DESY
April 2013

Scattering in General Gauge Mediation: Vector Meson Dominance and Holography

1207.4484 1210.4935 and 1303.4534

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AvH fellow
Host: Andreas Weiler

General Gauge Mediation in 5D
GGM and Deconstruction
Warped General Gauge Mediation
Hybrid Gauge Mediation
General Resonance Mediation
Holography for General Gauge Mediation

DESY

Alexander von Humboldt
Stiftung / Foundation

This topic overlaps

...with QCD

...with Pheno & BSM

...with String theory

so please ask questions

Motivation

hidden sectors are probably strongly coupled

but maybe we can develop tools to understand them?

General Gauge Mediation was developed for strong coupling

OPE's?   Dualities?   Other tools?

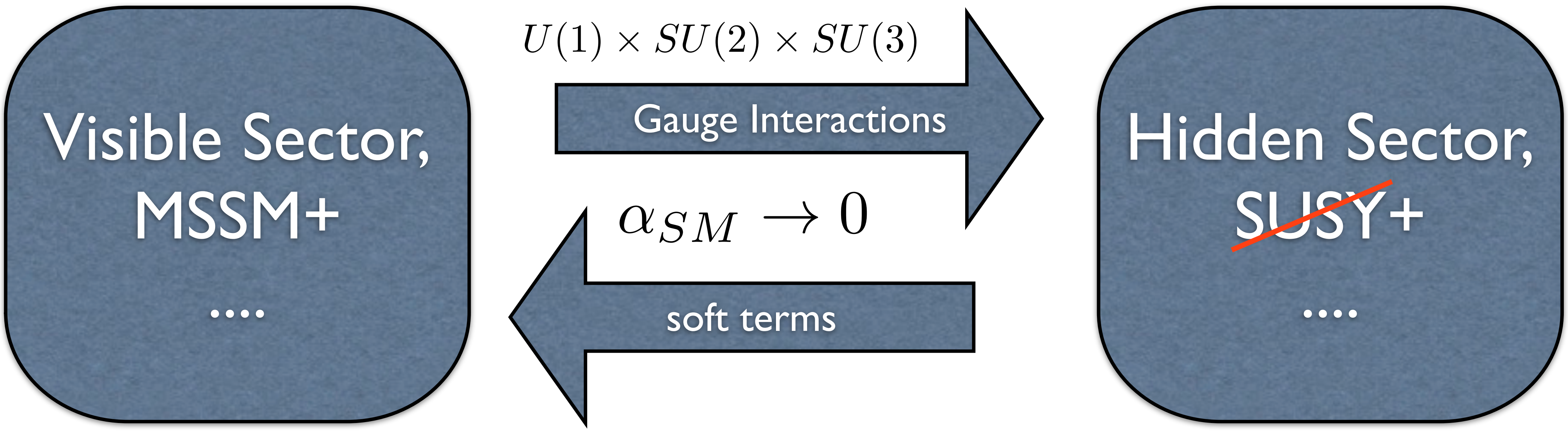
(for instance David Shih et al recently found large A-terms from OPE techniques: 1302.2642)

General Gauge Mediation

Meade, Seiberg, Shih 0801.3278

Also see the original:
Gouvea, Moroi, Murayama
9701244

A model independent framework for gauge mediated supersymmetry breaking



encodes spontaneous breaking in current correlators

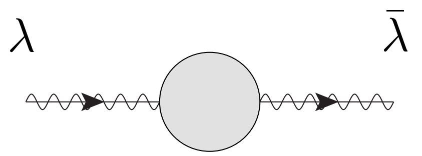
$$\mathcal{L}_{int} = g_{SM} \left(JD + J_\mu A^\mu - j_\alpha \lambda^\alpha - \bar{j}^{\dot{\alpha}} \bar{\lambda}_{\dot{\alpha}} \right)$$

The key point of GGM: we want to understand and encode strongly coupled hidden sectors that break supersymmetry dynamically

The building blocks

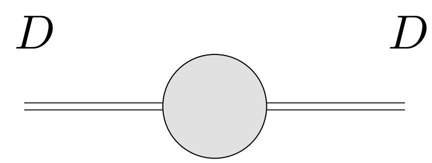
current current correlators

$F.T.\,\langle j_\alpha(x)\bar{j}_{\dot\alpha}(y)\rangle$



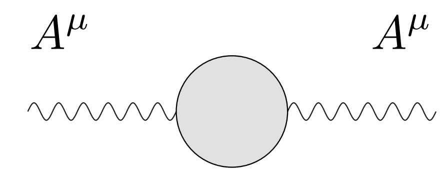
$= \tilde{C}_{1/2}(s)$

$F.T.\,\langle J(x)J(y)\rangle$



$= \tilde{C}_0(s)$

$F.T.\,\langle J_\mu(x)J_\nu(y)\rangle$

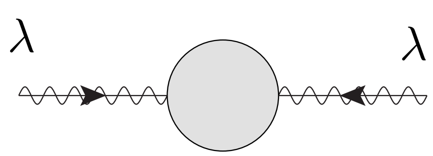


$= \tilde{C}_1(s)$

A "model" makes an assumption about the "blobs"

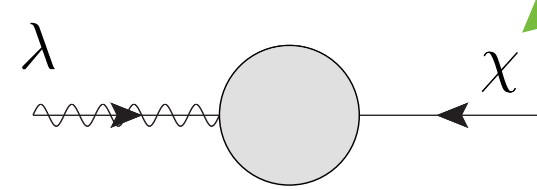
gaugino

Majorana gaugino soft mass

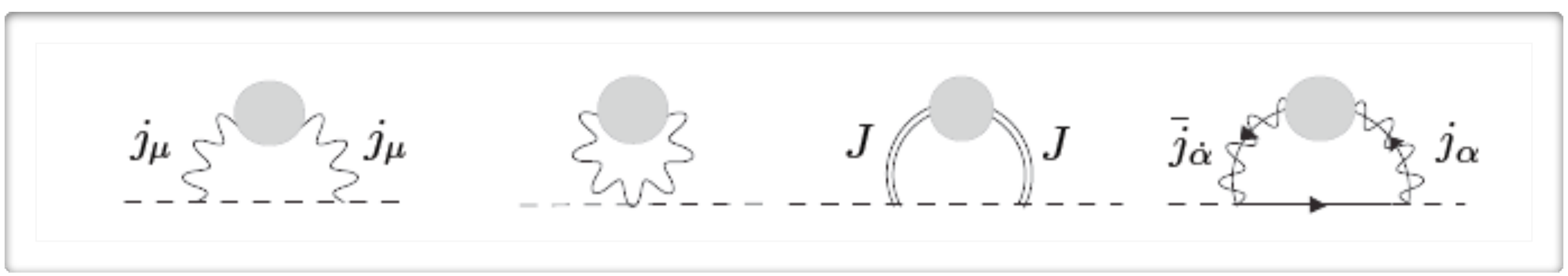


$F.T.\,\langle j_\alpha(x)j_\beta(y)\rangle$

new fermion d.o.f.



Dirac soft mass possible
(Benakli & Goodsell)



is an sfermion soft mass

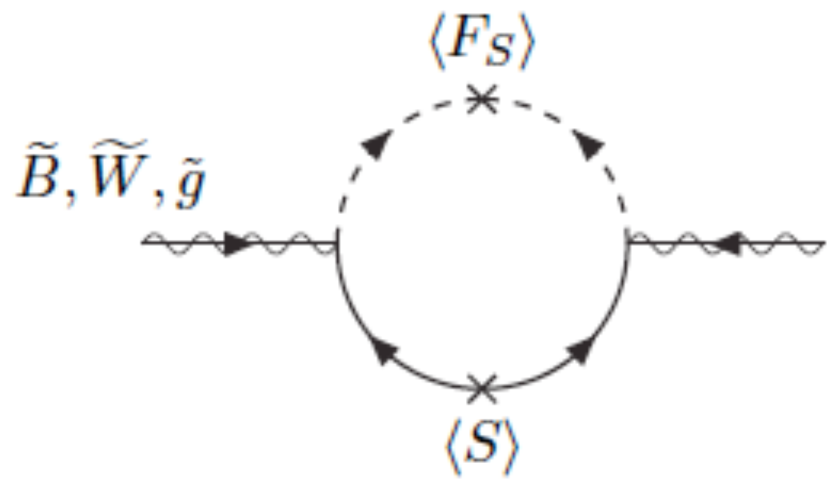
perturbative in α_{SM}, all orders in the "electric" hidden sector couplings α_{hidden}

If the model is a just a messenger model then the GGM programme achieves little... Just use the reviews Giudice & Rattazzi 9801271
(in most cases)

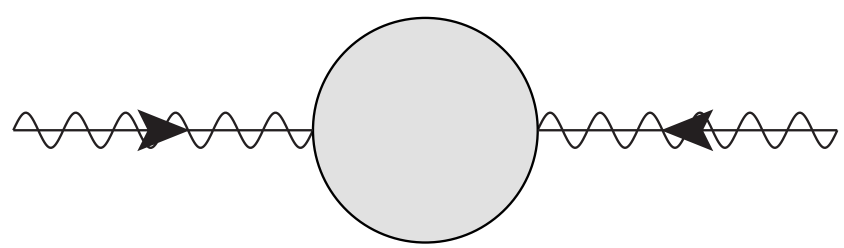
S.Martin 9608224

What is a blob?

