chiral superfields in the hidden sector (the "**messengers**") have non-vanishing SM gauge quantum numbers (there should not be too many messenger in order to avoid the Landau-pole problem)

This kind of coupling is flavor blind, and so solves automatically the flavor problem

An extra mechanism is needed to generate $(\mu, B\,\mu)$, and it is not so straightfoward to generate both μ and B of the same order, and also of the same order of $m^2_{H_{u,d}}$ (μ problem)

Minimal Gauge Mediation

In the minimal scenario we can think of just one messenger pair $T, \tilde{T}$ (for example in the $5 + \bar{5}$ of $SU(5)_{\rm GUT}$), which couples to the SUSY breaking spurion S with the superpotential:

$$S T \tilde{T} \, .$$

The field S breaks SUSY via an F-term:

$$S = M + \theta^2 F \, .$$

The bosonic components of the messenger superfield get a mass

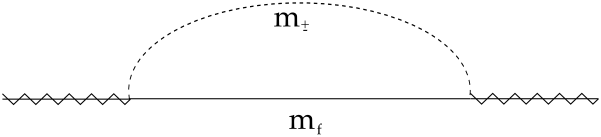
$$m_{\pm} = \sqrt{M^2 \pm F} \, ,$$

while the fermionic component has mass

$$m_f = M \, .$$

Gaugino masses in MGM

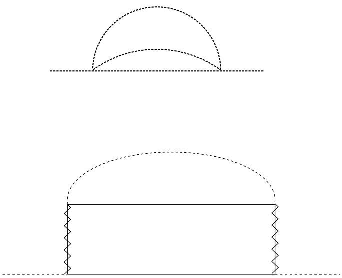
They are generated at one loop :

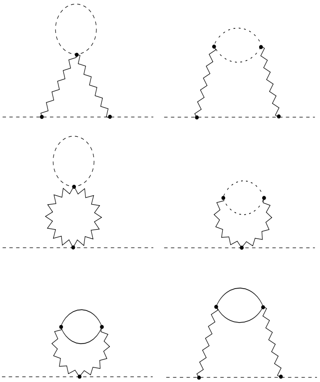


$$g^2 \int \frac{d^4k}{(2\pi)^4} \left(\frac{1}{k^2 - M^2 - F} - \frac{1}{k^2 - M^2 + F} \right) \frac{\not{k} + M}{k^2 - M^2} \approx \frac{\alpha}{4\pi} \frac{F}{M} \, ,$$

Sfermion masses^2 in MGM

They are generated at two-loops :





Result of the calculation in MGM

n_r: Dynkin index messengers. $C_r^{\tilde{f}}$: quadratic Casimir of MSSM sfermion

$$m_{\tilde{g}_r} = \frac{\alpha_r}{4\pi}\frac{F}{M} n_r\, q(x)\,, \qquad x = F/M^2\,,$$

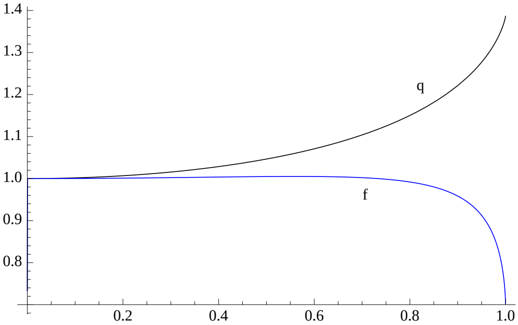
$$q(x) = \frac{1}{x^2}\left((1+x)\log(1+x) + (1-x)\log(1-x)\right)\,.$$

$$m^2_{\tilde{f}} = 2\left(\frac{F}{M}\right)^2 \sum_r \left(\frac{\alpha_r}{4\pi}\right)^2 C_r^{\tilde{f}} n_r f(x)\,,$$

$$f(x) = (1+x)\left(\log(1+x) - 2\mathrm{Li}_2\left(\frac{x}{1+x}\right) + \frac{1}{2}\mathrm{Li}_2\left(\frac{2x}{1+x}\right)\right) + (x \to -x)$$

S. Dimopoulos, G. F. Giudice and A. Pomarol, hep-ph/9607225.
S. P. Martin, hep-ph/9608224.

Plot for MGM



The functions $q(x)$ and $f(x)$ which give the gaugino masses and the sfermion masses^2 in MGM. $x = F/M^2$.

