Anomaly and gaugino mediation

“Supergravity” mediation

X is in the hidden sector, M_{Pl} suppressed couplings

$$
\begin{aligned}
W &= W_{\rm hid}(X) + W_{\rm vis}(\psi) \\
f &= \left(\delta^i_j - \tfrac{c^i_j}{M^2_{\rm Pl}} X^\dagger X\right) \psi^{j\dagger} e^V \psi_i + \ldots \\
\tau &= \tfrac{\theta_{\rm YM}}{2\pi} + i\,\tfrac{4\pi}{g^2} + i\,\tfrac{k}{M_{\rm Pl}} X + \ldots
\end{aligned}
$$

SUSY breaking VEV

$$\langle X \rangle = M + \mathcal{F}_X \theta^2 \ ,$$

induced squark and gluino masses:

$$(M^2_q)^i_j = c^i_j \tfrac{\mathcal{F}^2_X}{M^2_{\rm Pl}} \ , \ \ M_\lambda = k\,\tfrac{\mathcal{F}_X}{M_{\rm Pl}}$$

no reason for the c^i_j to respect flavor symmetries $\Rightarrow$ FCNCs

Naive Expectation

Kähler function might have flavor-blind form:

$$K = X^\dagger X + \psi^{i\dagger} e^V \psi_i$$

$\Rightarrow$

$$f = -3 + \frac{1}{M_{\rm Pl}^2}\left[X^\dagger X + \left(1 + \frac{X^\dagger X}{M_{\rm Pl}^2}\right)\psi^{i\dagger} e^V \psi_i + \ldots\right]$$

interactions are flavor-blind but there are direct interactions induced by Planck scale (string) states which have been integrated out

these interactions should not be flavor-blind

they must generate Yukawa couplings

Extra Dimensions

SUSY breaking sector separated by a distance r from the MSSM
two sectors on different 3-branes embedded in the higher dimensional theory Interactions suppressed by

$$e^{-Mr}$$

where M is the higher dimensional Planck/string scale
If only supergravity states propagate in bulk
then setting $e^a_\mu = 0$ and $\Sigma = M$ must decouple the two sectors
Lagrangian must have the form

$$\begin{aligned} W &= W_{\rm hid} + W_{\rm vis} \\ f &= c + f_{\rm hid} + f_{\rm vis} \\ \tau W_\alpha^2 &= \tau_{\rm hid} W^2_{\alpha^2 {\rm hid}} + \tau_{\rm vis} W^2_{\alpha {\rm vis}} \end{aligned}$$

all interactions between the two sectors due to supergravity
form of f implies a Kähler function of the form

$$K = -3M_{\rm Pl}^2 \ln\left(1 - \frac{f_{\rm hid} + f_{\rm vis}}{3M_{\rm Pl}^2}\right)$$

Integrate out Hidden Sector

dropping Planck suppressed interactions in effective theory:

$$\begin{aligned}\mathcal{L}_{\text{eff}} = \int d^4\theta \psi^\dagger e^V \psi \tfrac{\Sigma^\dagger\Sigma}{M^2} + \int d^2\theta \tfrac{\Sigma^3}{M^3}(m_0\psi^2 + y\psi^3) \\ -\tfrac{i}{16\pi}\int d^2\theta \tau W^\alpha W_\alpha + h.c.\end{aligned}$$

where the conformal weights of the fields determine the R-charges to be

$$R[\Sigma] = \tfrac{2}{3},\ \ R[\psi] = 0$$

only trace of the hidden sector is in compensator field Σ, rescale

$$\tfrac{\Sigma\psi}{M} \to \psi\ , R[\psi] = \tfrac{2}{3}$$

$$\begin{aligned}\mathcal{L}_{\text{eff}} \quad &= \quad \int d^4\theta \psi^\dagger e^V \psi + \int d^2\theta (\tfrac{\Sigma}{M} m_0\psi^2 + y\psi^3) \\ &\quad -\tfrac{i}{16\pi}\int d^2\theta \tau W^\alpha W_\alpha + h.c.\end{aligned}$$

If $m_0 = 0$, then the theory is classically scaleand conformally invariant
Σ decouples classically