In a perturbative model, (like a messenger model) a blob
is just a simple one loop diagram



At strong coupling it is (unfortunately) very complicated

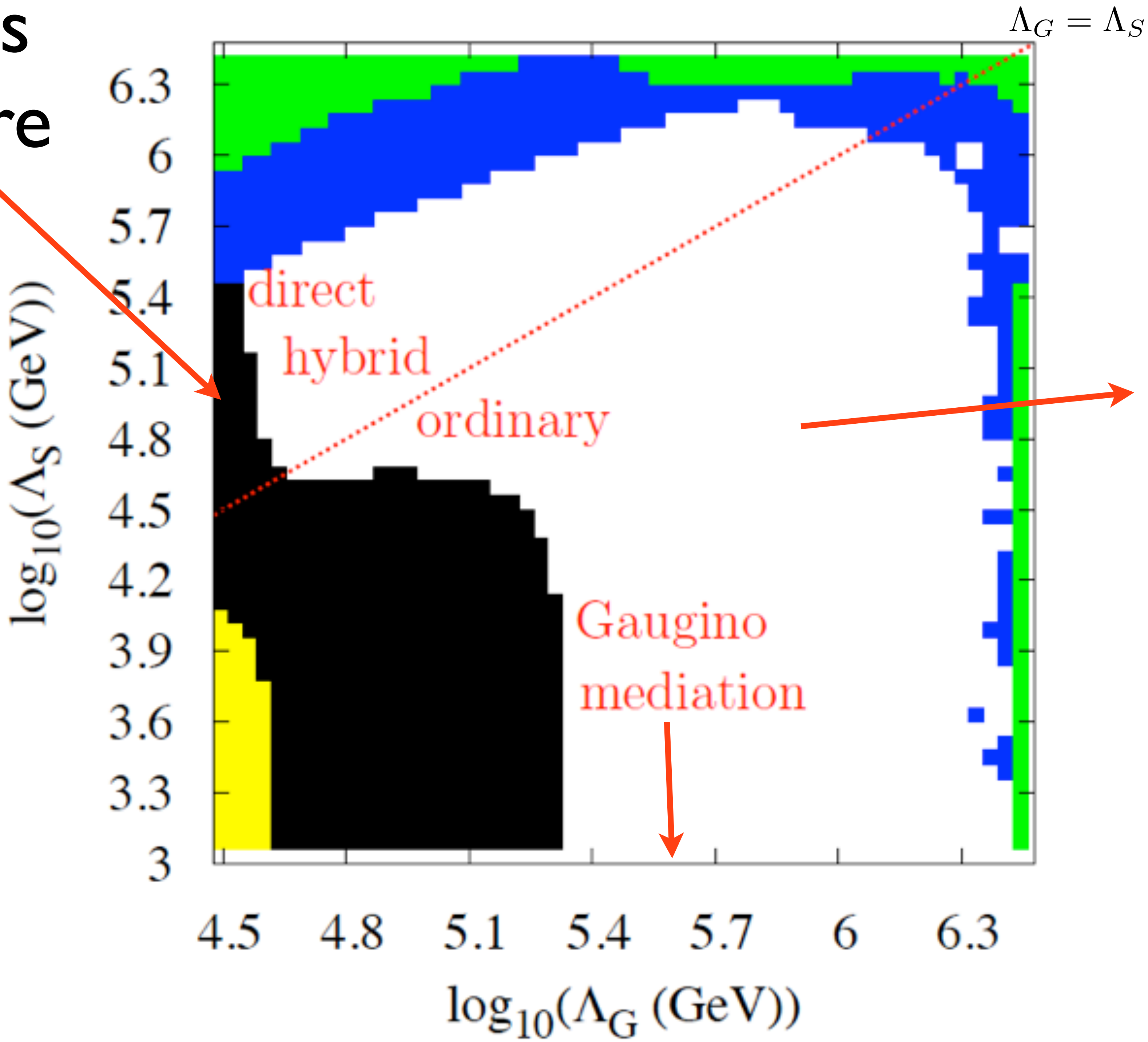


I'm sorry
(its not my fault, I'm just the messenger)

....more motivation

Generic ISS models live here

S. Abel, M. Dolan, J. Jaeckel & V. Khoze 1009.1164
Dolan, Grellscheid, Jaeckel, Khoze & Richardson 1104.0585



This area is most likely!
Build models that live here!

This is HARD to do, normally.

We did it first in here!

"General Gauge Mediation in 5D"
M.M. Rodolfo Russo 1004.3305

Are there 4D examples that can replicate this feature?

what kinds of strong coupling?

...if Seiberg duals don't work!?

Too negative?

Shih et al: 1302.2642

"...the notion of a loop factor might not even apply..."

"...even in strongly coupled cases where field redefinitions are not necessarily applicable..."

Are there calculable models?

Holography?

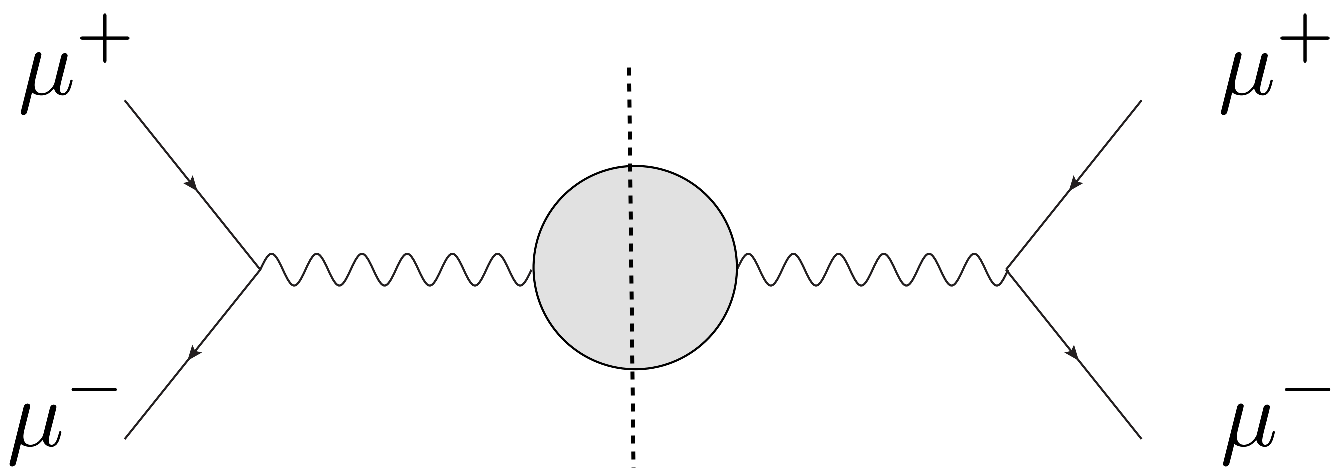
Let's look at one attempt that uses scattering

Fortin, Intriligator, Stergiou 1109.4940

A 10-100 PeV collider?

cross sections of visible to hidden matter computed for perturbative messenger models.

Visible sector:
leptons
sleptons
quarks
squarks
....