A more general messenger sector

Several messengers $(T_i, \tilde{T}_j)$, and a more general superpotential:

$$W = (S\lambda_{ij} + m_{ij})T_i\tilde{T}_j ,$$

where we take a basis in which m_{ij} is diagonal and λ_{ij} is real and symmetric (we can do this if messenger parity and CP invariance is assumed). In the $F << m_i^2$ limit:

$$m_{\tilde{g}} \propto \frac{g^2}{8\pi^2} F \frac{\partial}{\partial S} \log\det(\lambda S + m) = \frac{g^2}{8\pi^2} F \sum_i \frac{\lambda_{ii}}{m_i} ,$$

$$m_{\tilde{f}}^2 \propto \frac{g^4 Y^2 F^2}{64\pi^4} \sum_i \left(\frac{\lambda_{ii}^2}{m_i^2} + \sum_{j\neq i} \frac{\lambda_{ij}^2}{m_i^2 - m_j^2} \log \frac{m_i^2}{m_j^2} \right) .$$

C. Cheung, A. L. Fitzpatrick, D. Shih, 0710.3585 ; T. T. Dumitrescu, Z. Komargodski, N. Seiberg, D. Shih, 1003.2661

Very heavy sfermions in Direct Gauge Mediation

In models of Direct Gauge Mediation, the messengers are a part of the SUSY breaking sector

The SUSY breaking sector can be described by an O'Raifeartaigh model; then there always exist tree-level flat directions emanating from any local SUSY breaking vacuum, which is stabilized by the Coleman-Weinberg one loop potential

If the pseudo-moduli space is locally stable everywhere, then the gaugino masses are zero at the leading order in SUSY breaking:

$$m_{\tilde{g}} \propto F \frac{\partial}{\partial S} \log \det(\lambda S + m) = 0$$

Need for an "**Uplifted Vacuum**" if one wants to consider Direct Gauge Mediation and avoid an hierarchy between gaugino and sfermions masses (with consequent fine tuning due to very heavy sfermions)

Z. Komargodski, D. Shih, 0902.0030

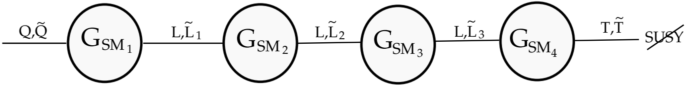
Gaugino Mediation

It is then interesting to study mechanisms that suppress sfermion masses compared to gaugino masses in gauge mediation, such as

Gaugino Mediation

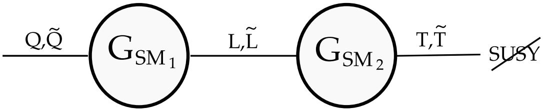
GM was introduced in the context of extra dimensions

Deconstruction suggests how to implement gaugino mediation in a 4-dimensional theory:



H. C. Cheng, D. E. Kaplan, M. Schmaltz and W. Skiba, hep-ph/0106098;
C. Csaki, J. Erlich, C. Grojean and G. D. Kribs, hep-ph/0106044.

Minimal gaugino-gauge mediation



We will consider the shortest non-trivial quiver (1 link field $(L, \tilde{L})$)
The messengers $T, \tilde{T}$ are coupled to the SUSY breaking spurion as in MGM

$$W = ST\tilde{T} + K(L\tilde{L} - v^2)$$

Higgsing by the link field

The following combination of the two gauge groups gets a mass:

$$2v^2(g_1^2+g_2^2)\ \left(\frac{g_1 A_\mu^1 - g_2 A_\mu^2}{\sqrt{g_1^2+g_2^2}}\right)^2$$

The corresponding gaugino mixes with the link fermion to form a Dirac fermion:

$$v\sqrt{2}(g_1\lambda_1 - g_2\lambda_2)(\psi_L - \psi_{\tilde{L}})$$

The gauge boson and the gaugino :

$$\frac{g_2 A_\mu^1 + g_1 A_\mu^2}{\sqrt{g_1^2+g_2^2}}\,, \qquad \lambda_A = i\,\frac{g_2\lambda_1 + g_1\lambda_2}{\sqrt{g_1^2+g_2^2}}\,,$$

stay massless at tree-level.

