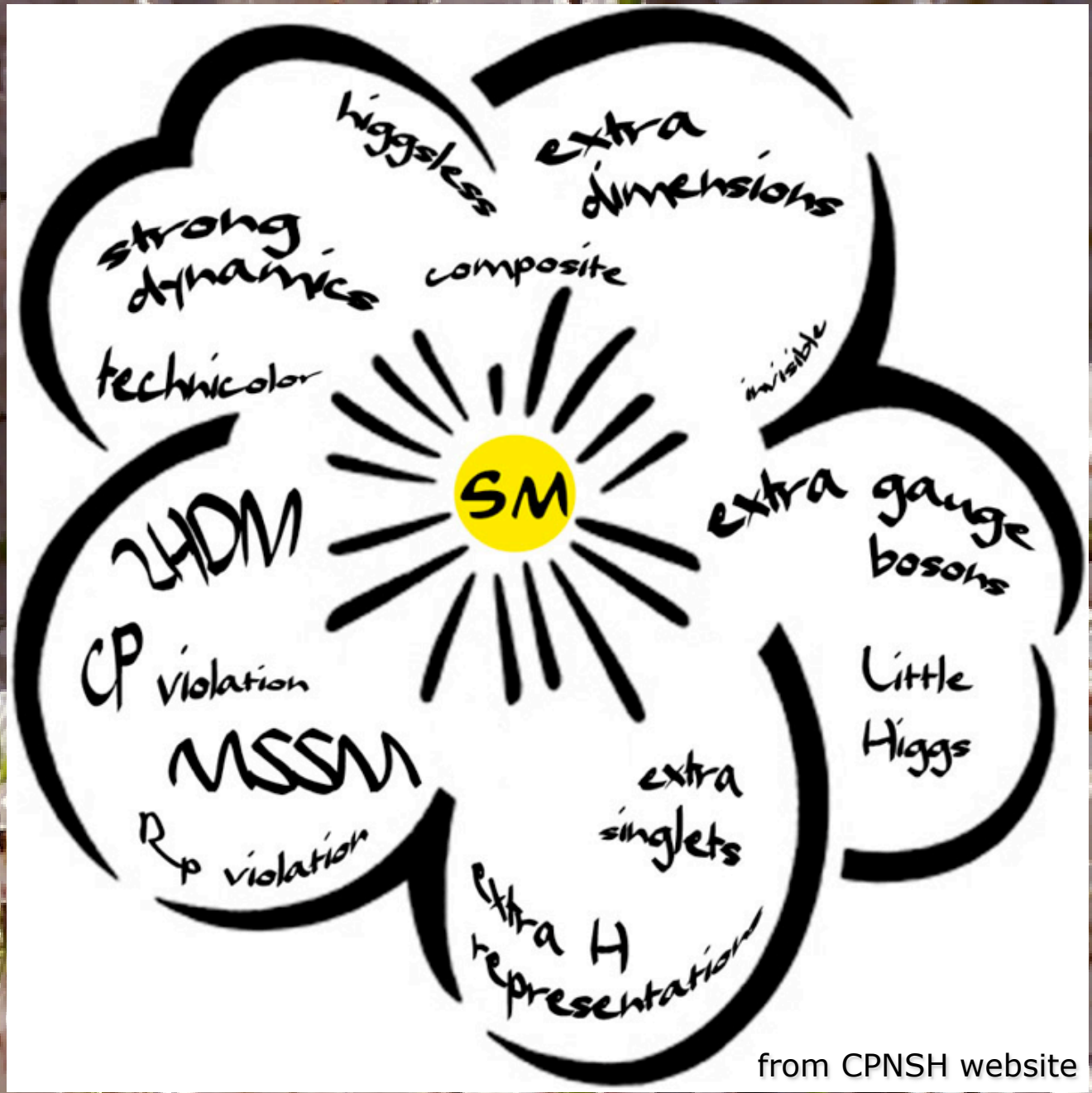
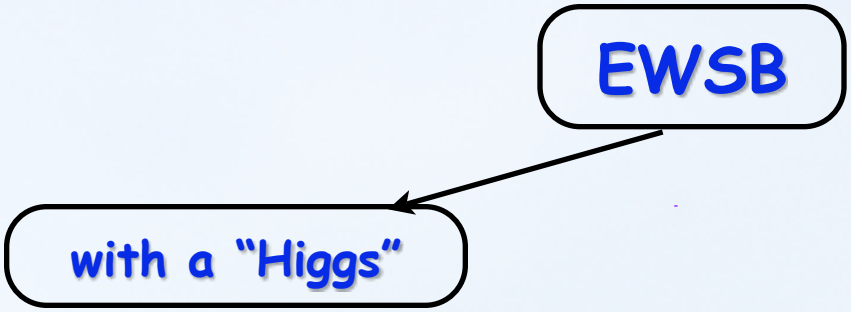
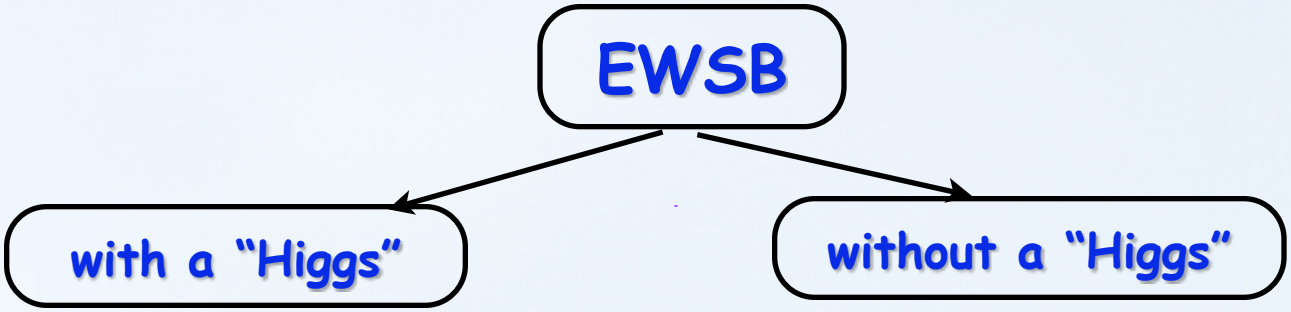
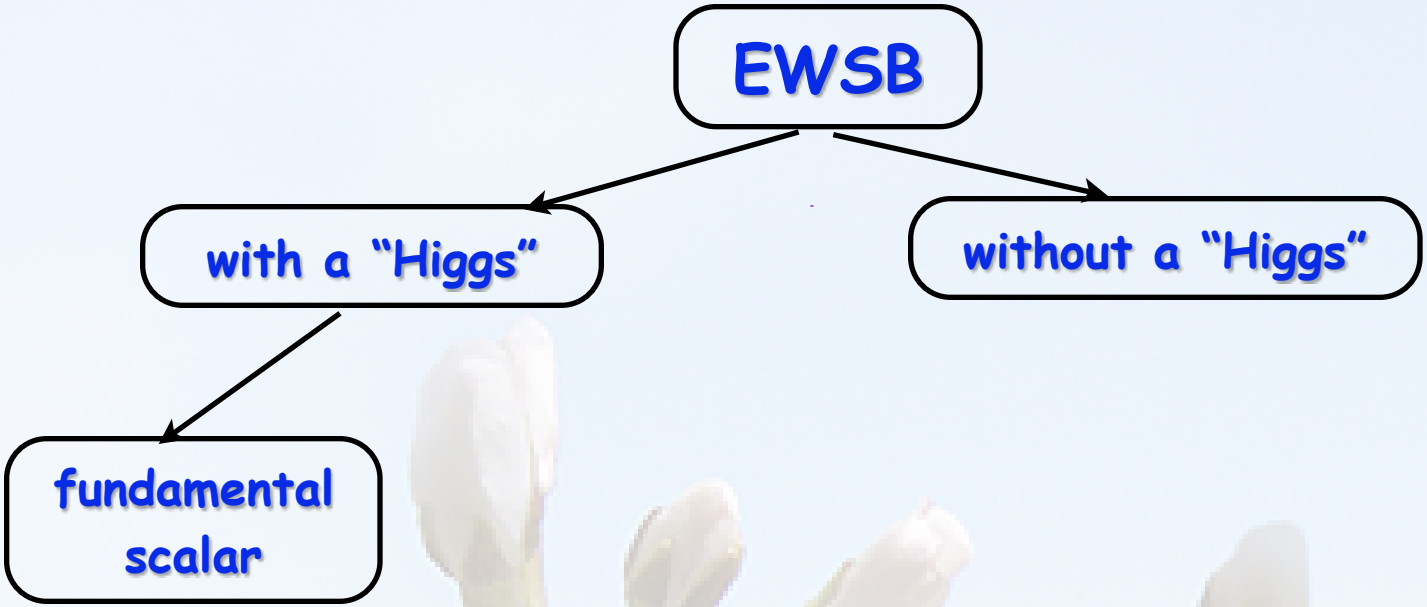