Hidden sector:
messenger fields
+ spurion

$$W = X\Phi\tilde{\Phi}$$

$$X = M + \theta^2 F$$

$$\phi_\pm \text{ with } m_\pm^2 = M^2 \pm F$$

$$\psi, \tilde{\psi} \quad \text{with} \quad M$$

optical theorem

$$\sigma(\text{visible} \to \text{hidden}, s) = \frac{(4\pi\alpha)^2}{2s} \text{Disc } \Pi(s)$$

Examples

~~$SUSY$~~

$$\text{Disc}\tilde{C}_0(s) = \frac{1}{4\pi s}\sqrt{s^2 - 4|X|^2 + 4|F|^2}$$

$SUSY$

$$\text{Disc}\tilde{C}_0(s) = \frac{1}{4\pi s}\left(1 - \frac{4M^2}{s}\right)^{1/2}$$

"In principle" determine GGM correlators from experimental cross sections

$$i(16\pi^2\alpha)^2\left[\tilde{C}_a(s) - \tilde{C}_a(0)\right] = \sum_{cuts} \frac{s}{\pi} \int_{s_0'}^{\infty} ds' \frac{\sigma_a(s')}{s' - s}$$

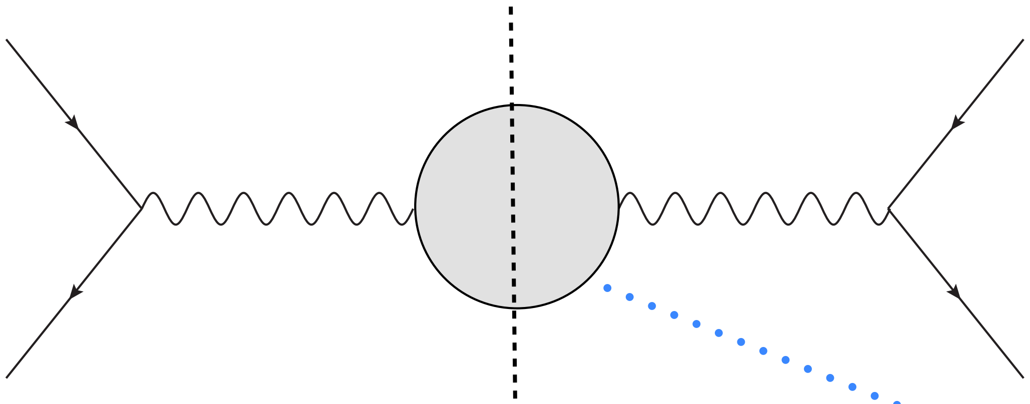
soft masses and cross sections are related

But we want to get away from perturbative messenger models

Can we develop intuition with QCD?

Can QCD tell us something about the "blobs" and therefore something about the soft masses?

QCD



$$i\mathcal{M}(e^+, e^- \to e^+, e^-)$$

gives $\sigma(e^+, e^- \to hadrons)$

quark current $\mathcal{O}^\mu = \bar{q}\gamma^\mu q$

perturbative in α_{em}

all orders in α_s

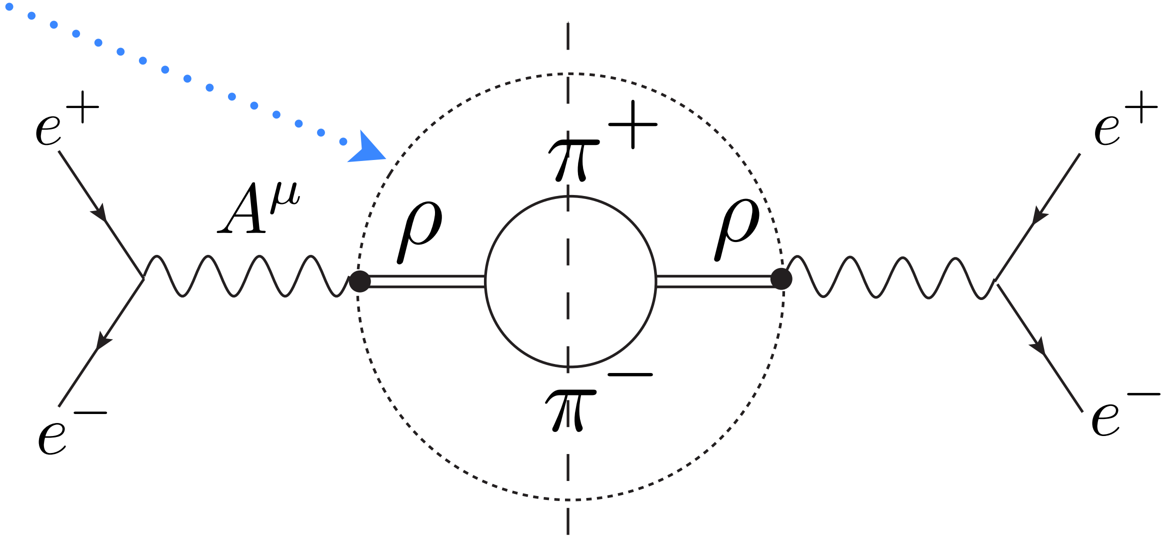
=

Hadronic picture

"look under the hood"

Sum of many parts

one such piece: $\sigma(e^+ e^- \to \pi^+, \pi^-)$



perturbative in α_{em}

perturbative in α_{mag}

Can QCD tell us something about the "blobs" and therefore something about the soft masses?

Pion physics and vector meson dominance

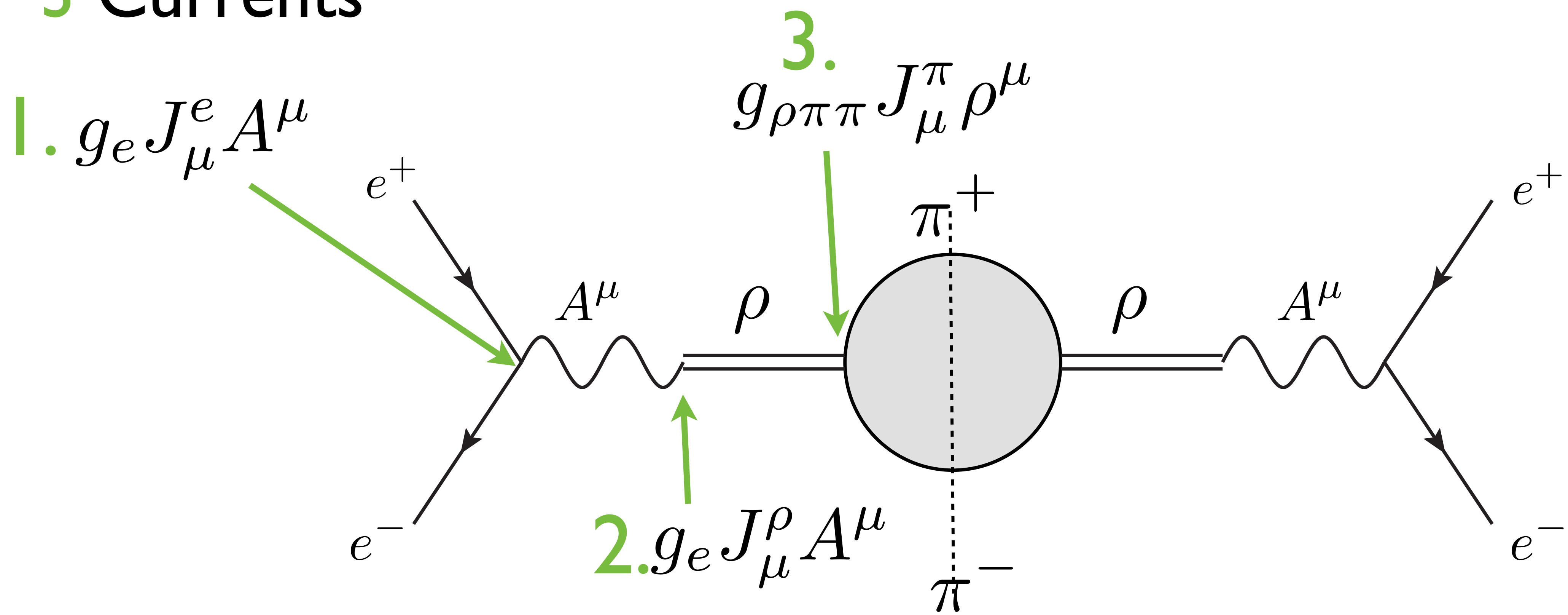
$$\sigma(e^+,e^- \to \pi^+,\pi^-) = \frac{(4\pi\alpha)^2}{4\pi 12 s}\left(1-\frac{4m_\pi^2}{s}\right)^{3/2} |F(s)|^2\theta(s-4m_\pi^2)$$

Nambu 1957
Sakurai 1960
Murray Gell-Mann 1961
Kroll, Lee & Zumino 1967
+ many many more

A hidden local symmetry

Completely 4D

3 Currents



<u>We learn that</u>

a) Pions couple to rho

b) There is a form factor

"modified current operator"

$$\langle A|g_e J^{em}|B\rangle = \frac{-g_e}{g_\rho}\frac{m_\rho^2}{q^2-m_\rho^2}\langle A|g_{\rho\pi\pi}J^\pi|B\rangle$$