Soft masses

The gaugino masses are the same as in MGM (at one loop, with effective coupling g_e):

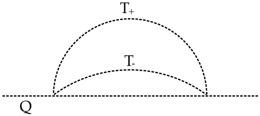
$$\frac{1}{g_e^2} = \frac{1}{g_1^2} + \frac{1}{g_2^2}\,.$$

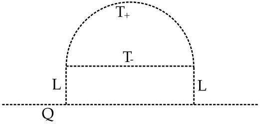
The link field gets a VEV v; in the limit $v >> M$ (where M is the messenger mass), MGM sfermion masses are recovered

The gaugino mediation limit corresponds to $v << M$, where sfermion masses are suppressed

We computed the 2-loops expression for the sfermion masses; for $v << M$ this vanishes and the leading contribution is at 3-loops (this limit was studied in A. De Simone, J. Fan, M. Schmaltz and W. Skiba, 0808.2052)

Scalar contribution



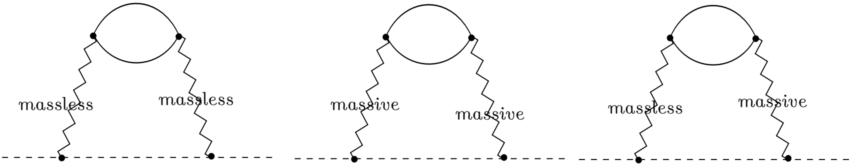


$$-2\int \frac{d^4p}{(2\pi)^4}\frac{d^4k}{(2\pi)^4}\frac{1}{(k-p)^2-m_+^2}\frac{1}{p^2-m_-^2}\frac{1}{k^2}\left(\frac{4g_1^2g_2^2v^2}{k^2-m_v^2}\right)^2$$

$$=\int \frac{d^4p}{(2\pi)^4}\frac{d^4k}{(2\pi)^4}\,(\text{MGM integrand})\,f\ ,$$

$$\text{where}\, f(k^2,m_v^2)\equiv\left(\frac{m_v^2}{k^2-m_v^2}\right)^2\ , \qquad m_v=2v\sqrt{g_1^2+g_2^2}$$

Vector and gaugino contribution



$$\int \frac{d^4p}{(2\pi)^4}\frac{d^4k}{(2\pi)^4}\,(\mathrm{MGM\,integrand})\left(1+\frac{(k^2)^2}{(k^2-m_v^2)^2}-\frac{2k^2}{(k^2-m_v^2)}\right)\,.$$

$$=\int \frac{d^4p}{(2\pi)^4}\frac{d^4k}{(2\pi)^4}\,(\mathrm{MGM\,integrand})\,f\;,$$

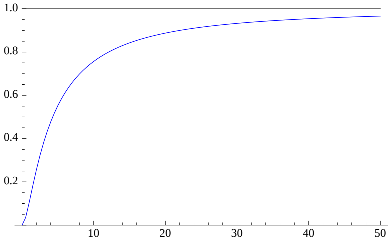
Similarly it happens for the gaugino contribution.
The same results were obtained by M. McGarrie, 1009.0012, using the deconstruction formalism

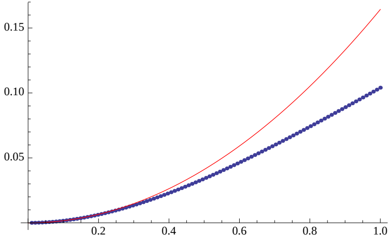
Sfermion masses[2]

$$x = \frac{F}{M^2}\,, \qquad y = \frac{m_v}{M}\,, \qquad m_v = 2v\sqrt{g_1^2 + g_2^2}\,, \qquad \frac{1}{g_e^2} = \frac{1}{g_1^2} + \frac{1}{g_2^2}\,.$$

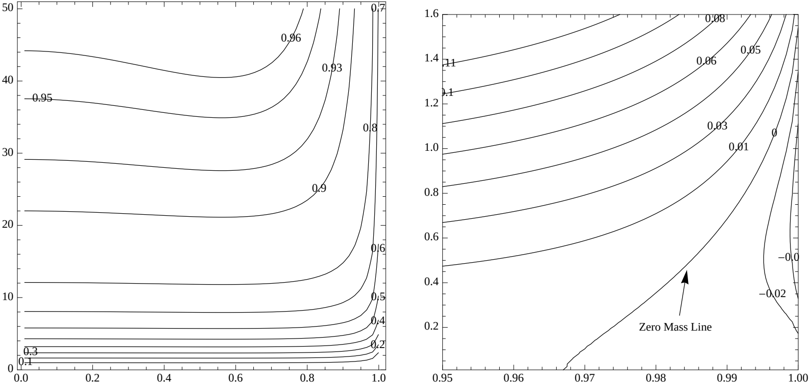
$$m_{\tilde{f}}^2 = 4\left(\frac{F}{M}\right)^2 \left(\frac{\alpha_e}{4\pi}\right)^2 s(x,y)\,,$$