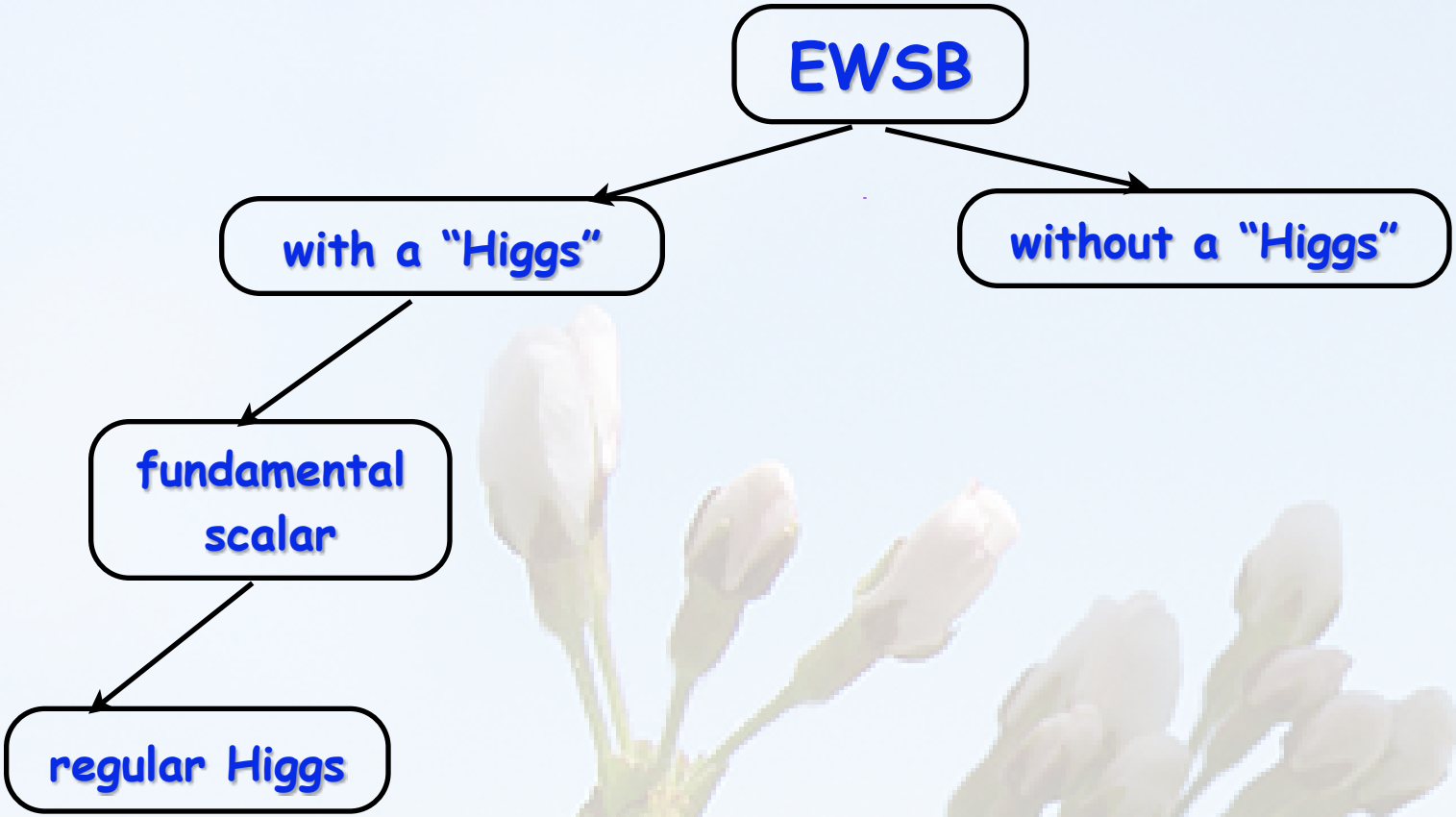
from CPNSH website

EWSB


EWSB
with a "Higgs"

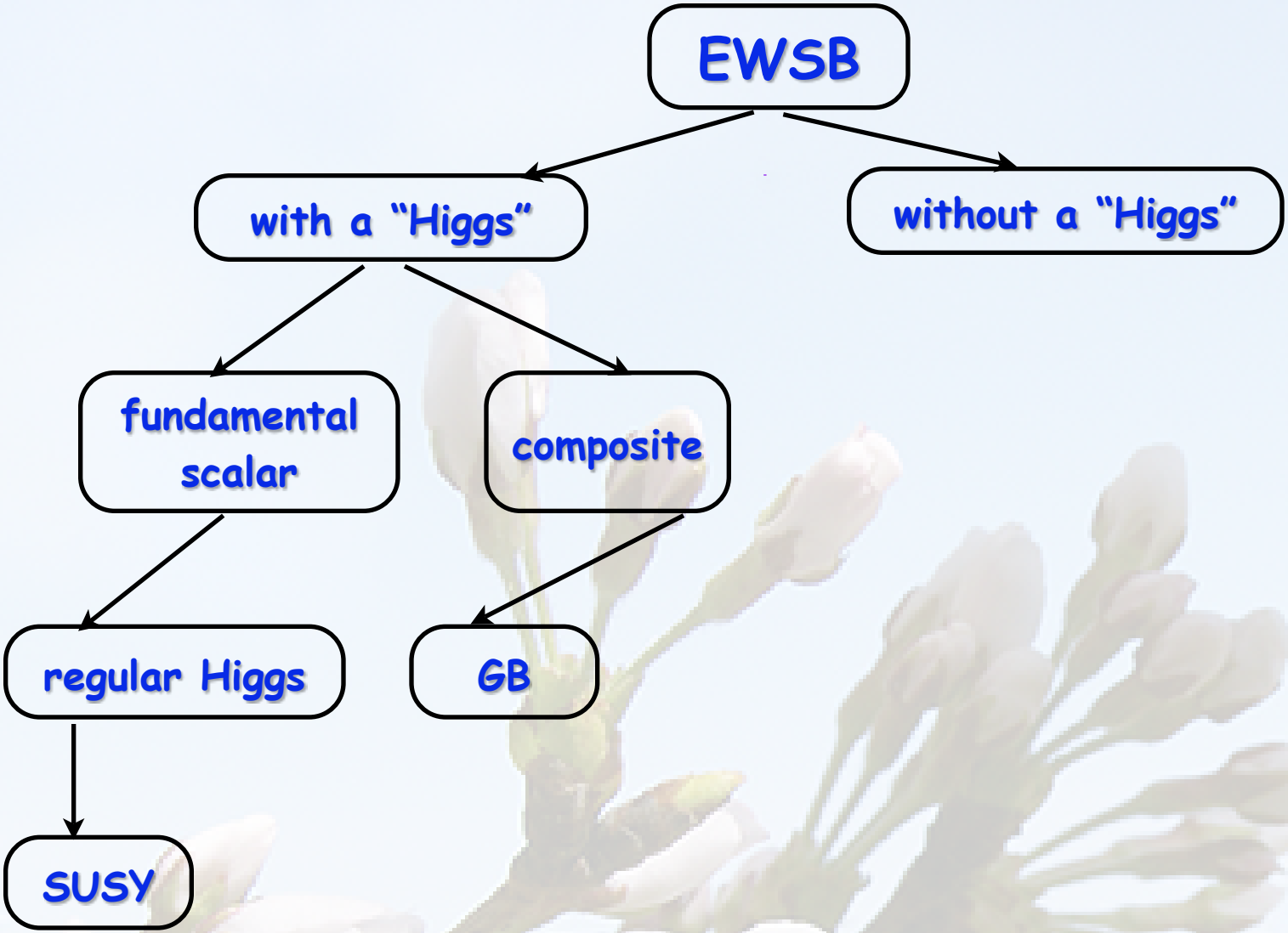

EWSB
with a "Higgs"
without a "Higgs"