A form factor

$$F(s) = \frac{-g_e}{g_\rho}\frac{m_\rho^2}{s-m_\rho^2}$$

The famous "current field identity"

$$J^\rho_\mu = -\frac{m_\rho^2}{g_\rho}\rho_\mu$$

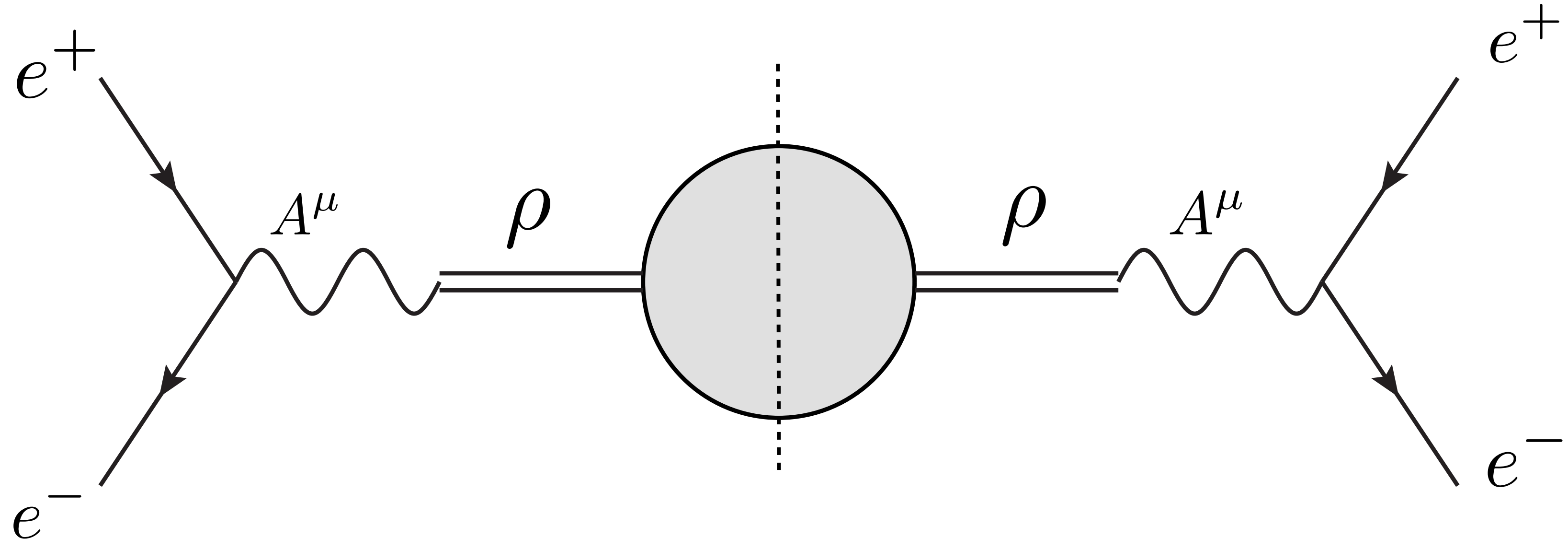
an operator field correspondence

Can we build this into GGM? YES

"General Resonance Mediation": McGarrie 1207.4484

$$\sigma(e^+e^- \to \rho \to \phi^+\phi^-)$$

Intermediate resonances in cross sections of visible to hidden sector



$$F(s) = \frac{-g_e}{g_\rho}\frac{m_\rho^2}{s - m_\rho^2}$$

$$\mathcal{J}_\rho = -\frac{m_\rho^2}{g_\rho}\rho \quad \text{where} \quad D^2\rho = 0$$

"supercurrent field identity"
MM 1207.4484

In general

$$\sigma_a(visible \to hidden, s) = \frac{(4\pi\alpha)^2}{2s}|F(s)|^2 \,\text{Disc}\, \tilde{C}_a(s)$$

We may now compute all cross sections for a visible sector to a perturbative messenger model with intermediate resonances

Summary

The key idea is to build models around scattering

RED

$$\sigma_a(visible \to hidden) = \frac{(4\pi\alpha)^2}{2s}\ Disc\ \tilde{C}_a(s)$$

OR

$$F(s) = \frac{m_\rho^2}{s + m_\rho^2}$$

form factor or no form factor?

BLACK?

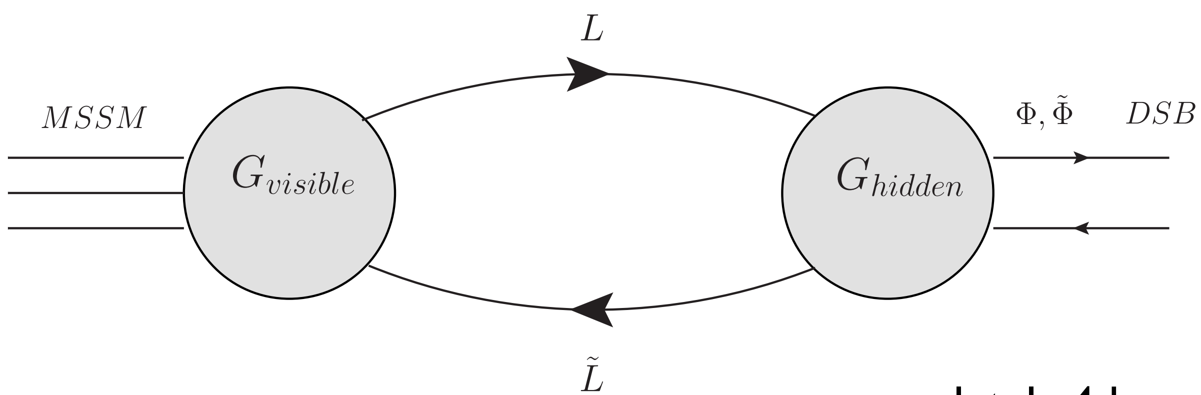
$$\sigma_a(visible \to hidden) = \frac{(4\pi\alpha)^2}{2s}|F(s)|^2\ Disc\ \tilde{C}_a(s)$$

Similar to the hadronic world: perhaps we should take it more seriously?

Ideally, determine this form factor from experiment	impossible
or from computer simulations	hard
or from toy models and effective field theory	possible

What does this tell us about SUSY breaking?

Simplest case
corresponds to a 2 site quiver model



completely 4d

Form factor

$$F(s) = \frac{m_\rho^2}{s + m_\rho^2}$$

"GGM and Deconstruction"
McGarrie 1009.0012 and 1101.5158

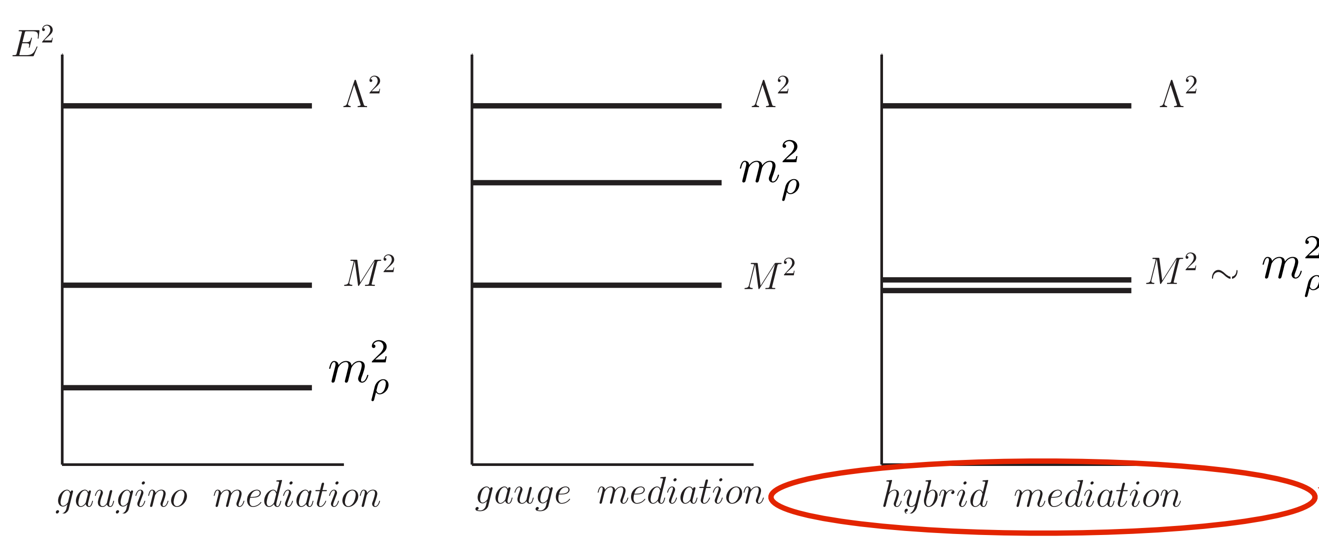
Extensions in Auzzi & Giveon 1009.1714 1011.1664 + ...

easyDiracgauginos Abel & Goodsell 1102.0014

M.M. Bharucha, Goudelis To appear

A hidden local symmetry,
exhibits vector meson dominance

3 Regimes depends on ratio $y = \frac{m_\rho}{M}$



most likely?