Some plots of $s(x,y)$ as a function of y for fixed $x << 1$ (blue); in red quadratic fit for $y << 1$:





Sfermion masses^2, contour plot



Sfermion masses^2 function s in the (x, y) plane,

$$\left(x = \frac{F}{M^2}\ ,\ y = \frac{m_v}{M}\right).$$

Sfermion masses^2, analytical expression

$$s(x,y) = \frac{1}{2x^2}\left(s_0 + \frac{s_1+s_2}{y^2} + s_3 + s_4 + s_5\right) + (x \to -x)\,,$$

$$s_0 = 2(1+x)\left(\log(1+x) - 2\mathrm{Li}_2\left(\frac{x}{1+x}\right) + \frac{1}{2}\mathrm{Li}_2\left(\frac{2x}{1+x}\right)\right)\,,$$

$$s_1 = -4x^2 - 2x(1+x)\log^2(1+x) - x^2\,\mathrm{Li}_2(x^2)\,,$$

$$s_2 = 8\,(1+x)^2\,h\left(\frac{y^2}{1+x},1\right) - 4x\,(1+x)\,h\left(\frac{y^2}{1+x},\frac{1}{1+x}\right) - 4xh\left(y^2,1+x\right) - 8h\left(y^2,1\right)\,,$$

$$s_3 = -2h\left(\frac{1}{y^2},\frac{1}{y^2}\right) - 2x\,h\left(\frac{1+x}{y^2},\frac{1}{y^2}\right) + 2(1+x)h\left(\frac{1+x}{y^2},\frac{1+x}{y^2}\right)\,,$$

$$s_4 = (1+x)\left(2h\left(\frac{y^2}{1+x},\frac{1}{1+x}\right) - h\left(\frac{y^2}{1+x},1\right) - h\left(\frac{y^2}{1+x},\frac{1-x}{1+x}\right)\right)\,,$$

$$s_5 = 2h\left(y^2,1+x\right) - 2h\left(y^2,1\right)\,.$$

$$h(a,b) = \int_0^1 dx\left(1 + \mathrm{Li}_2(1-\mu^2) - \frac{\mu^2}{1-\mu^2}\log\mu^2\right)\,, \qquad \mu^2 = \frac{ax+b(1-x)}{x(1-x)}\,.$$

From the Soft Masses to the physical MSSM spectrum

Now one has to solve the MSSM RG equations up to the elecroweak scale, and then diagonalize the mass matrices for each class of MSSM particle; there exists several programs that can do this, for example SOFTSUSY

We choose v in such a way that $y_0 = 1$, in order to keep the massive vectors decoupled from the RG MSSM equations; also for very low v we cannot neglect the 3-loops contributions, which are more difficult to compute

This is a hybrid regime (where $v \approx M$) between MGM and gaugino mediation

NLSP

The lightest SUSY particle in Gauge Mediation is the gravitino,

$$m_{3/2} = \frac{F}{k\sqrt{3}M_P} \qquad \text{where} \qquad k = F/F_0 < 1\,.$$

Assuming R-parity conservation we expect that all SUSY particle will promptly decay into cascades leading to the NLSP; the nature of the NLSP then determines the nature of the signatures in collider experiments

In MGM the NLSP can be a bino or a stau (for 1 messenger it is usually a bino).