EWSB
with a "Higgs"
without a "Higgs"
fundamental scalar


EWSB
with a "Higgs"
without a "Higgs"
fundamental scalar
regular Higgs


EWSB
with a "Higgs"
without a "Higgs"
fundamental scalar
regular Higgs
SUSY


EWSB
with a "Higgs"
without a "Higgs"
fundamental scalar
regular Higgs
GB
SUSY


EWSB
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fundamental scalar
composite
regular Higgs
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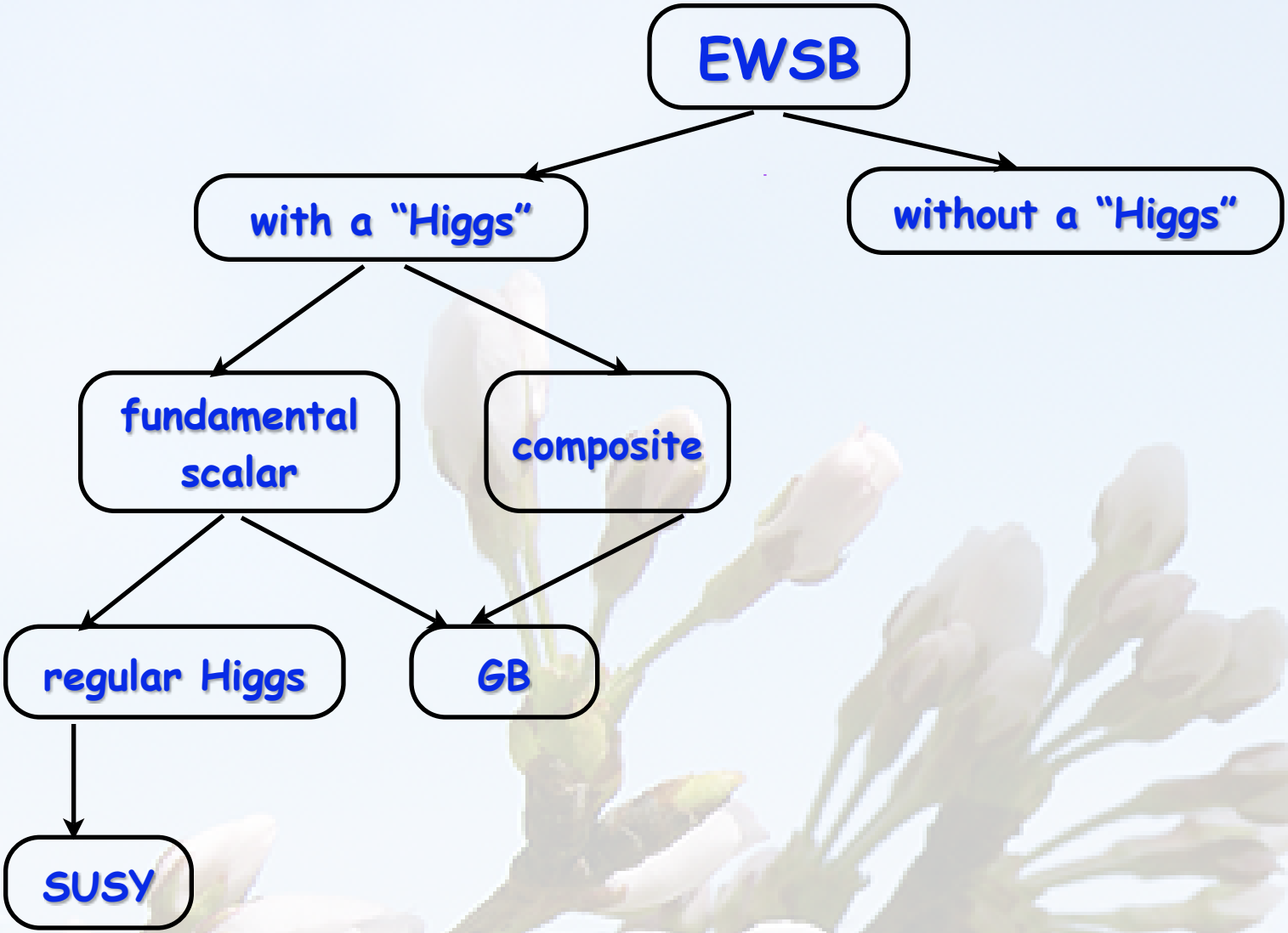