Super-Weyl anomaly

quantum corrections break scale-invariance: couplings run
e.g. a two-point function has dependence on the cutoff Λ
$\Rightarrow$ dependence on Σ spurion of conformal symmetry:

$$G = \frac{1}{p^2}\, h\left(\frac{p^2 M^2}{\Lambda^2 \Sigma^\dagger \Sigma}\right)$$

h can only depend on the combination $\Lambda\Sigma/M$ and conjugate because of the classical conformal invariance
since Λ is real, only the combination $\Lambda^2\Sigma^\dagger\Sigma/M^2$ appears
effects of the scaling anomaly determined by β functions and γ

cutoff dependence only occurs in the Kähler function and τ

if we renormalize effective theory down to scale μ we must have:

$$\begin{aligned}
\mathcal{L}_{\rm eff} \quad &= \quad \int d^4\theta\, Z\left(\frac{\mu M}{\Lambda\Sigma}, \frac{\mu M}{\Lambda\Sigma^\dagger}\right) \psi^\dagger e^V \psi \\
& \quad\quad + \int d^2\theta\, y\psi^3 - \frac{i}{16\pi}\int d^2\theta\, \tau W^\alpha W_\alpha + h.c.
\end{aligned}$$

Compensator Dependence

Z is real and R-symmetry-invariant, must have

$$Z = Z\left(\frac{\mu M}{\Lambda|\Sigma|}\right)$$

where

$$|\Sigma| = \left(\Sigma^\dagger \Sigma\right)^{1/2}$$

for global SUSY, with $\Sigma = M_{\text{Pl}}$, axial symmetry is anomalous θ_{YM} shifts when the ψs are re-phased due to the chiral anomaly
in superconformal gravity, scale and axial anomalies vanish
Σ dynamical, re-phased $\Rightarrow$ shift in θ_{YM} is canceled
since τ is holomorphic we have

$$\tau = i\frac{\widetilde{b}}{2\pi}\ln\left(\frac{\mu M}{\Lambda\Sigma}\right)$$

μ dependence determines that $\widetilde{b} = b$

SUSY breaking: gaugino mass

SUSY breaking will be communicated to auxiliary supergravity fields:

$$\langle\Sigma\rangle = M + \mathcal{F}_\Sigma \theta^2$$

induces a θ^2 term in $\tau \Rightarrow$ gaugino mass:

$$M_\lambda \quad = \quad \frac{i}{2\tau}\frac{\partial\tau}{\partial\Sigma}\bigg|_{\Sigma=M}\mathcal{F}_\Sigma = \frac{bg^2}{16\pi^2}\frac{\mathcal{F}_\Sigma}{M} \ .$$

this SUSY breaking mass arises through the one-loop anomaly this mechanism is known as anomaly mediation

SUSY breaking

We can also Taylor expand Z in superspace:

$$Z = \left[Z - \frac{1}{2}\frac{\partial Z}{\partial \ln \mu}\left(\frac{\mathcal{F}_\Sigma}{M}\theta^2 + \frac{\mathcal{F}_\Sigma^\dagger}{M}\bar{\theta}^2\right) + \frac{1}{4}\frac{\partial^2 Z}{\partial (\ln \mu)^2}\frac{|\mathcal{F}_\Sigma|^2}{M^2}\theta^2\bar{\theta}^2 \right] \Big|_{\Sigma=M}$$

canonically normalize kinetic terms by rescaling:

$$\psi' = Z^{1/2}\left(1 - \frac{1}{2}\frac{\partial \ln Z}{\partial \ln \mu}\frac{\mathcal{F}_\Sigma}{M}\theta^2\right)\Big|_{\Sigma=M}\psi$$

Using

$$\gamma \equiv \frac{\partial \ln Z}{\partial \ln \mu}\ ,\ \beta_g \equiv \frac{\partial g}{\partial \ln \mu}\ ,\ \beta_y \equiv \frac{\partial y}{\partial \ln \mu}$$

we find

$$\begin{aligned} Z\psi^\dagger e^V \psi &= \left[1 + \frac{1}{4}\frac{\partial \gamma}{\partial \ln \mu}\frac{|\mathcal{F}_\Sigma|^2}{M^2}\theta^2\bar{\theta}^2\right]\psi'^\dagger e^V \psi' \\ &= \left[1 + \frac{1}{4}\left(\frac{\partial \gamma}{\partial g}\beta_g + \frac{\partial \gamma}{\partial y}\beta_y\right)\frac{|\mathcal{F}_\Sigma|^2}{M^2}\theta^2\bar{\theta}^2\right]\psi'^\dagger e^V \psi' \end{aligned}$$