In the hybrid regime $y \approx 1$ the NLSP is a stau almost everywhere in the parameter space already for one messenger (except for high messenger scale, low $\tan\beta$)

MSSM spectrum examples, 1 pair of messengers

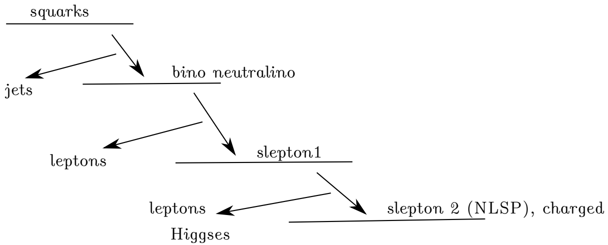
$N_{\rm mess} = 1$, $\tan\beta = 20$, $\alpha_{g_2}^{-1} = 10$	$M = 2.4 \times 10^5$, $\Lambda = 0.99M$, $v = 9.6 \times 10^4$	$M = 10^8$, $\Lambda = 2.1 \times 10^5$, $v = 3.9 \times 10^7$	$M = 10^{15}$, $\Lambda = 1.5 \times 10^5$, $v = 3.7 \times 10^{14}$
(y_1, y_2, y_3)	(1, 1.10, 1.66)	(1, 1.10, 1.39)	(1, 1.03, 1.05)
$(s(1), s(2), s(3))$	(0.02, 0.03, 0.09)	(0.10, 0.12, 0.16)	(0.10, 0.11, 0.11)
(M_1, M_2, M_3)	(497, 862, 1808)	(372, 589, 999)	(430, 472, 497)
(m_Q, m_u, m_d)	(665, 652, 651)	(707, 668, 663)	(332, 289, 275)
(m_L, m_e)	(140, 59)	(257, 131)	(205, 152)
$(\mu, B\mu)$	$(534, 736^2)$	$(661, 598^2)$	$(610, -176^2)$
$m_{\tilde{g}}$	2131	1475	1089
$m_{\tilde{\chi}^0}$	(425, 526, 528, 845)	(281, 520, 637, 666)	(198, 375, 606, 618)
$m_{\tilde{\chi}^\pm}$	(516, 845)	(520, 665)	(375, 618)
$(m_{\tilde{u}_L}, m_{\tilde{d}_L})$	(1405, 1407)	(1298, 1300)	(1027, 1030)
$(m_{\tilde{u}_R}, m_{\tilde{d}_R})$	(1380, 1380)	(1258, 1256)	(981, 975)
$(m_{\tilde{t}_1}, m_{\tilde{t}_2})$	(1280, 1383)	(1102, 1251)	(781, 978)
$(m_{\tilde{b}_1}, m_{\tilde{b}_2})$	(1354, 1377)	(1218, 1249)	(929, 965)
$(m_{\tilde{e}_R}, m_{\tilde{e}_L}, m_{\tilde{\nu}_e})$	(129, 302, 292)	(174, 363, 354)	(223, 368, 359)
$(m_{\tilde{\tau}_1}, m_{\tilde{\tau}_2}, m_{\tilde{\nu}_\tau})$	(106, 309, 291)	(150, 368, 352)	(197, 371, 355)
m_{h_0}	116	116	116
$(m_{H_0}, m_{A_0}, m_{H_\pm})$	(566, 566, 572)	(689, 689, 694)	(660, 660, 666)
$(\mu, B\mu)$	$(519, 641^2)$	$(631, 735^2)$	$(600, 687^2)$