SUSY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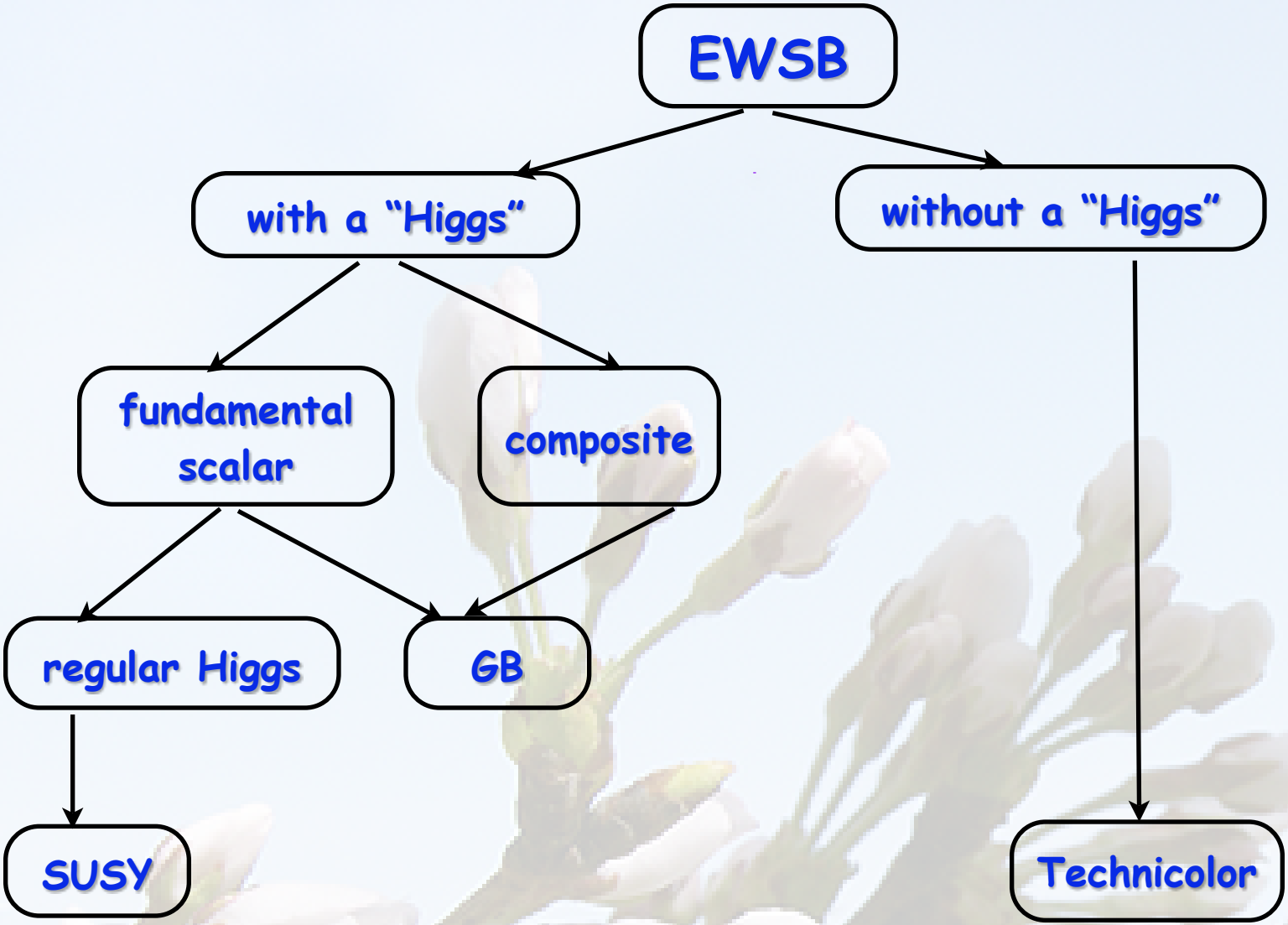
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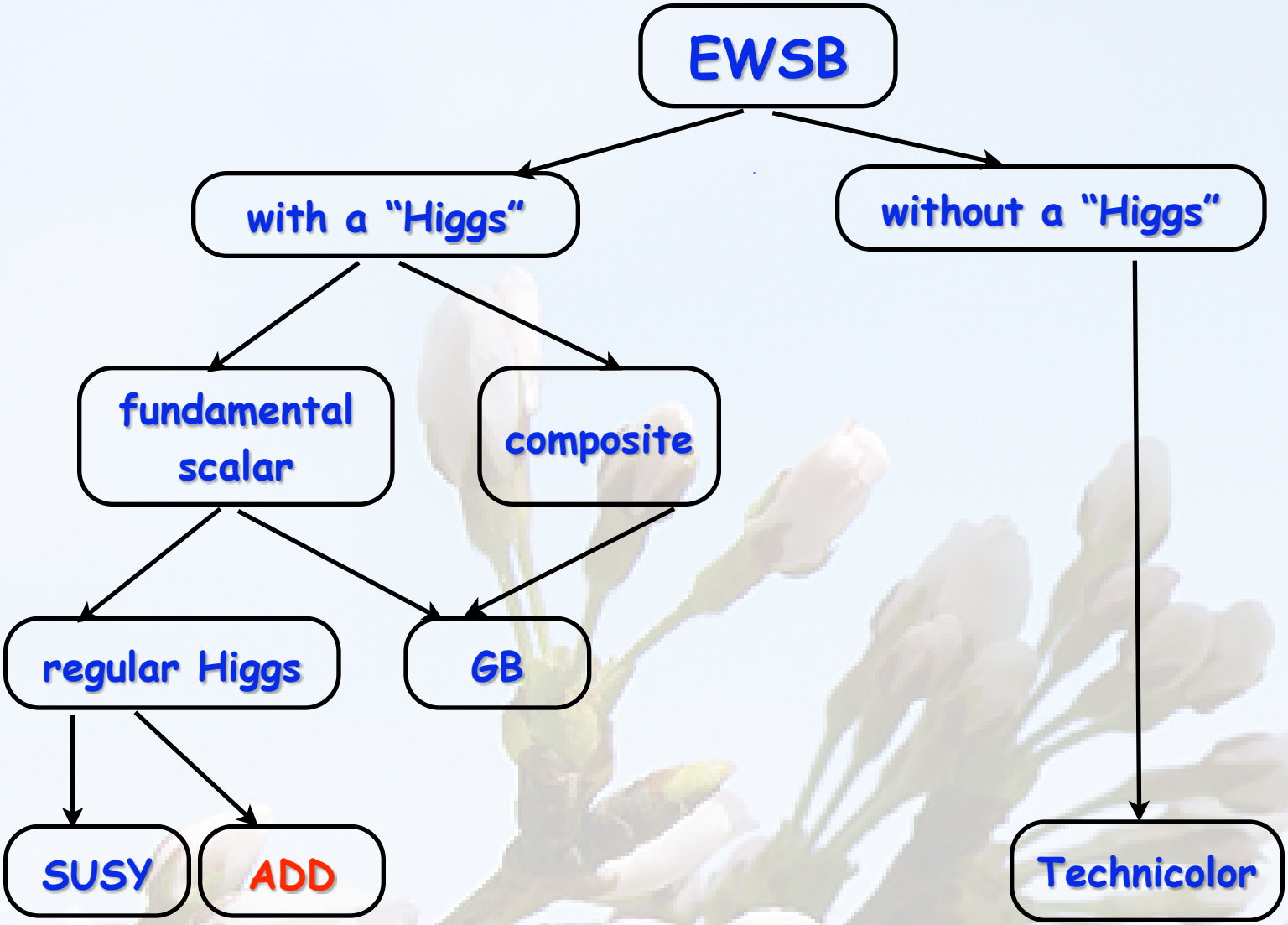
Technicolor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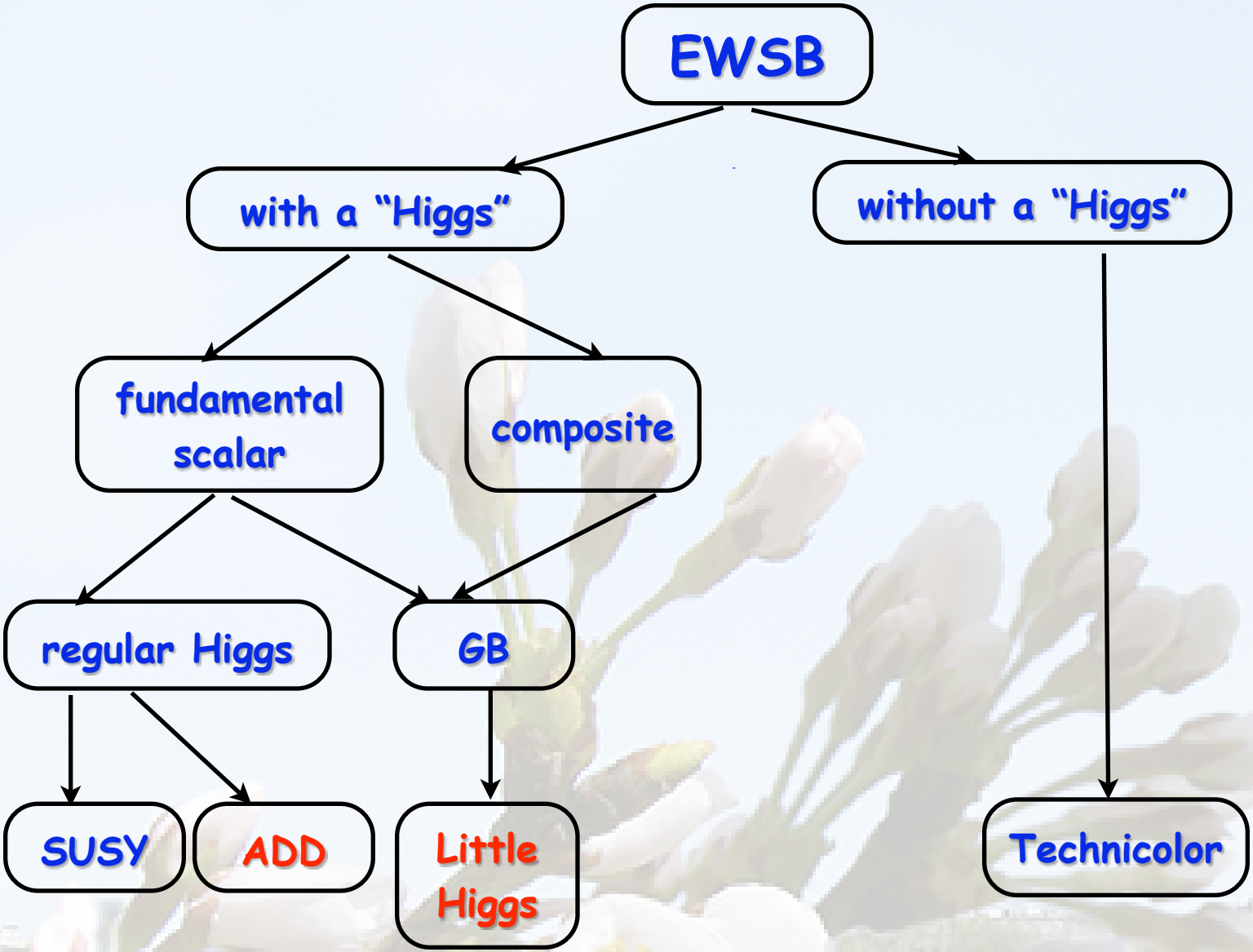
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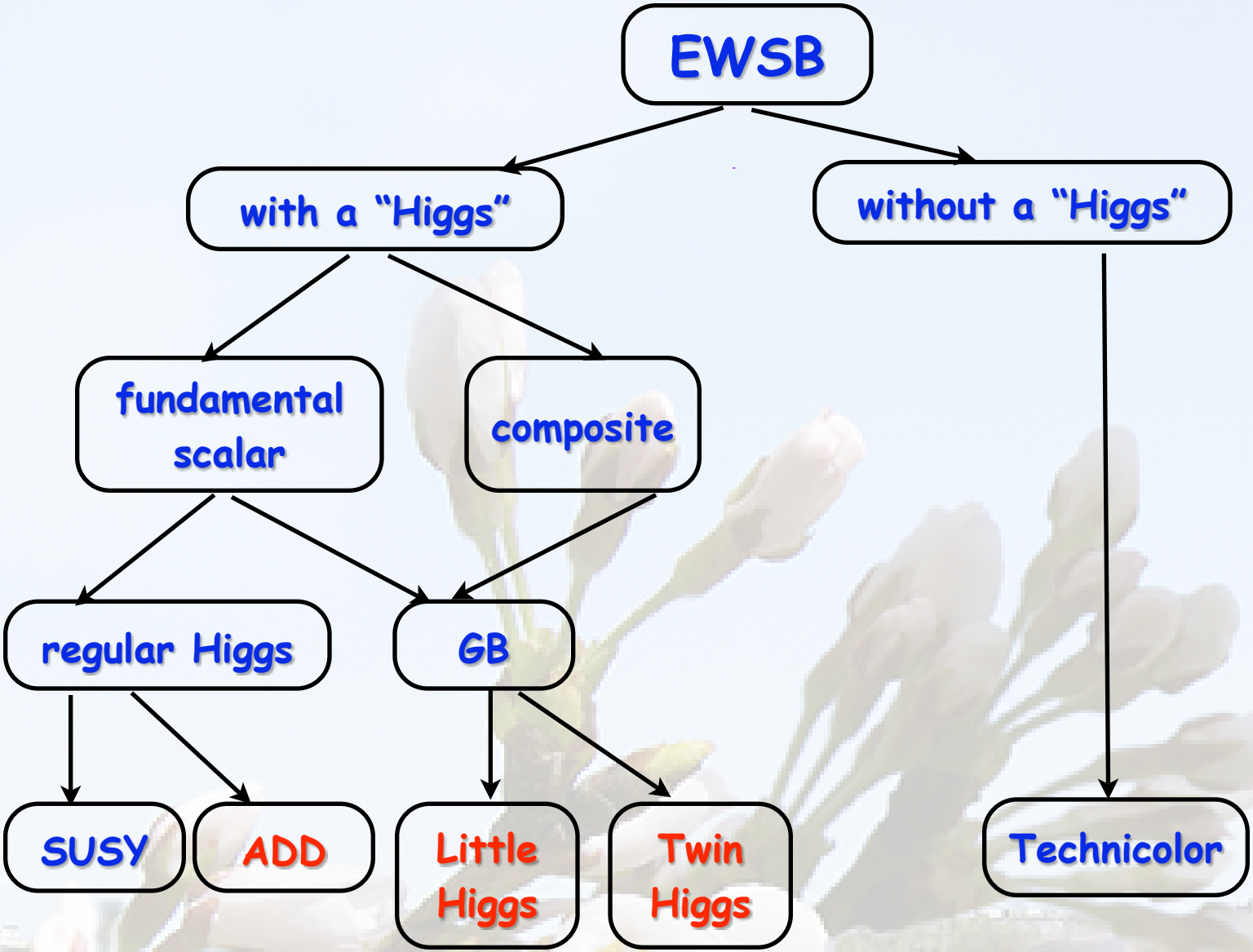
Little Higgs
Technicolor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GB
SUSY
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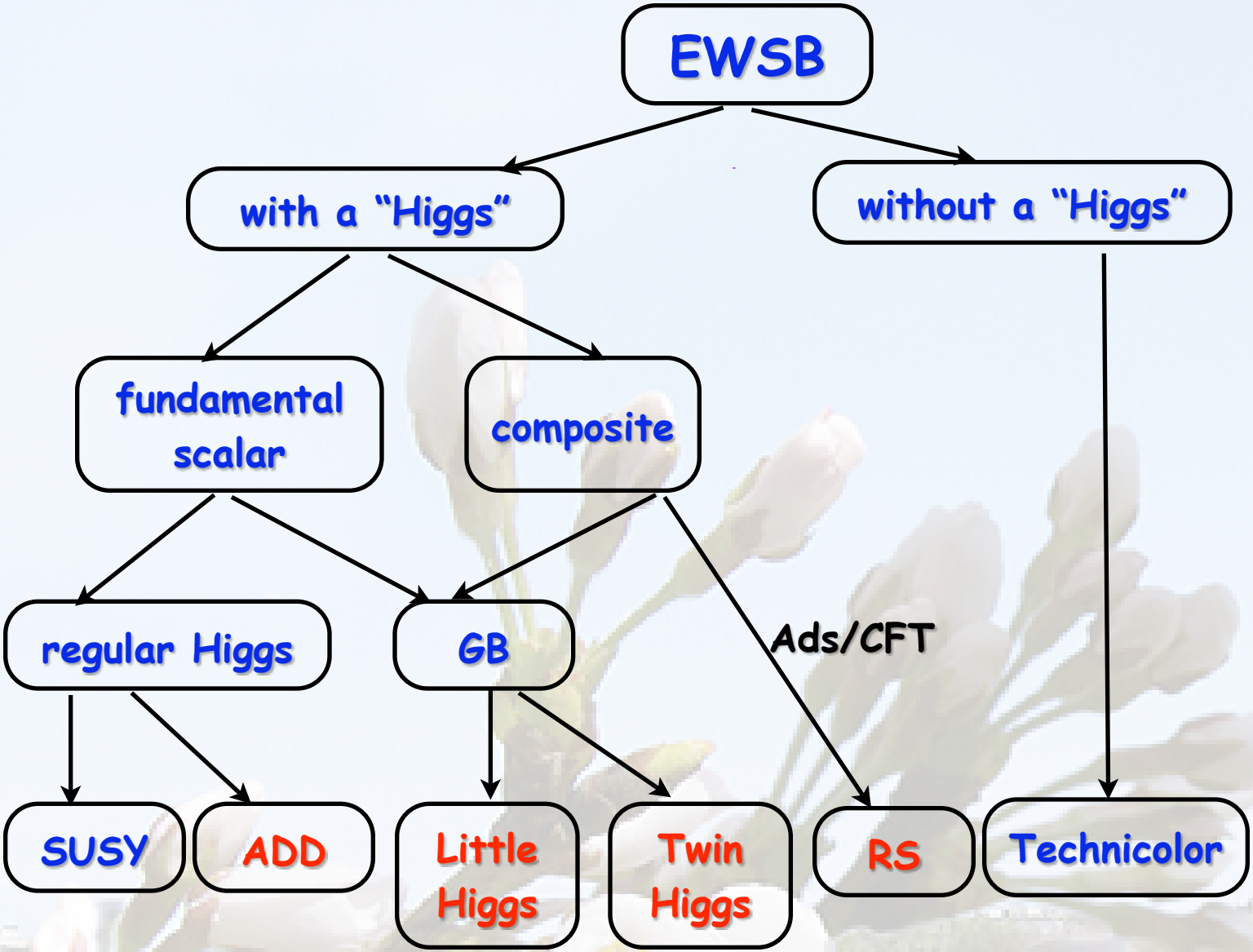
Technicolor