Squark and Slepton Masses

$$M^2_{\tilde{\psi}} = -\frac{1}{4}\left(\frac{\partial\gamma}{\partial g}\beta_g + \frac{\partial\gamma}{\partial y}\beta_y\right)\frac{|\mathcal{F}_\Sigma|^2}{M^2}$$

to leading order

$$\gamma = \frac{1}{16\pi^2}(4\,C_2(r)g^2 - ay^2), \;\; \beta_g = -\frac{b\,g^3}{16\pi^2}\;, \;\; \beta_y = \frac{y}{16\pi^2}(ey^2 - fg^2)$$

so

$$M^2_{\tilde{\psi}} = \frac{1}{512\pi^4}\left[4\,C_2(r)\,b\,g^4 + ay^2(ey^2 - fg^2)\right]\frac{|\mathcal{F}_\Sigma|^2}{M^2}$$

first term is positive for asymptotically free gauge theories
negative mass squared for sleptons since in the MSSM the $U(1)_Y$ and $SU(2)_L$ gauge couplings are not asymptotically free

$W(\psi)$ after rescaling gives trilinear interactions with coefficient

$$A_{ijk} = \frac{1}{2}\left(\gamma_i + \gamma_j + \gamma_k\right)y_{ijk}\frac{\mathcal{F}_\Sigma}{M}$$

Trilinear Terms

gauge mediation: messengers have masses

$$\langle X \rangle = M_X \left(1 + \frac{\mathcal{F}_X}{M_X}\theta^2\right)$$

anomaly mediation: the cutoff is

$$\Lambda \frac{\Sigma}{M} = \Lambda \left(1 + \frac{\mathcal{F}_\Sigma}{M}\theta^2\right)$$

mass of the regulator fields with anomaly mediation
the regulator is the messenger

Heavy SUSY Thresholds

after rescaling, the mass m of a SUSY threshold becomes $m\Sigma/M$
low-energy Z and τ have the following dependence:

$$Z\left(\frac{\mu M}{\Lambda|\Sigma|}, \frac{|m||\Sigma|}{\Lambda|\Sigma|}\right), \quad \tau\left(\frac{\mu M}{\Lambda\Sigma}, \frac{m\Sigma}{\Lambda\Sigma}\right)$$

gaugino and sfermion masses are independent of m since m/Λ has no dependence on the spurion Σ
anomaly is insensitive to UV physics, completely determined by the low-energy effective theory
threshold and regulator contribute with opposite signs and cancel
SUSY breaking in the mass term $\rightarrow$ cancellation would not complete

soft masses only depend on β_g, β_y, $\partial\gamma/\partial g$, $\partial\gamma/\partial y$ at weak scale, M_W

The μ problem

in order to get EWSB in the MSSM need μ and b terms:

$$W = \mu\, H_u H_d \ , \ \ V = b\, H_u H_d$$

with

$$b \sim \mu^2$$

need $\mu \sim$ soft masses, so in anomaly-mediation require

$$\mu \sim \tfrac{\alpha}{4\pi} \tfrac{\mathcal{F}_\Sigma}{M}$$

including a coupling to spurion field Σ that directly gives a μ term:

$$W = \mu \tfrac{\Sigma^3}{M^3} H_u H_d$$

we also gives a tree-level b term

$$b \ = \ 3 \tfrac{\mathcal{F}_\Sigma}{M} \mu \sim \tfrac{12\pi}{\alpha} \mu^2$$

which is much too large

The μ problem

more complicated possibility:

$$\mathcal{L}_{\rm int} = \int d^4\theta \, \delta \, \frac{X+X^\dagger}{M} H_u H_d \frac{\Sigma\Sigma^\dagger}{M^2} + h.c. \qquad (*)$$