MSSM spectrum examples, 5 pairs of messengers

$N_{\rm mess} = 5$ $\tan\beta = 20$ $\alpha_{g_2}^{-1} = 10$	$M = 7.0 \times 10^4$ $\Lambda = 0.99M$ $v = 2.8 \times 10^4$	$M = 10^8$ $\Lambda = 5 \times 10^4$ $v = 3.9 \times 10^7$	$M = 10^{15}$ $\Lambda = 3.4 \times 10^4$ $v = 3.6 \times 10^{14}$
(y_1, y_2, y_3) $(s(1), s(2), s(3))$	$(1, 1.10, 1.73)$ $(0.02, 0.03, 0.10)$	$(1, 1.10, 1.39)$ $(0.10, 0.12, 0.16)$	$(1, 1.03, 1.05)$ $(0.10, 0.11, 0.11)$
(M_1, M_2, M_3) (m_Q, m_u, m_d) (m_L, m_e) $(\mu, B\mu)$	$(706, 1240, 2709)$ $(462, 454, 453)$ $(90, 38)$ $(496, 812^2)$	$(443, 700, 1185)$ $(374, 353, 351)$ $(137, 70)$ $(647, 576^2)$	$(487, 534, 562)$ $(168, 146, 139)$ $(104, 77)$ $(655, -204^2)$
$m_{\tilde{g}}$	3005	1705	1212
$m_{\tilde{\chi}^0}$	$(481, 495, 645, 1212)$	$(334, 578, 626, 696)$	$(225, 424, 650, 664)$
$m_{\tilde{\chi}^\pm}$	$(490, 1212)$	$(578, 695)$	$(424, 664)$
$(m_{\tilde{u}_L}, m_{\tilde{d}_L})$ $(m_{\tilde{u}_R}, m_{\tilde{d}_R})$ $(m_{\tilde{t}_1}, m_{\tilde{t}_2})$ $(m_{\tilde{b}_1}, m_{\tilde{b}_2})$	$(1577, 1579)$ $(1548, 1548)$ $(1459, 1558)$ $(1530, 1546)$	$(1325, 1327)$ $(1294, 1293)$ $(1145, 1291)$ $(1253, 1285)$	$(1102, 1105)$ $(1060, 1057)$ $(855, 1052)$ $(1004, 1045)$
$(m_{\tilde{e}_R}, m_{\tilde{e}_L}, m_{\tilde{\nu}_e})$ $(m_{\tilde{\tau}_1}, m_{\tilde{\tau}_2}, m_{\tilde{\nu}_\tau})$	$(144, 345, 335)$ $(129, 348, 334)$	$(149, 333, 323)$ $(122, 339, 321)$	$(200, 360, 351)$ $(171, 364, 347)$
m_{h_0} $(m_{H_0}, m_{A_0}, m_{H_\pm})$	116 $(560, 560, 566)$	116 $(663, 663, 668)$	116 $(693, 693, 698)$
$(\mu, B\mu)$	$(485, 652^2)$	$(618, 717^2)$	$(645, 723^2)$

Leptogenic SUSY spectra

In the low-scale mediation regime, both the right handed as well as the left-handed sleptons are lighter than the bino; this leads to cascade scenarios with copious leptons production.



A. De Simone, J. Fan, V. Sanz, W. Skiba 0903.5305.

Slepton co-NLSP

Since the the right-handed slepton masses originate from a flavor universal boundary condition, the right handed selecton and smuon are always nearly degenerate; the lightest stau $\tilde{\tau}_1$ is always the lightest right-handed slepton, because of RG running and left-right mixing.

For sufficiently small $\tan\beta$ (for example, $\tan\beta = 8$), the model has Slepton co-NLSP: the first two generations of sleptons dominantly decay to a lepton and a gravitino instead than to $\tilde{\tau}_1$

$$\delta m_{\tilde{l}_R} = m_{\tilde{e}_R} - m_{\tilde{\tau}_R} \lesssim 5 - 10\,\mathrm{GeV}\,,$$

Multilepton final states, J. T. Ruderman and D. Shih, 1009.1665.

A messenger sector from a dynamical model

"Direct gaugino mediation", D. Green, A. Katz, Z. Komargodski, arXiv:1008.2215

The messenger sector is as follows :

$$W = (S\lambda_{ij}+m_{ij})T_i\tilde{T}_j\,,\qquad m_{ij} = \begin{pmatrix} M & m \\ m & 0 \end{pmatrix},\qquad \lambda_{ij} = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}.$$

The gaugino masses are vanishing at the leading order in F/M (so in principle the sfermions are very heavy compared to gauginos)

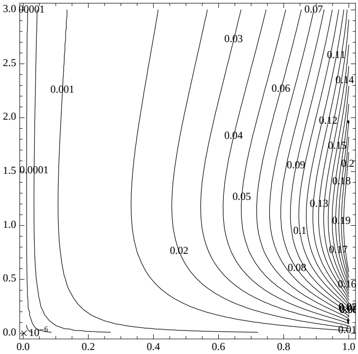
What is the effect of the sfermion mass suppression ?

We can again insert the same momentum dependent factor in the sfermion masses integral (M. Sudano, 1009.2086).