EWSB
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Ads/CFT
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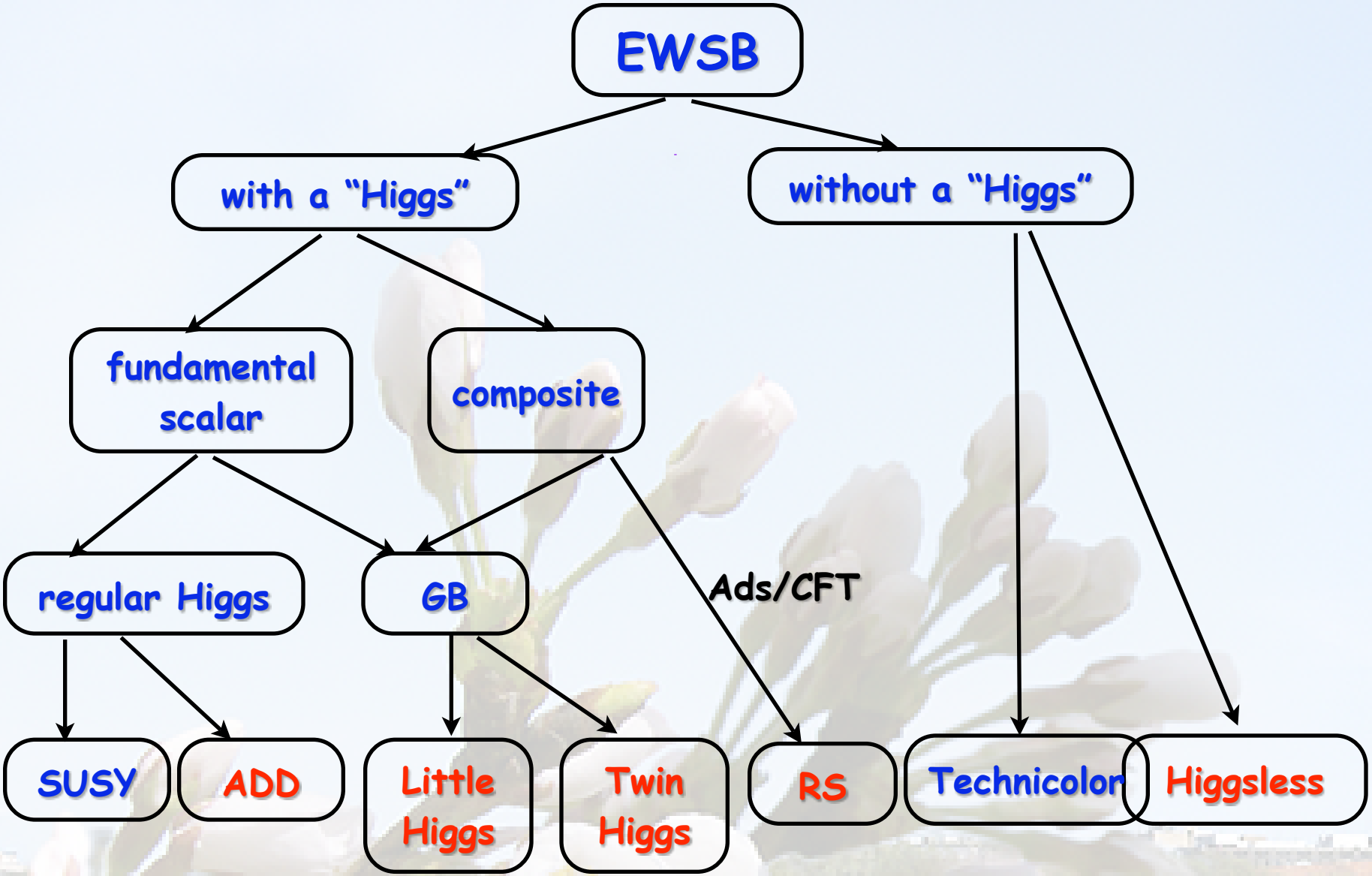
Little Higgs
Twin Higgs
RS
Technicolor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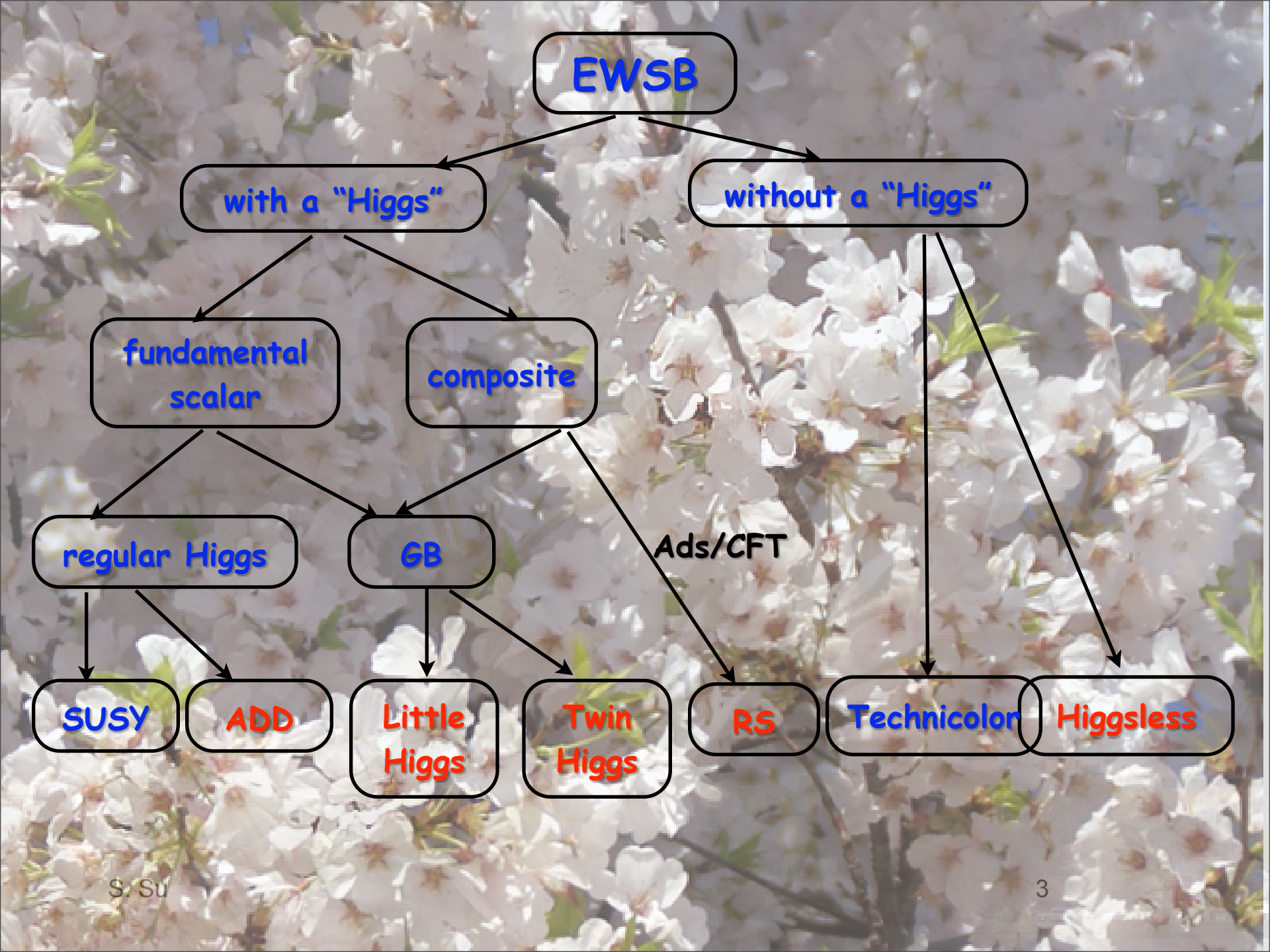
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Signatures in the Electroweak Symmetry Breaking Sector