where X is a SUSY breaking field, rescale

$$\frac{\Sigma H_i}{M} \longrightarrow H_i$$

$$\mathcal{L}_{\rm eff\ int} = \int d^4\theta \, \delta \, \frac{X+X^\dagger}{M} H_u H_d \frac{\Sigma^\dagger}{\Sigma} + h.c.$$

assuming $\langle X \rangle = \theta^2 \mathcal{F}_X$, picking out the $\bar\theta^2$ and $\theta^2\bar\theta^2$ terms $\Rightarrow$

$$\begin{aligned} \mu &= \delta \left(\frac{\mathcal{F}_X^\dagger}{M} + \frac{\mathcal{F}_\Sigma^\dagger}{M} \right) \\ b &= \delta \left(\frac{\mathcal{F}_X}{M} \frac{\mathcal{F}_\Sigma^\dagger}{M} - \frac{\mathcal{F}_X^\dagger}{M} \frac{\mathcal{F}_\Sigma}{M} \right) \end{aligned}$$

b vanishes at tree-level if $\mathcal{F}_\Sigma \propto \mathcal{F}_X$

The μ problem

b term is generated at one-loop, canonically normalize the Higgs:

$$H_i' \quad = \quad Z_i^{1/2}\left(1 - \tfrac{1}{2}\gamma_i \tfrac{\mathcal{F}_\Sigma}{M}\theta^2\right)\Big|_{\Sigma=M} H_i$$

if $\delta \sim \alpha/4\pi$, we find:

$$b \quad = \quad \delta \tfrac{\mathcal{F}_X^\dagger}{2M}\left(\gamma_u \tfrac{\mathcal{F}_\Sigma}{M} + \gamma_d \tfrac{\mathcal{F}_\Sigma}{M}\right) = \mathcal{O}(\mu^2)$$

this relies on the coefficients of X and $X^\dagger$ in (*) being equal
seems fine-tuned

generated in 5D toy model without fine-tuning
fifth (extra) dimension has a compactification radius r_c

5D Gravity

for $r \ll r_c$ the gravitational potential is

$$\frac{1}{r^2 M^3}$$

rather than the 4D Newton potential

$$\frac{1}{r M_{\rm Pl}^2}$$

static potential given by the spatial Fourier transform of the graviton propagator with zero energy exchange:

$$V(r) \sim \int d^{D-1}p \, \frac{e^{i\vec{p}.\vec{r}}}{\vec{p}^2} \sim \frac{1}{r^{D-3}}$$

Matching the potentials at $r = r_c$ we have

$$M_{\rm Pl}^2 = r_c M^3$$

5D Vector Exchange

introduce a massive vector superfield V which propagates in the 5D bulk (canonical dimension 3/2)
Integrating over fifth dimension, assume the 4D effective theory has form:

$$\mathcal{L} = \int d^4\theta \, r_c m^2 V^2 + aV(X + X^\dagger)M^{1/2} + \frac{bV}{M^{1/2}} H_u H_d \frac{\Sigma\Sigma^\dagger}{M^2} + h.c.$$

first term is a mass term and V is normalized to dimension $\frac{1}{2}$
Integrating out V and performing the usual rescaling gives

$$\mathcal{L}_{\rm int} \sim \int d^4\theta \frac{ab}{r_c m^2}(X + X^\dagger) H_u H_d \frac{\Sigma\Sigma^\dagger}{M^2} + h.c. + \ldots$$

with

$$r_c m \sim \mathcal{O}(1), \;\; ab \sim \mathcal{O}\left(\frac{\alpha}{4\pi}\right)$$

$\rightarrow$ required interaction
existence proof that μ problem can be solved in anomaly-mediation

Slepton masses

squark and slepton masses:

$$M^2_{\tilde{\psi}} = \frac{1}{512\pi^4}\left[4\,C_2(r)\,b\,g^4 + ay^2(ey^2 - fg^2)\right]\frac{|\mathcal{F}_\Sigma|^2}{M^2}$$

b is negative for $SU(2)_L$ and $U(1)_Y$ $\Rightarrow$ sleptons are tachyonic
possible solutions:

- new bulk fields which couple leptons and the SUSY breaking fields
- new Higgs fields with large Yukawa couplings
- new asymptotically free gauge interactions for sleptons, $\Rightarrow$ leptons and sleptons are composite
- heavy SUSY violating threshold (messengers) with a light singlet

consider the last possibility, sometimes known as "anti-gauge mediation"

Anti-Gauge Mediation

consider a singlet X and N_m messengers ϕ and $\overline{\phi}$ in $\Box$s and $\overline{\Box}$s of $SU(5)$ GUT with a superpotential

$$W = \lambda X \phi \overline{\phi}$$

X is pseudo-flat: it gets a mass through anomaly mediation
when we renormalize down to a scale $\sim X$ we have a Kähler term

$$\int d^4\theta \, Z\left(\frac{XX^\dagger M^2}{\Lambda^2 \Sigma \Sigma^\dagger}\right) X^\dagger X$$

scalar potential

$$\begin{aligned} V(X) &= m_X^2(X)|X|^2 \\ &= \tfrac{N_m}{16\pi^2}\lambda^2(X)\left[A\lambda^2(X) - C^a g_a^2(X)\right]\tfrac{|\mathcal{F}_\Sigma|^2}{M^2}|X|^2 \end{aligned}$$

Anti-Gauge Mediation

If messengers have asymptotically free gauge interactions then $m_X^2(X)$ can change sign, and X is stabilized nearby (Coleman–Weinberg)

$$\langle X \rangle = m$$

then $\mathcal{F}$ component of X is proportional to $m\mathcal{F}_\Sigma$:

$$\mathcal{F}_X \sim \tfrac{N_m \lambda^2}{16\pi^2} \tfrac{m\,\mathcal{F}_\Sigma}{M}$$

splitting in the messenger masses is a loop effect
threshold depends on light VEV $\rightarrow$ extra contribution to soft masses
low-energy couplings only depend on

$$\widetilde{X} = X\tfrac{M}{\Sigma}\ , \tfrac{\mathcal{F}_{\widetilde{X}}}{\langle \widetilde{X} \rangle} = \tfrac{\mathcal{F}_X}{m} - \tfrac{\mathcal{F}_\Sigma}{M} \approx -\tfrac{\mathcal{F}_\Sigma}{M}$$

because of the loop factor suppression

Taylor Expansion in Superspace

gaugino mass:

$$
\begin{aligned}
M_\lambda &= -\frac{1}{2\tau}\frac{\partial\tau}{\partial\ln\Sigma}\bigg|_{\Sigma=M}\frac{\mathcal{F}_\Sigma}{M_{\rm Pl}} \\
&= \frac{1}{2\tau}\left(\frac{\partial\tau}{\partial\ln\mu}+\frac{\partial\tau}{\partial\ln X}\right)\frac{\mathcal{F}_\Sigma}{M_{\rm Pl}} \\
&= \frac{\alpha(\mu)}{4\pi}(b-N_m)\frac{\mathcal{F}_\Sigma}{M_{\rm Pl}}
\end{aligned}
$$

first term is usual anomaly mediation
second term is minus the gauge mediation answer

hence the name Anti-Gauge Mediation

Taylor Expansion in Superspace

squark or slepton mass squared:

$$\begin{aligned} M^2_{\tilde{\psi}} &= -\left(\frac{\partial}{\partial \ln \mu} + \frac{\partial}{\partial \ln |X|}\right)^2 \ln Z(\mu, |X|) \frac{|\mathcal{F}_\Sigma|^2}{4M^2_{\rm Pl}} \\ &= \frac{2C_2(r)b}{(4\pi)^2}\left[\alpha^2(\mu) - \alpha^2(\mu)\frac{N_m}{b} + (\alpha^2(\mu) - \alpha^2(m))\frac{N_m^2}{b^2}\right]\frac{|\mathcal{F}_\Sigma|^2}{M^2_{\rm Pl}} \end{aligned}$$

first term is anomaly mediation term
second term is minus the gauge mediation term
final term is RG running induced by gaugino mass