We have a new hybrid regime where

$$@M_{SUSY} : m_\lambda^2 > m_{\tilde{f}}^2$$

soft masses are analytically calculable to 2 loops!
and cross sections are now known.

The quiver models may be related to Seiberg duality through tools of "Hidden Local Symmetry" (Abel & Barnard 1202.2863)

Such setups may be generalised to long linear quivers
these deconstruct an extra dimension.

It is natural to extend these to holographic setups

All these developments have taken place in the QCD literature:

Vector Meson Dominance

Nambu 1957, Sakurai 1960, Murray Gell-Mann 1961, Kroll, Lee & Zumino 1967 + many many more

"Nonlinear Realization and Hidden Local Symmetries", Bando et al 1980's

"QCD and Dimensional Deconstruction" 0304182

"QCD and a Holographic Model of Hadrons" 0501128 & 0510268

"Holography for General Gauge Mediation"

M.M.: 1210.4935

also $AdS/\not{SUSY}$

"General Gauge Mediation in 5D"
M.M. Rodolfo Russo 1004.3305

"Warped General Gauge Mediation"
M.M. Daniel C. Thompson 1009.4696

Abel & Gherghetta 1010.5655

IR hardwall/
slice of AdS

Check list

1. Metric: slice of AdS $$ds^2 = \left(\frac{R}{z}\right)^2 (\eta^{\mu\nu} dx_\mu dx_\nu + dz^2)$$
2. Interval $$L_0 < z < L_1$$
3. Flavour symmetries $$SU(N_f)_L \times SU(N_f)_R \to SU(N_f)_V$$
4. Scale matching $$\frac{R}{g^2_{5d(YM)}} = \frac{N_c}{12\pi^2}$$
5. Sources $$A^0_\mu(x), \lambda^0_\alpha(x), D^0(x)$$
6. Operators $$\mathcal{O}_\mu(x), \mathcal{O}_\alpha(x), \mathcal{O}(x)$$
7. Bulk field $$A^\mu(q,z) = A^\mu_0(q) K(q,z)$$
8. Bulk to boundary propagator $$K(q,z) = \frac{V(q,z)}{V(q,L_0)}$$

$$V(q,z) = zq\left[Y_0(qL_1)J_1(qz) - J_0(qL_1)Y_1(qz)\right]$$

N=1 5d super Yang-Mills
action in the bulk

compute...

“Holography for General Gauge Mediation”

M.M.: 1210.4935

IR hardwall/
slice of AdS

N=1 5d super Yang-Mills action in the bulk

$$SU(N_f)_L \times SU(N_f)_R$$

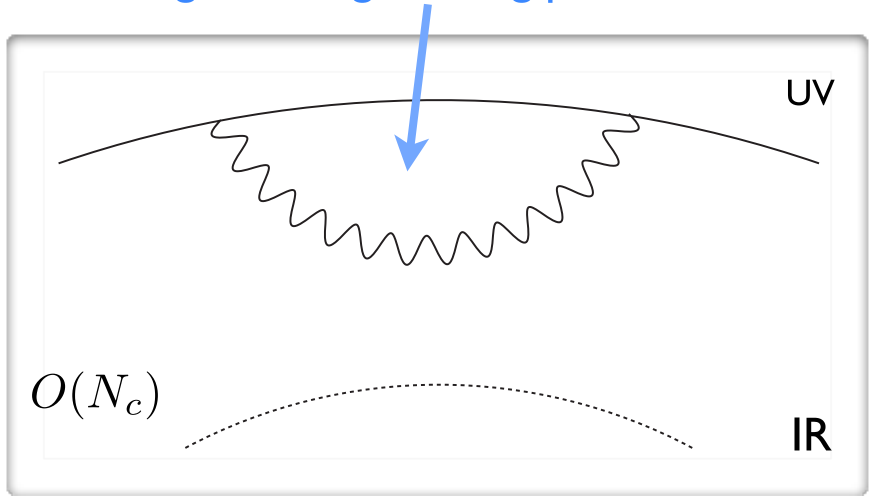
$$ds^2 = \left(\frac{R}{z}\right)^2 (\eta^{\mu\nu} dx_\mu dx_\nu + dz^2) \qquad L_0 < z < L_1 \qquad \frac{R}{g^2_{5d(YM)}} = \frac{N_c}{12\pi^2}$$

$$A^\mu(q,z) = A^\mu_0(q) \frac{V(q,z)}{V(q,L_0)}$$

$$\int d^4x e^{ip.x} \langle \mathcal{O}_\mu(x) \mathcal{O}_\nu(0) \rangle = \Pi(p^2) P^{\mu\nu}$$

$$\Pi(q^2) = \frac{1}{q} \left(\frac{R}{z} \frac{\partial_z V(q,z)}{V(q,L_0)} \right)_{z=L_0}$$

gives a log running piece



<u>An AdS/SQCD proposal</u>

4D: operator		Field	Δ	m^2
$\mathcal{O}(x)$	$\rightarrow$	$D(z,x)$	2	-4
$\mathcal{O}_\alpha(x)$	$\rightarrow$	$\lambda_\alpha(z,x)$	5/2	1/2
$\mathcal{O}_\mu(x)$	$\rightarrow$	$A_\mu(z,x)$	3	0

The UV operators that correspond to bulk fields

$$\mathcal{O}_{L,R} = \phi^\dagger \phi_{L,R}$$

$$\mathcal{O}^\alpha_{L,R} = -i\sqrt{2}\phi^\dagger q^\alpha_{L,R}$$

$$\mathcal{O}^\mu_{L,R} = \bar{q}\sigma^\mu q_{L,R} - i\left(\phi^\dagger \partial^\mu \phi - \partial^\mu \phi^\dagger \phi\right)_{L,R}$$

UV boundary correlators give a supersymmetric effective action

$$\left[3\Pi_1(q^2) - 4\Pi_{1/2}(q^2) + \Pi_0(q^2)\right] \equiv 0 \qquad \langle \mathcal{O}_\alpha(x) \mathcal{O}_\beta(0) \rangle \equiv 0$$

Related to the Gibbons-Hawking boundary terms of SYM

So far.....

We end up with a supersymmetric boundary effective action

$$\int \frac{d^4q}{(2\pi)^4}\left[\frac{1}{4}\Pi_1(q^2)F_{\mu\nu,0}F_0^{\mu\nu} - i\Pi_{1/2}(q^2)\lambda_0\sigma_\mu\partial^\mu\bar{\lambda}_0 + \frac{1}{2}\Pi_0(q^2)D_0^2\right]$$

for a weakly gauged flavour symmetry of the (non) CFT

$$\int d^4x e^{ip.x}\langle\mathcal{O}_\mu(x)\mathcal{O}_\nu(0)\rangle = \Pi(p^2)P^{\mu\nu}$$

Typically a complicated expression involving Bessel functions:

$$\Pi(q^2) = \frac{a(L_0)}{g_5^2 q}\left[\frac{J_{\alpha-1}(qL_0)Y_\beta(qL_1) - J_\beta(qL_1)Y_{\alpha-1}(qL_0)}{J_\alpha(qL_0)Y_\beta(qL_1) - J_\beta(qL_1)Y_\alpha(qL_0)}\right]$$

$\alpha = 1, \beta = 0$ Determined from conformal dimensions of operators

Next....