Shufang Su • U. of Arizona

Phenomenology Symposium 2007

Outline

- What I will and will not to cover
- EWSB scenarios and its signatures

SUSY | ADD | Little Higgs | Twin Higgs | RS | Technicolor | Higgsless

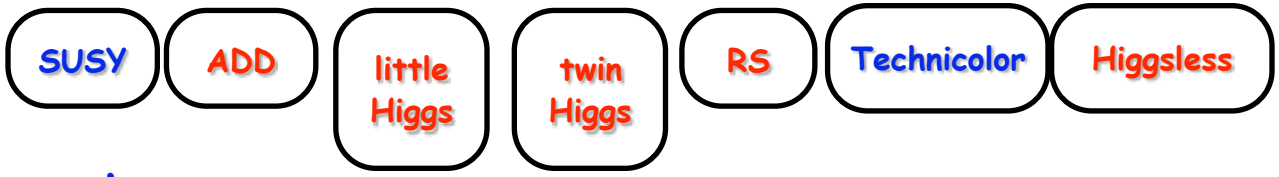
- The difficult question

What I Will and Will Not Cover?

Will not discuss

- Scenarios do not directly related to EWSB and (little) Hierarchy
  - UED, split SUSY, GUT, ...
- Indirect signatures: effects in precision measurements
- Higgs properties

Will focus on

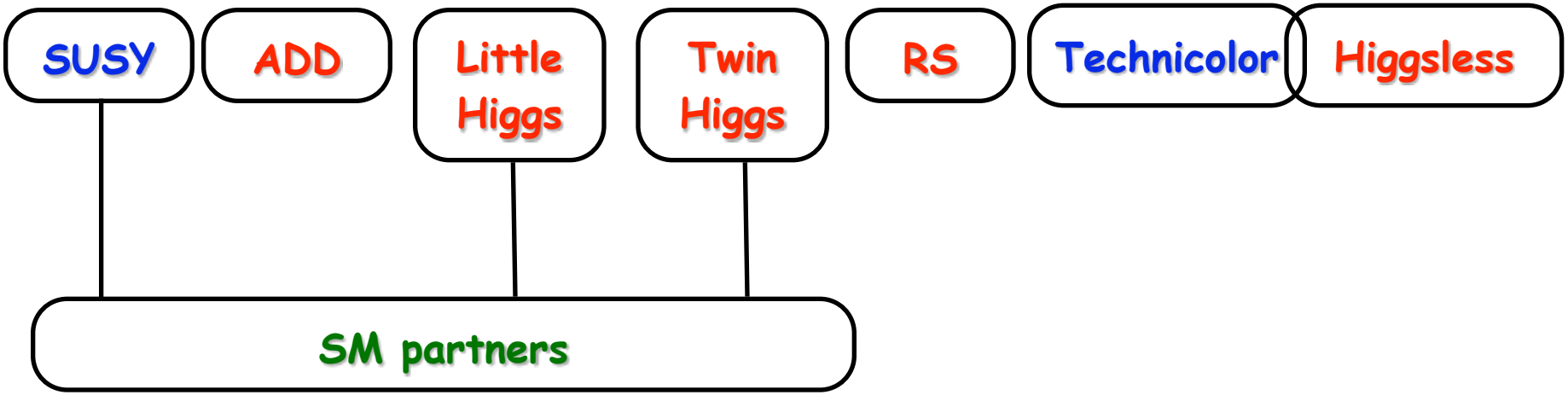


- Recent developments
- Direct search signatures @ LHC
- try to be as model independent as possible
  - particle directly related to the cancellation of quadratic divergence
  - particles essential to the scenario
  - minimum (vanilla) model (might not be the best model)