Slepton Masses

$$
\begin{aligned}
M^2_{\tilde{\psi}} &= -\left(\frac{\partial}{\partial \ln \mu} + \frac{\partial}{\partial \ln |X|}\right)^2 \ln Z(\mu, |X|) \frac{|\mathcal{F}_\Sigma|^2}{4 M^2_{\mathrm{Pl}}} \\
&= \frac{2 C_2(r) b}{(4\pi)^2} \left[\alpha^2(\mu) - \alpha^2(\mu) \frac{N_m}{b} + (\alpha^2(\mu) - \alpha^2(m)) \frac{N_m^2}{b^2}\right] \frac{|\mathcal{F}_\Sigma|^2}{M^2_{\mathrm{Pl}}}
\end{aligned}
$$

for the sleptons $M^2_{\tilde{\psi}} > 0 \Rightarrow$ RG term dominates $\Leftrightarrow N_m$ sufficiently large

cannot m too large, higher dimension operators dominate, e.g.

$$
\int d^4\theta \frac{X^\dagger X}{M^2_{\mathrm{Pl}}} \psi^\dagger e^V \psi
$$

would give

$$
M^2_{\tilde{\psi}} = -\frac{|\mathcal{F}_X|^2}{M^2_{\mathrm{Pl}}}
$$

for $m \sim M_{\mathrm{GUT}}$ we need $N_m \geq 4$

μ Problem

adding singlet S cangenerate μ and b terms

$$\int d^2\theta \lambda' S H_u H_d + \tfrac{k}{3} S^3 + \tfrac{y}{2} S^2 X$$

one-loop a kinetic mixing:

$$\int d^4\theta \widetilde{Z} S X^\dagger + h.c.$$

for $\langle X \rangle \neq 0$, S is massive and can be integrated out:

$$S \sim -\tfrac{\lambda'}{y} \tfrac{H_u H_d}{X}$$

$$\rightarrow \quad \mathcal{L}_{\rm eff} = -\tfrac{\lambda'}{y} \int d^4\theta \tfrac{X^\dagger}{X} H_u H_d \widetilde{Z}\left(\tfrac{|X| M_{\rm Pl}}{\Lambda |\Sigma|}\right) + h.c.$$

produces μ term at one-loop, b term at two-loops:

$$\mu = -\frac{\lambda'}{y}\frac{1}{2}\frac{\partial \widetilde{Z}}{\partial \ln |X|} \;, \quad b = -\frac{\lambda'}{y}\frac{1}{4}\frac{\partial^2 \widetilde{Z}}{\partial (\ln |X|)^2}$$

Gaugino mediation

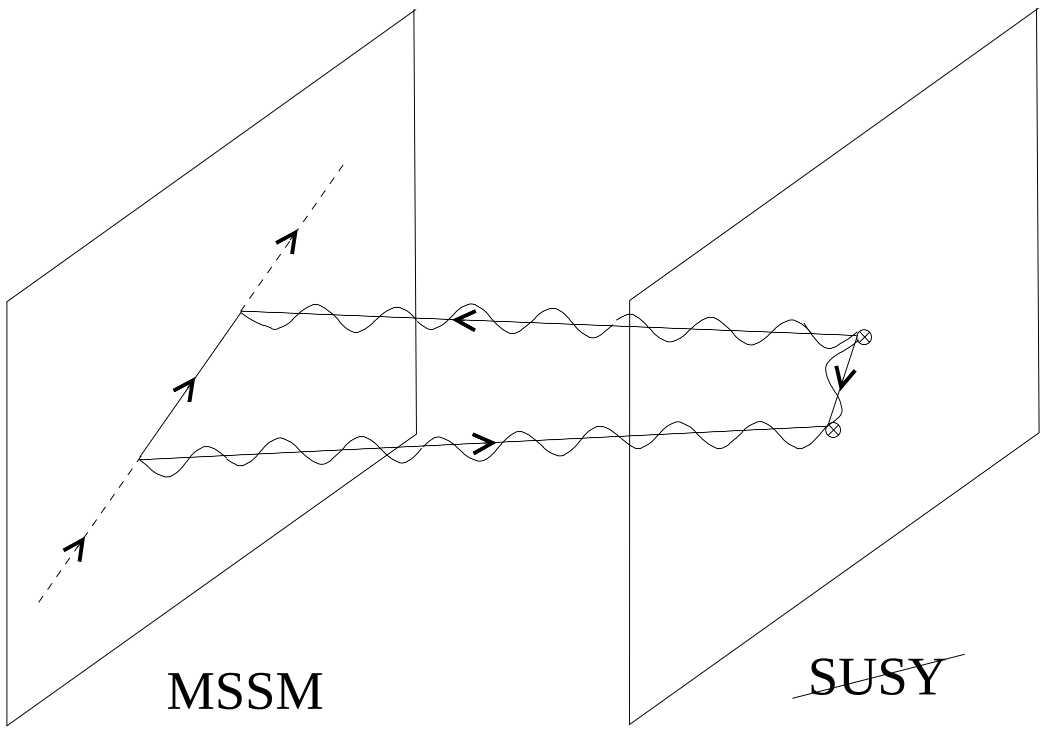
RG running from gaugino mass $\rightarrow$ + mass^2 for squarks and sleptons
consider models where only gauginos get masses at leading order
squarks have strong gauge coupling $\Rightarrow$ heavier than sleptons
large top Yukawa coupling and heavy stops $\Rightarrow$ radiative EWSB