Gaugino masses

$$x = \frac{F}{m^2}\,, \qquad y_i = \frac{m_{v_i}}{m}\,, \qquad z = \frac{M}{m}\,,$$

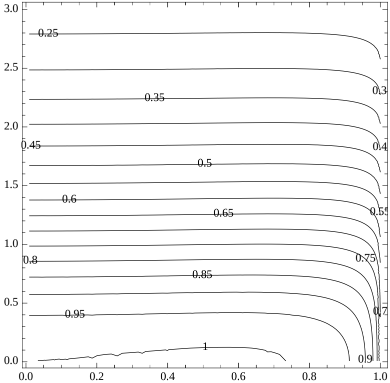
$$M_a = \frac{\alpha_a}{4\pi}\frac{F}{m} n_a \mathcal{G}(x,z)\,, \qquad \text{where } \mathcal{G}(x,z)\ :$$

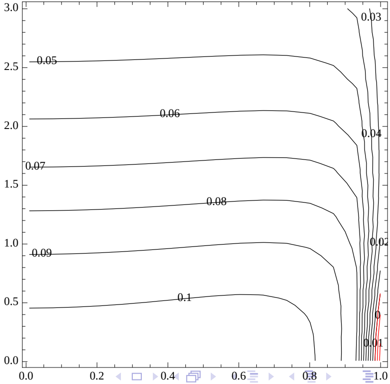


Sfermion masses

$$m_{\tilde{f}}^2 = 2\left(\frac{F}{m}\right)^2 \sum_a \left(\frac{\alpha_a}{4\pi}\right)^2 C_a n_a \mathcal{F}(x, y_i, z)\,.$$

Left: $\mathcal{F}(x,z)$ for $y \to \infty$; Right: $\mathcal{F}(x,z)$ for $y \to 1$;





MSSM spectrum example

$$x = F/M^2 = 0.8\,, \qquad y_i = m_{v_i}/M \approx 0.5\,, \qquad m = M$$

$N_{\rm mess} = 1$ $\tan\,\beta = 20$ $\alpha_{g_2}^{-1} = 5$	$M = m = 9 \times 10^5$ $\Lambda = 7.210^5$ $v = 1.8 \times 10^5$
$(s(1), s(2), s(3))$	$(0.03, 0.03, 0.04)$
(M_1, M_2, M_3) (m_Q, m_u, m_d) (m_L, m_e) $(\mu, B\mu)$	$(92, 162, 347)$ $(1411, 1353, 1348)$ $(434, 201)$ $(586, 705^2)$
$m_{\tilde{g}}$	520
$m_{\tilde{\chi}_0}$	$(80, 159, 579, 585)$
$m_{\tilde{\chi}_\pm}$	$(159, 586)$
$(m_{\tilde{u}_L}, m_{\tilde{d}_L})$ $(m_{\tilde{u}_R}, m_{\tilde{d}_R})$ $(m_{\tilde{t}_1}, m_{\tilde{t}_2})$ $(m_{\tilde{b}_1}, m_{\tilde{b}_2})$	$(1438, 1440)$ $(1379, 1374)$ $(1253, 1377)$ $(1354, 1377)$
$(m_{\tilde{e}_R}, m_{\tilde{e}_L}, m_{\tilde{\nu}_e})$ $(m_{\tilde{\tau}_1}, m_{\tilde{\tau}_2}, m_{\tilde{\nu}_\tau})$	$(215, 437, 429)$ $(202, 438, 428)$
m_{h_0} $(m_{H_0}, m_{A_0}, m_{H_\pm})$	115 $(679, 679, 684)$
$m_{\rm messengers}/M$	$(0.31, 0.62, 0.75, 1.45, 1.62, 1.80)$

(work in progress with Tomer Shacham)

More general quiver structure

Gaugino/gauge mediation can be studied on more general quiver structures (in the case of linear quiver, with equal gauge couplings, see McGarrie, 1009.0012)

A general two-loop formula for the momentum dependent factor in the sfermion mass formula can be written (valid for arbitrary quiver, general gauge couplings)

Let us consider sfermion charges under the r-th gauge group, while messengers charged under s-th; then

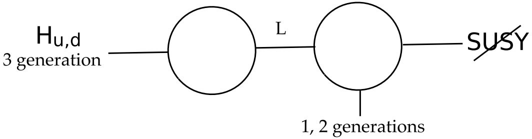
$$f_{r,s}(k^2) = \frac{1}{g_e^4} \sum_{i,j} \frac{p^2}{p^2 - m_{v_i}^2} \frac{p^2}{p^2 - m_{v_j}^2} g_r^2 g_s^2 U_{r,i}^\dagger U_{i,s} U_{s,j}^\dagger U_{j,r} \, ,$$

where m_{v_i} are the vector masses and U is the matrix which diagonalizes the vector mass matrix.