New Particles at a Glance

SUSY | ADD | Little Higgs | Twin Higgs | RS | Technicolor | Higgsless

New Particles at a Glance



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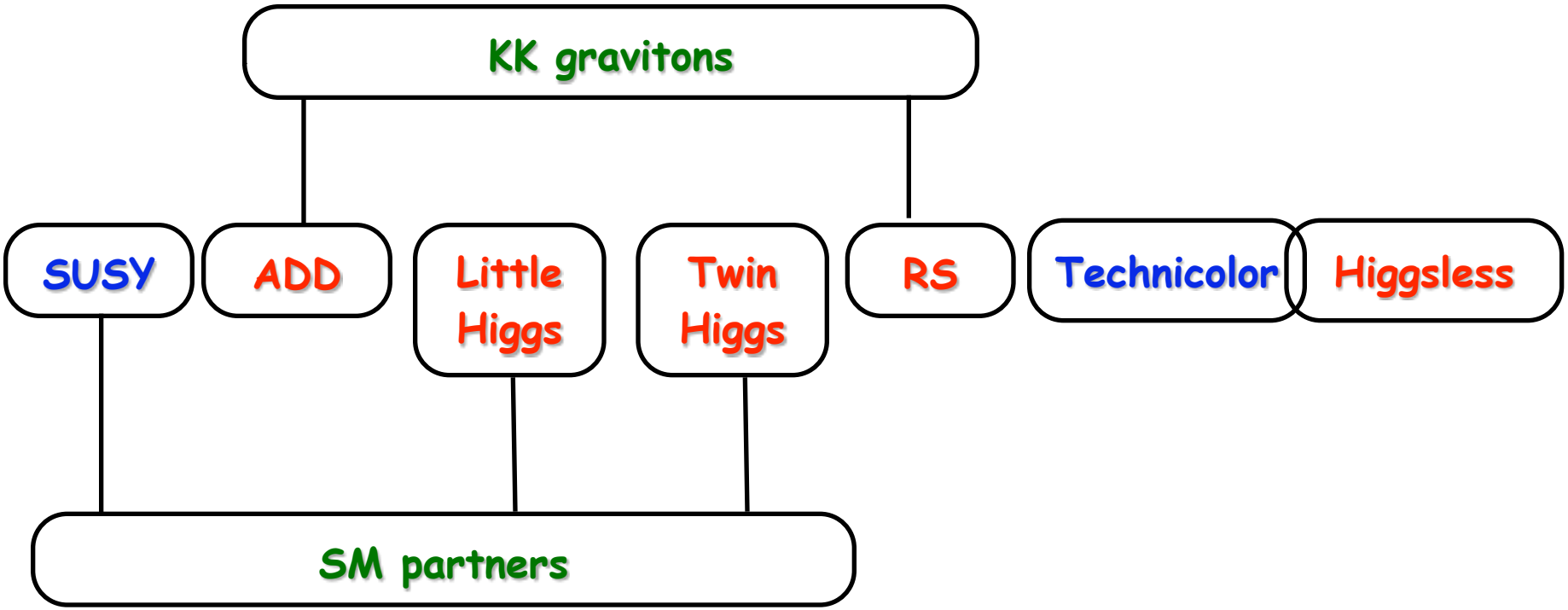

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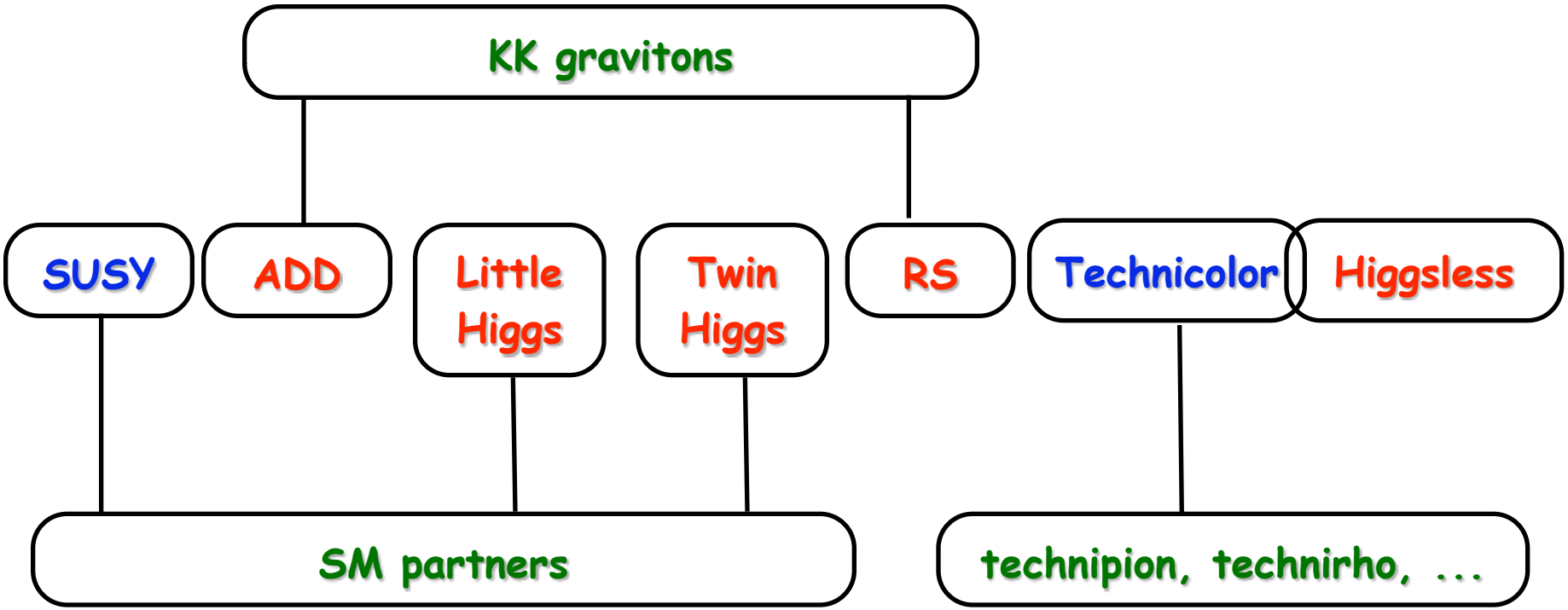

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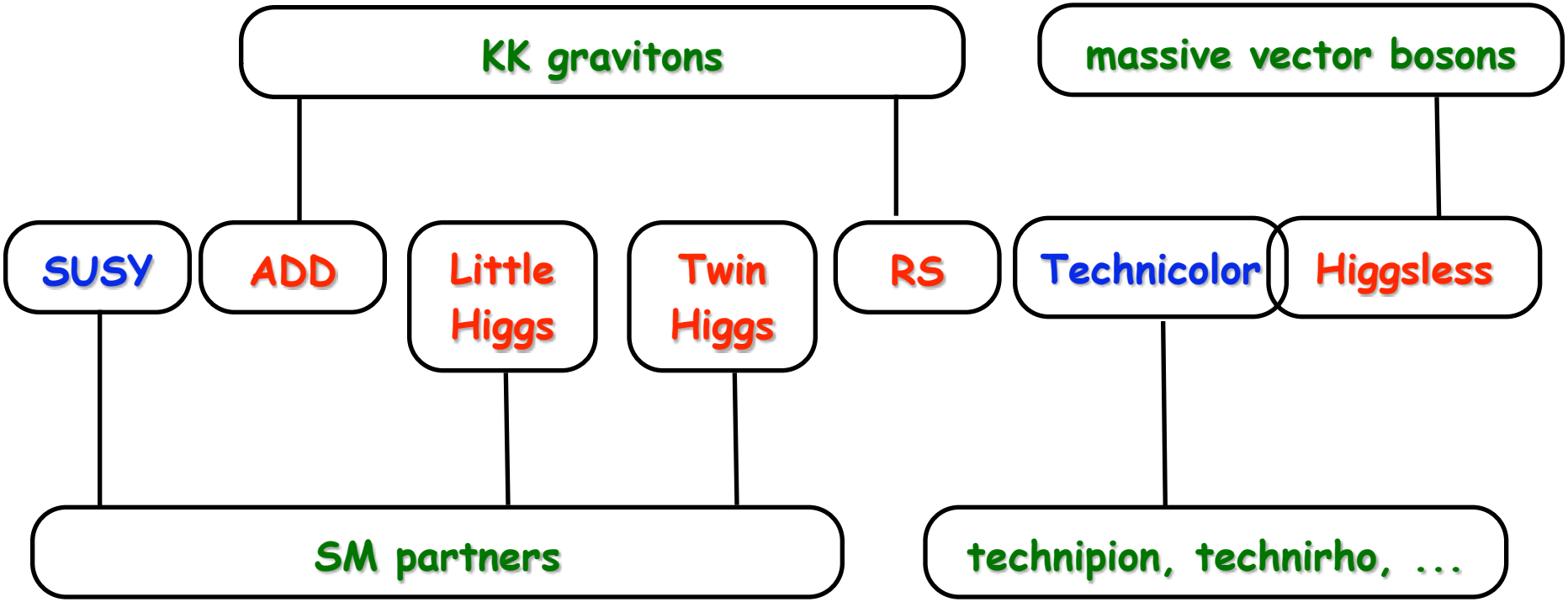

SUSY

Supersymmetry

By now, everyone knows what usual SUSY signals are ...

you always hear people say
" If there is supersymmetry, we can observe it at the LHC."