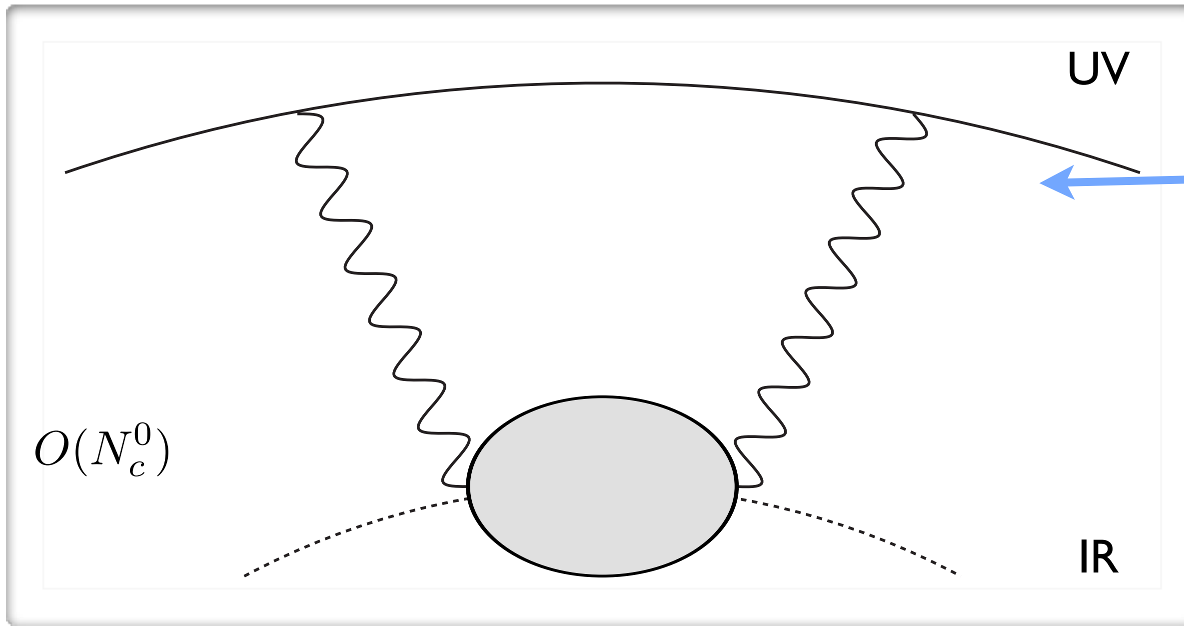
Introduce IR localised correlators that encode supersymmetry breaking

SUSY breaking currents located on an IR brane or live in the bulk

$$A_\mu J^\mu = \int dz K(p,z) A^0_\mu J^\mu = A^0_\mu J^\mu \Lambda(p)$$

An effective vertex function generated by a bulk to boundary propagator

Ignore $O(1/N_c)$ corrections



$A^0_\mu \Lambda(p) \tilde{C}(p^2/M^2) P^{\mu\nu} \Lambda(p)\ A^0_\nu$

$$\delta L_{eff}^{\not{SUSY}}|_{UV} = \frac{g^2_{SM}}{2} \tilde{C}_0(0) D_0^2 - i g^2_{SM} \tilde{C}_{1/2}(0) \lambda_0 \sigma_\mu \partial^\mu \bar{\lambda}_0 - \frac{g^2_{SM}}{4} \tilde{C}_1(0) F_{\mu\nu,0} F_0^{\mu\nu}$$

may be written as a boundary effective action too

If you also assume a messenger sector then*

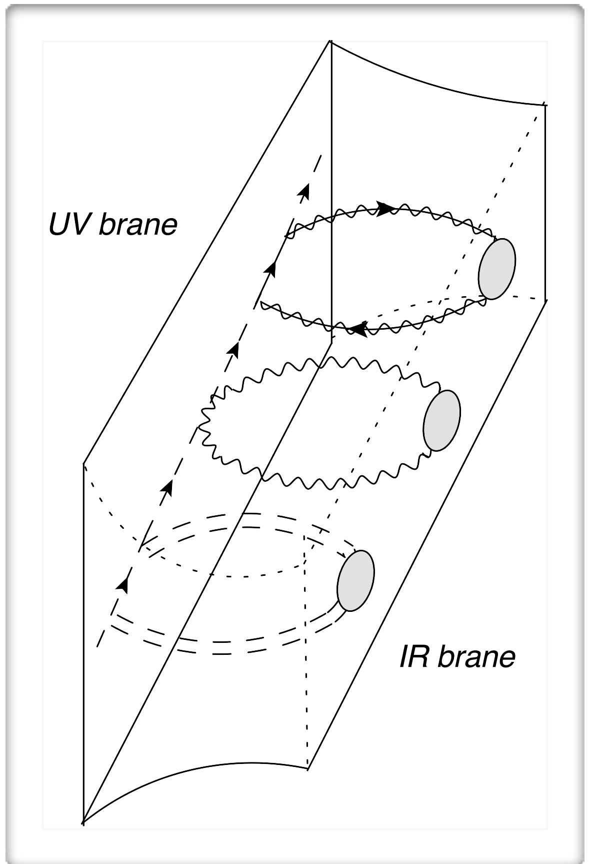
* this part is not necessary. It is a further additional assumption

$$m_\lambda = \left(\frac{\alpha_{IR}}{4\pi}\right)\left(\frac{R}{z}\right)\left[\frac{2Fg(x)}{M}\right]$$

soft masses are calculable!

$$m^2_\phi = \left(\frac{\alpha_{IR}}{4\pi}\right)^2 \left(\frac{R}{z}\right)^2 \left[\frac{F}{M}\right]^2 \left|\frac{1}{\hat{M}}\right|^2 \int dp\ p\ \Lambda^2(p)$$

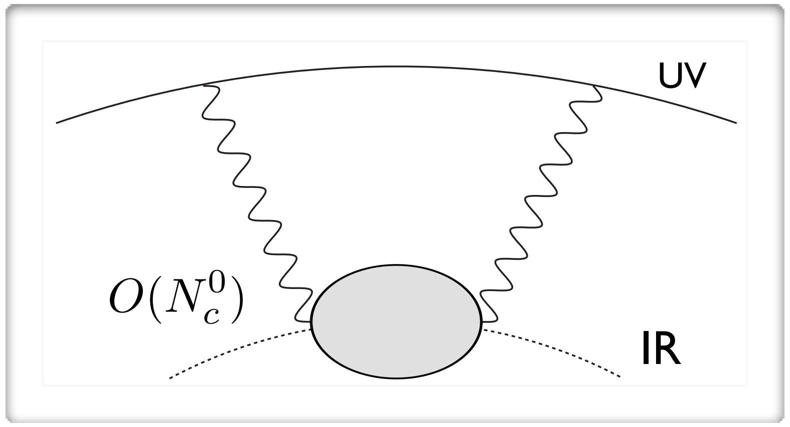
Holographic Scattering



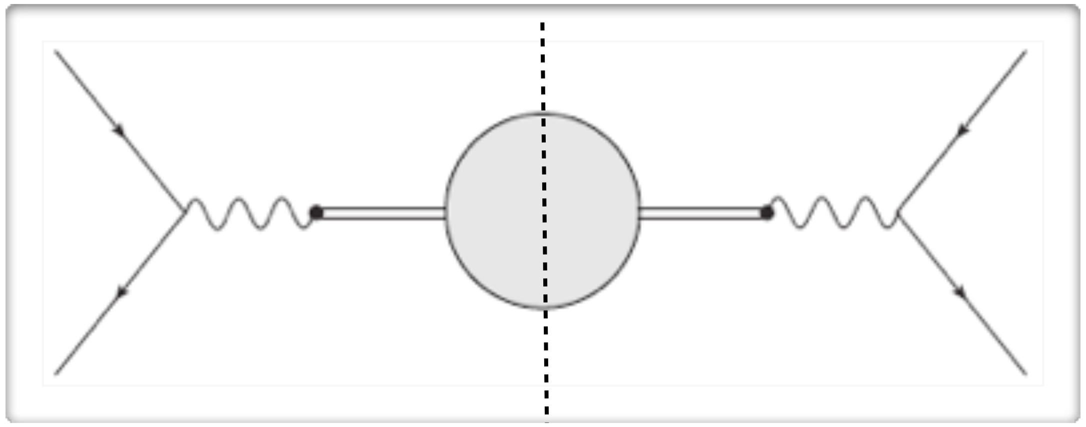
$$F_n \epsilon_\mu = \langle 0 | \mathcal{O}_\mu | \rho_n \rangle$$

meson decay constant

$$g_n = g_5 g_{IR} \int dz \psi_n(z) \varphi(z) \tilde{\varphi}(z) \delta(z - L_1)$$



The form factor encodes a sum of monopole contributions of an infinite tower of vector mesons with decay constants for each meson