simple set up: compact extra dimension with radius

$$r_c \sim \frac{1}{M_{\mathrm{GUT}}}$$

gauge fields propagate in bulk
SUSY breaking on brane at the other end of the fifth dimension
Yukawa couplings only source of flavor violation
GIM mechanism suppresses FCNCs

Gaugino mediation



gaugino propagating in bulk mediates SUSY breaking

Gaugino mediation

4D gauge coupling related to the 5D coupling by

$$\frac{1}{g_4^2} F^a_{\mu\nu} F^{a\mu\nu} = \frac{1}{g_5^2} \int dx^5 \, F^a_{\mu\nu} F^{a\mu\nu} \ , \ \ g_4^2 = \frac{g_5^2}{r_c}$$

no chirality in 5D, minimal SUSY theory has $\mathcal{N} = 2$
vector supermultiplet $\rightarrow$ 4D vector + adjoint chiral:

$$(A_N, \lambda_L, \lambda_R, \phi) \rightarrow (A_\nu, \lambda_L) + (\phi + iA_5, \lambda_R)$$

fifth component of gauge field is a scalar
choose boundary conditions so:
adjoint chiral supermultiplet vanishes on one 3-brane
vector multiplet does not
only vector supermultiplet has massless mode (independent of x_5)
$\Rightarrow$ breaks SUSY $\rightarrow \mathcal{N} = 1$

Gaugino mediation

SUSY breaking on one brane communicated by local interactions

$$\begin{aligned} \mathcal{L} &\propto \int dx^5 \int d^2\theta \left(1 + \delta(x_5 - r_c)\frac{X}{M^2}\right) W^\alpha W_\alpha + h.c. \\ &\propto r_c \lambda^\dagger \overline{\sigma}^\mu D_\mu \lambda + \frac{\mathcal{F}_X}{M^2}\lambda^\dagger\lambda + \ldots \end{aligned}$$

gaugino mass generated by auxiliary fields on SUSY breaking brane

$$M_\lambda = \frac{1}{r_c M}\frac{\mathcal{F}_X}{M}$$

Gaugino mediation

bulk gluino loops with two mass insertions give the largest contribution to the squark/slepton masses:

$$M^2_{\tilde{\psi}} \sim \frac{g_5^2}{16\pi^2}\left(\frac{\mathcal{F}_X}{M^2}\right)^2 \frac{1}{r_c^3} = \frac{g_4^2}{16\pi^2} M_\lambda^2 \ ,$$

suppressed relative to gluino mass squared
for $r_c \ll M_W^{-1}$ 4D RG running

$$\mu \frac{d}{d\mu} m_Q^2 \propto -g^2 M_\lambda^2 + c g^4 \mathrm{Tr}\left((-1)^{2F} m_i^2\right)$$

dominates by a large logarithm, $\ln r_c M_W$, over the 5D loop contribution

all the soft masses are determined by gaugino masses and r_c
very predictive scenario