A model with Effective Supersymmetry

"Effective supersymmetry": the third generation sfermions are light ($\mathcal{O}(\mathrm{TeV})$), while the first and second are considerably heavier.

This can be realized if we make the standard model generations charged under different nodes of the quiver (such as in N. Craig, D. Green, A. Katz, 1103.3708):



We can apply our general formula:

$$f_{3\mathrm{gen}}(p^2) = \frac{m_v^4}{(p^2 - m_v^2)^2}\,, \qquad f_{1,2\mathrm{gen}}(p^2) = \left(\frac{p^2(g_2^2/g_e^2) - m_v^2}{p^2 - m_v^2}\right)^2 .$$

MSSM spectrum example

$N_{\text{mess}} = 1$ $\tan\ \beta = 20$	$M = 2.8 \times 10^5$ $\Lambda = 0.99M$	$M = 10^8$ $\Lambda = 2.3 \times 10^5$	$M = 10^{15}$ $\Lambda = 1.7 \times 10^5$
α_2^{-1} (y_1, y_2, y_3) $(r(1), r(2), r(3))$ $(s(1), s(2), s(3))$	7 (1., 1.06, 1.29) (34.83, 11.82, 2.83) (0.02, 0.03, 0.05)	6 (1., 1.05, 1.16) (39.88, 16.21, 5.82) (0.1, 0.11, 0.13)	5 (1., 1.01, 1.02) (22.46, 18.72, 16.91) (0.1, 0.11, 0.11)
(M_1, M_2, M_3) $(m_Q, m_u, m_d)_{1,2},$ $(m_Q, m_u, m_d)_3$ $(m_L, m_e)_{1,2}$ $(m_L, m_e)_3$ $(\mu, B\mu)$	(577, 994, 2058) (5228, 4572, 4284) (573, 555, 553) (3395, 2764) (152, 69) $(550, 768^2)$	(404, 637, 1076) (5298, 4633, 4343) (682, 637, 632) (3437, 2793) (270, 143) $(643, 522^2)$	(481, 528, 556) (4683, 4087, 3824) (365, 317, 302) (3063, 2499) (227, 170) $(592, -476^2)$
$m_{\tilde{g}}$	2625	1709	1296
$m_{\tilde{\chi}^0}$	(491, 542, 558, 1000)	(312, 557, 617, 674)	(228, 426, 577, 598)
$m_{\tilde{\chi}^\pm}$	(534, 999)	(556, 673)	(426, 598)
$(m_{\tilde{u}_L}, m_{\tilde{d}_L})$ $(m_{\tilde{u}_R}, m_{\tilde{d}_R})$ $(m_{\tilde{t}_1}, m_{\tilde{t}_2})$ $(m_{\tilde{b}_1}, m_{\tilde{b}_2})$	(5408, 5408) (4759, 4482) (1297, 1407) (1376, 1400)	(5415, 5415) (4747, 4459) (978, 1132) (1091, 1129)	(4771, 4771) (4172, 3909) (565, 786) (708, 771)
$(m_{\tilde{e}_R}, m_{\tilde{e}_L}, m_{\tilde{\nu}_e})$ $(m_{\tilde{\tau}_1}, m_{\tilde{\tau}_2}, m_{\tilde{\nu}_\tau})$	(2768, 3409, 3408) (124, 315, 297)	(2796, 3446, 3445) (131, 325, 305)	(2500, 3070, 3069) (120, 267, 236)
m_{h_0} $(m_{H_0}, m_{A_0}, m_{H_\pm})$	117 (580, 580, 585)	117 (650, 649, 655)	118 (582, 582, 588)
$(\mu, B\mu)$	$(533, 656^2)$	$(610, 692^2)$	$(572, 600^2)$

Conclusions

Already in the hybrid regime, minimal gaugino-gauge mediation leads to an effective sfermion mass suppression compared to Minimal Gauge Mediation. Leptogenic SUSY in the low-scale mediation regime.

Gauginos and sfermion masses can be comparable even if gaugino masses vanish at leading order in SUSY breaking. In this case, neutralino NLSP and light gluino.

Effective supersymmetry can be realized in models where different generation are coupled to different nodes of the quiver. There are important constraints from FCNC that should be inspected carefully (work in progress with Bjarke Gudnason).