Final states can be taken to be messenger fields

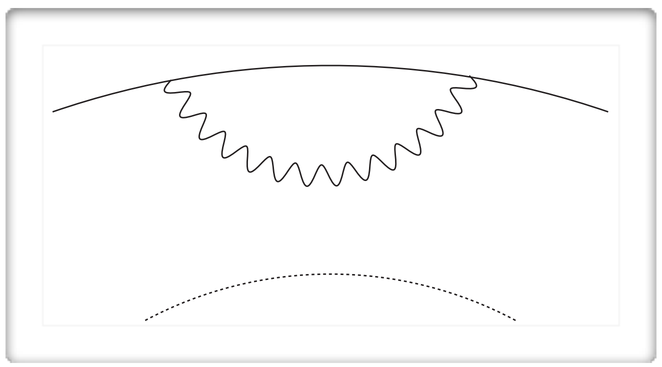
$$\sigma_a(vis \to hid) = \frac{(4\pi\alpha_{SM})^2}{2s} (g_{IR}^2 g_5^2) \sum_{n=1} \frac{F_n \psi_n(z)}{s + m_n^2} \sum_{\hat{n}=1} \frac{F_{\hat{n}} \psi_{\hat{n}}(z)}{s + m_{\hat{n}}^2} \mathrm{Disc}\, \tilde{C}_a(s/\hat{M})$$

$$\text{Duality in } e^+, e^- \to \text{hidden?}$$

Generating functional

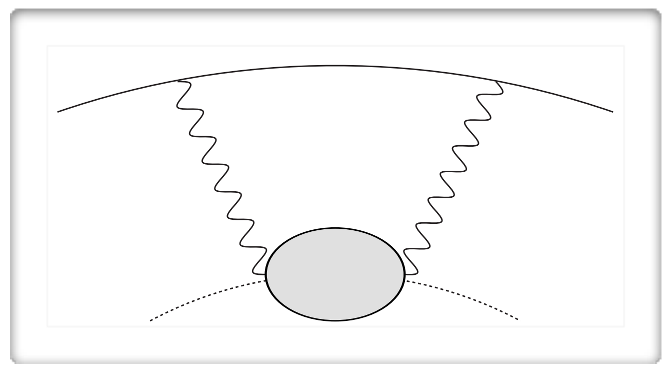
$$Z[A^0, \lambda^0, D^0] = \int_{V(L_0)=V^0} DV e^{-S_{bulk}(V)+\int d^4x d^4\theta V^0 \left[\mathcal{J}_{SM}(x)+\mathcal{O}(x)+\mathcal{J}_{\not{SUSY}}(x)\right]}$$

$$\int d^4x e^{ip.x} \langle \mathcal{O}_\mu(x)\mathcal{O}_\nu(0)\rangle = \Pi(p^2)P^{\mu\nu}$$



supersymmetric piece

$$\int d^4x e^{ip.x} \langle \mathcal{J}_\mu(x)\mathcal{J}_\nu(0)\rangle = \tilde{C}_1(p^2)P^{\mu\nu}$$



leading breaking piece

a sum of many different correlators make the total vacuum polarisation amplitude

all these correlators have a natural OPE expansion

finds application in AdS/condensed matter: Optical theorem gives conductivity

Engineering Holographic Graphene

Grignani , Namshik Kim , Gordon W. Semenoff **hep-th:1208.0867**

Strange Metal Transport Realized by Gauge/Gravity Duality

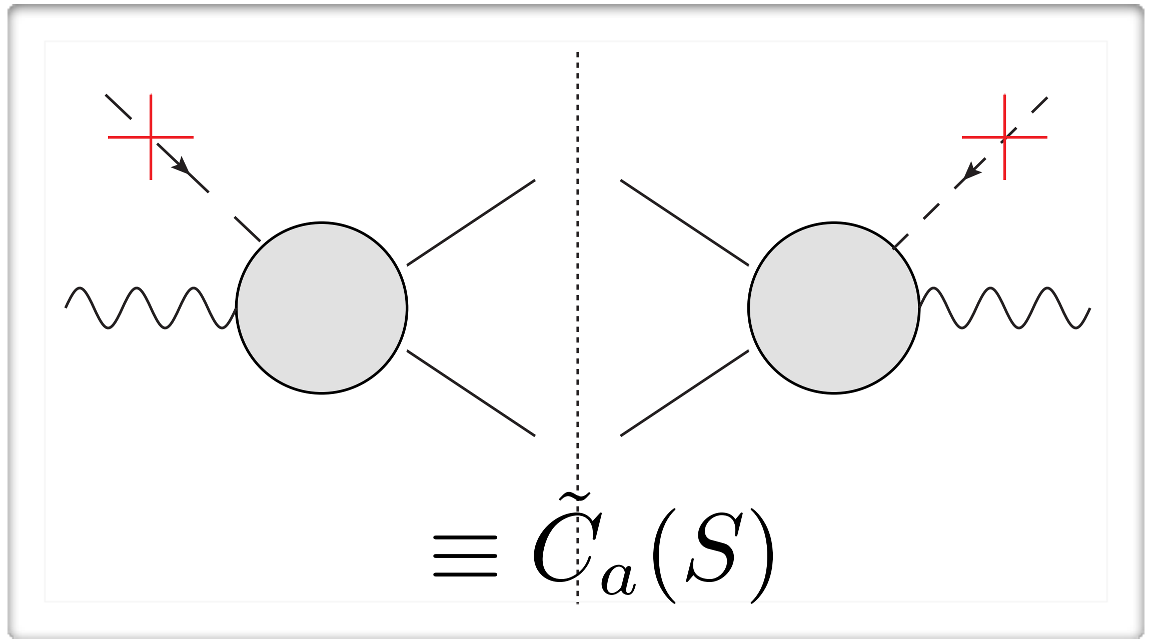
Thomas Faulkner, Nabil Iqbal, Hong Liu, John McGreevy, David Vegh DOI: 10.1126/science.1189134

D. Vecchia and Drago (1969)
Chua, Hama & Kiang (1970)
Frampton (1970)
Many others...

Speculative

A Veneziano-like amplitude for GGM?

$$F(s) \sim \frac{\Gamma[1-\alpha(s)]\Gamma[\lambda-\frac{1}{2}]}{\Gamma[\lambda-\alpha(s)]\Gamma[1/2]}$$



$A(1 \to 2)$

A fit to the pion data

$\lambda \sim 2$

$$\lim_{s\to\infty} F(s) \simeq 1/s^{\lambda-1}$$

$$\alpha(s) = 1/2 + s/2m_\rho^2$$

Infinitely rising linear Regge trajectories

Forward scattering amplitude

Higher spin states contribute too!

The point is that holographic models are toy models with a separation of scales between the spin 0,1/2,1,3/2,2 and the higher spin states.

What next?

maybe this way of thinking may lead to a better understanding of the hidden sector?

Pheno

Go back to the quiver models and do proper studies

currently implementing these models (including Dirac gauginos) into SARAH with Aoife Bharucha & Andreas Goudelis

How can we test these models further?

Theory

Maximal super Yang-Mills in 5d bulk? → MM 1303.4534

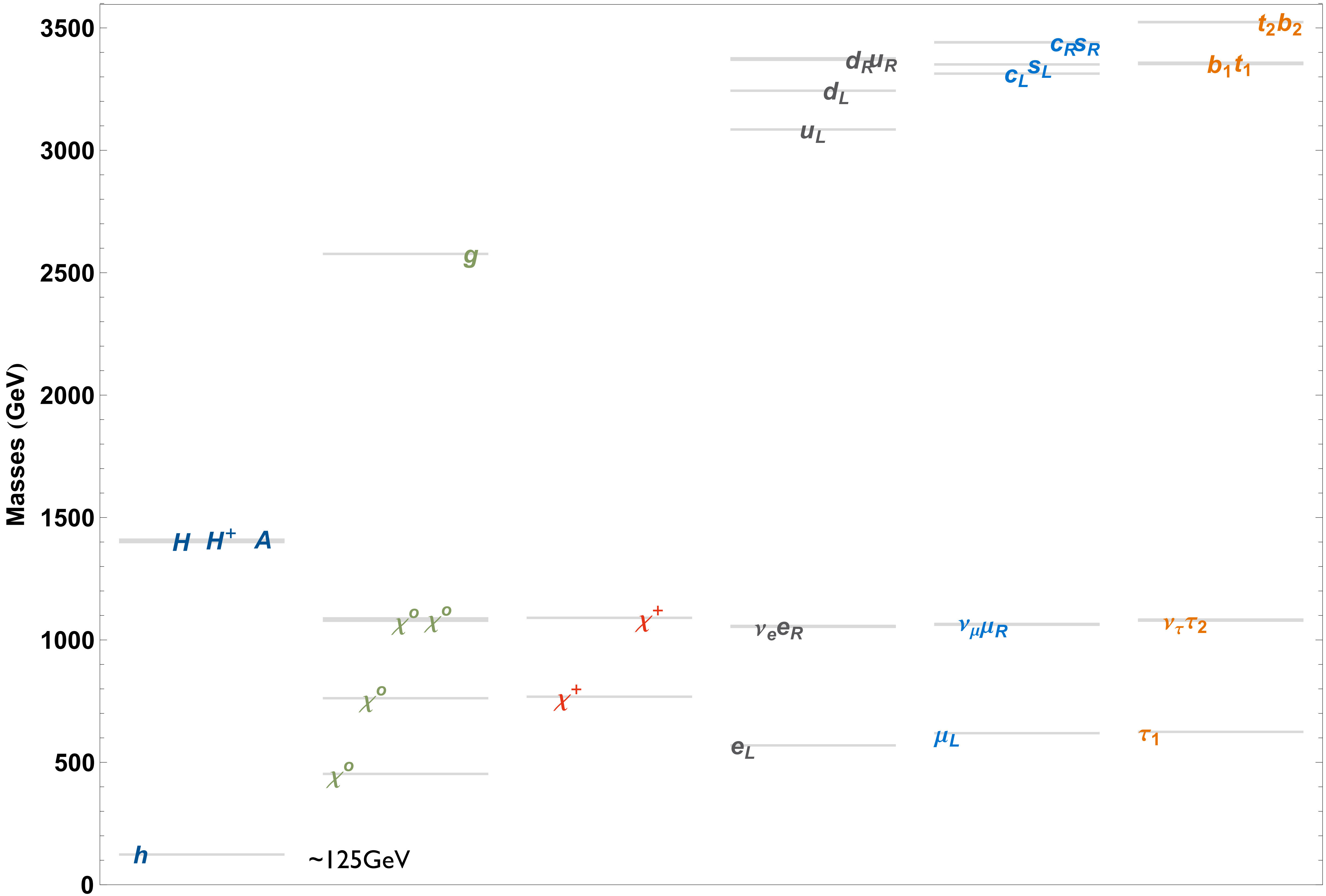
Relate the form factors to OPE's

Large A terms?

Building quivers from Seiberg duality with S. Abel

There are plenty of ways this instructive toy model may be extended!

Electroweak quiver



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Electroweak quiver: preliminary spectrum

Input

```
Block MINPAR  # Input parameters
    1    3.50000000E+05  # LambdaInput
    2    5.20000000E+06  # MessengerScale
    3    2.50000000E+01  # TanBeta
    4    1.00000000E+00  # SignumMu
    5    1.00000000E+00  # n5plets
    6    1.00000000E+00  # cGrav
    7    0.00000000E+00  # n10plets
    8    2.00000000E-01  # The1
    9    2.20000000E-01  # The2
   10    1.00000000E+05  # TScale
   11    4.00000000E+05  # vlvInput
   12    0.00000000E+00  # MkdInput
   13    0.00000000E+00  # MadInput
Block EXTPAR  # Input parameters
  106    8.00000000E-02  # YKInput
  107    8.00000000E-02  # YAInput
```

Output

```
Block MASS  # Mass spectrum
#   PDG code      mass           particle
   1000001     3.24350791E+03  # Sd_1
   1000003     3.35085914E+03  # Sd_2
   1000005     3.35231549E+03  # Sd_3
   2000001     3.36987298E+03  # Sd_4
   2000003     3.44147312E+03  # Sd_5
   2000005     3.52400410E+03  # Sd_6
   1000002     3.08515677E+03  # Su_1
   1000004     3.31328261E+03  # Su_2
   1000006     3.35789970E+03  # Su_3
   2000002     3.37588018E+03  # Su_4
   2000004     3.44074102E+03  # Su_5
   2000006     3.52329303E+03  # Su_6
   1000011     5.69311604E+02  # Se_1
   1000013     6.19171566E+02  # Se_2
   1000015     6.24530619E+02  # Se_3
   2000011     1.05715827E+03  # Se_4
   2000013     1.06542560E+03  # Se_5
   2000015     1.08320684E+03  # Se_6
   1000012     1.05353012E+03  # Sv_1
   1000014     1.06214101E+03  # Sv_2
   1000016     1.07891082E+03  # Sv_3
        25     1.23508263E+02  # hh_1
        35     1.39983318E+03  # hh_2
        36     1.40962078E+03  # Ah_2
        37     1.40578829E+03  # Hpm_2
        23     9.11876000E+01  # VZ
        24     8.03138130E+01  # VWm
         1     5.00000000E-03  # Fd_1
         3     1.05000000E-01  # Fd_2
         5     4.20000000E+00  # Fd_3
         2     3.00000000E-03  # Fu_1
         4     1.27000000E+00  # Fu_2
         6     1.72900000E+02  # Fu_3
        11     5.10998910E-04  # Fe_1
        13     1.05658000E-01  # Fe_2
        15     1.77700000E+00  # Fe_3
   1000021     2.57688158E+03  # Glu
   1000022     4.52864879E+02  # Chi_1
   1000023     7.61963085E+02  # Chi_2
   1000025     1.07840119E+03  # Chi_3
   1000035     1.08809948E+03  # Chi_4
   1000024     7.68185532E+02  # Cha_1
   1000037     1.09034034E+03  # Cha_2
```

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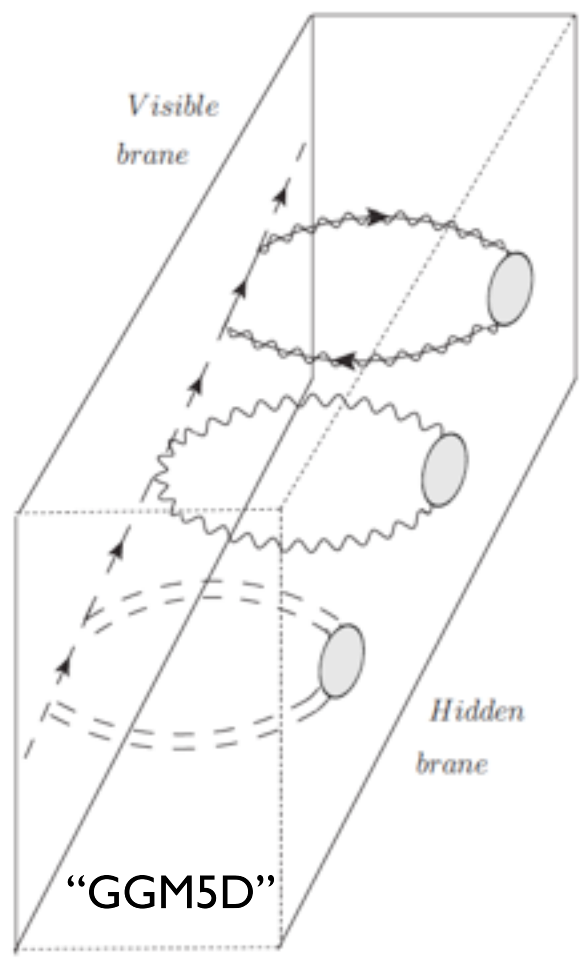
GMSB	Gaugino mediation	"GGM5D" M.M. & R.Russo 1004.3305
$m_\lambda = \left(\frac{\alpha}{4\pi}\right)\frac{F}{M}$	$m_\lambda = \left(\frac{\alpha}{4\pi}\right)\frac{F}{M}$	$m_\lambda = \left(\frac{\alpha}{4\pi}\right)\frac{F}{M}$
$m_\phi^2 = \left(\frac{\alpha}{4\pi}\right)^2 \lvert\frac{F}{M}\rvert^2$	$m_\phi^2 \simeq 0$ (+3 loop through RGE's)	$m_\phi^2 \simeq \left(\frac{\alpha}{4\pi}\right)^2 \lvert\frac{F}{M}\rvert^2 \times \lvert\frac{m_{KK}}{M}\rvert^\rho$ ρ ranges between $[0,2]$
$m_\phi^2 = m_\lambda^2$		



We have a new intermediate regime where

$$@M_{SUSY} : m_\lambda^2 > m_{\tilde{f}}^2$$

....more motivation: everyone's doing it now!

Abstracts:

Shih et al: 1302.2642

"...Using our formalism, we identify new avenues to solving these problems through **strong dynamics** in the messenger sector or hidden sector"

Fortin, Intriligator, Stergiou: 1109.4940

"...to constrain and analyze hidden sector theories that couple to our gauge forces and are **not necessarily weakly coupled**"

Fortin, Stergiou: 1212.2202

Field-theoretic Methods in Strongly-Coupled Models of General Gauge Mediation

"...We manage to obtain reasonable approximations to soft masses, even when the hidden sector is **strongly coupled.**"

Abel, Gherghetta: 1010.5655

"...we use our framework to study **strongly-coupled** scenarios of supersymmetry breaking mediated by gauge forces"

as well as ....

McGuirck,
Skenderis & Taylor
Argurio, Bertolini, Pietro, Porri Redigolo
Benini, Dymarsky, Franco, Kachru, Simic
McGuirck, Shiu, Sumitomi
Buican, Seiberg, Meade
Komargodski, Katz, Green