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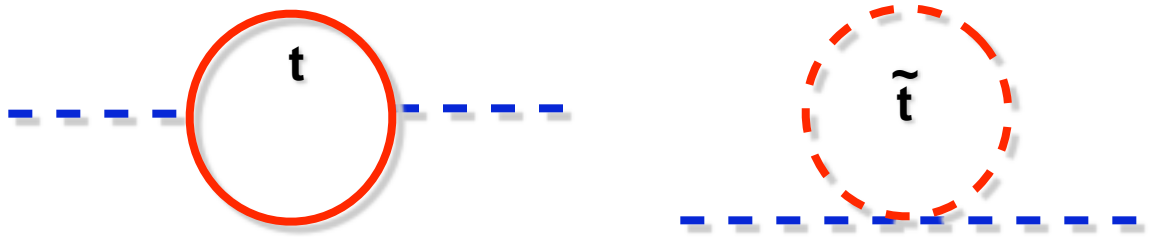

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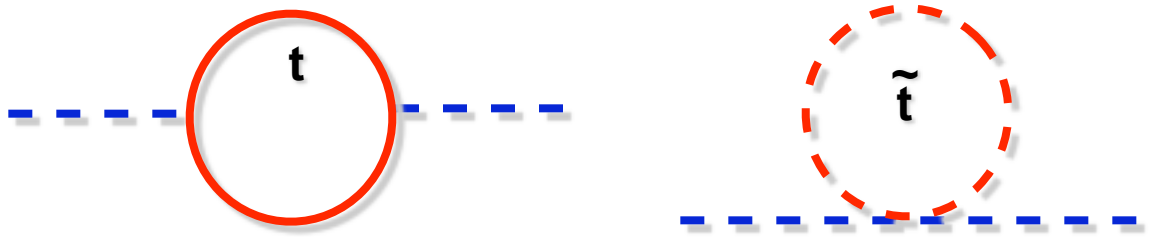

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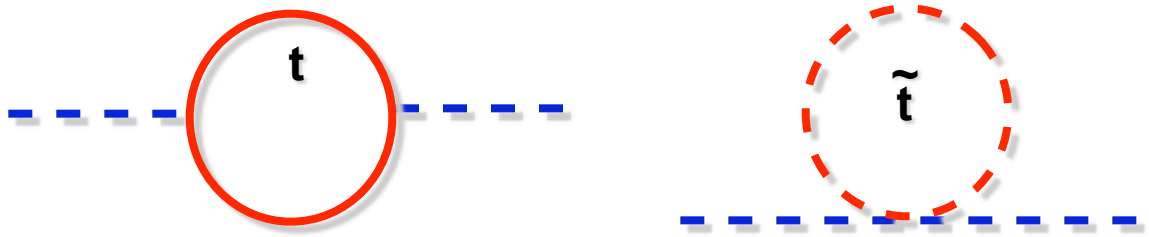

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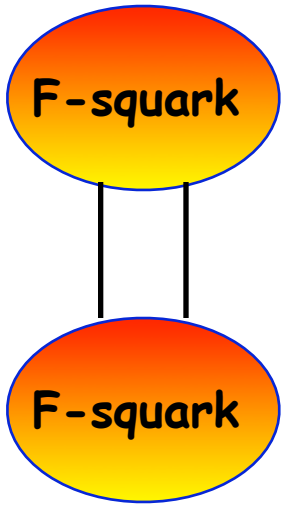
folded SUSY

Burdman, Chacko, Goh and Harnik, hep-ph/0609152

Signatures

Collider signature



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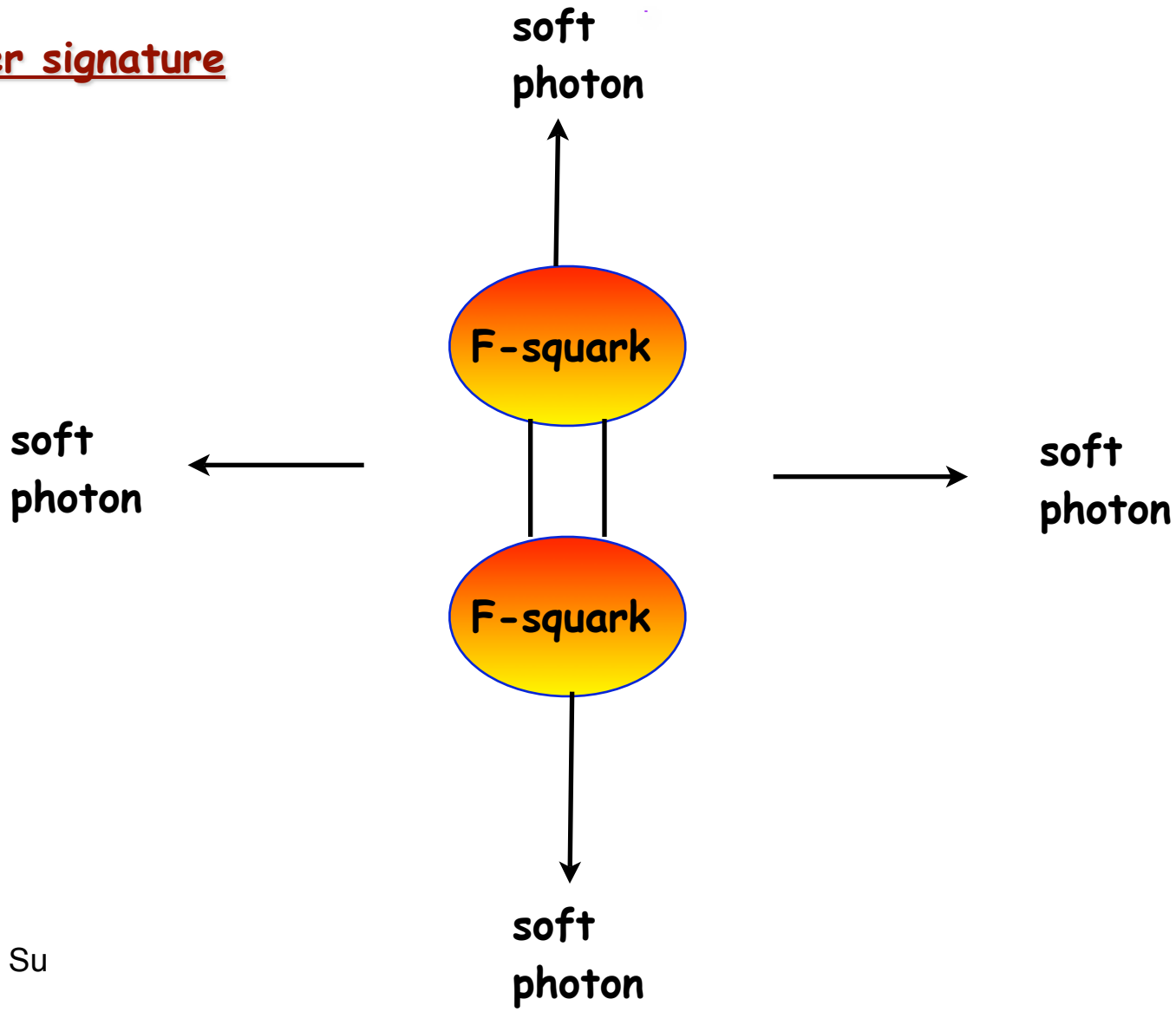

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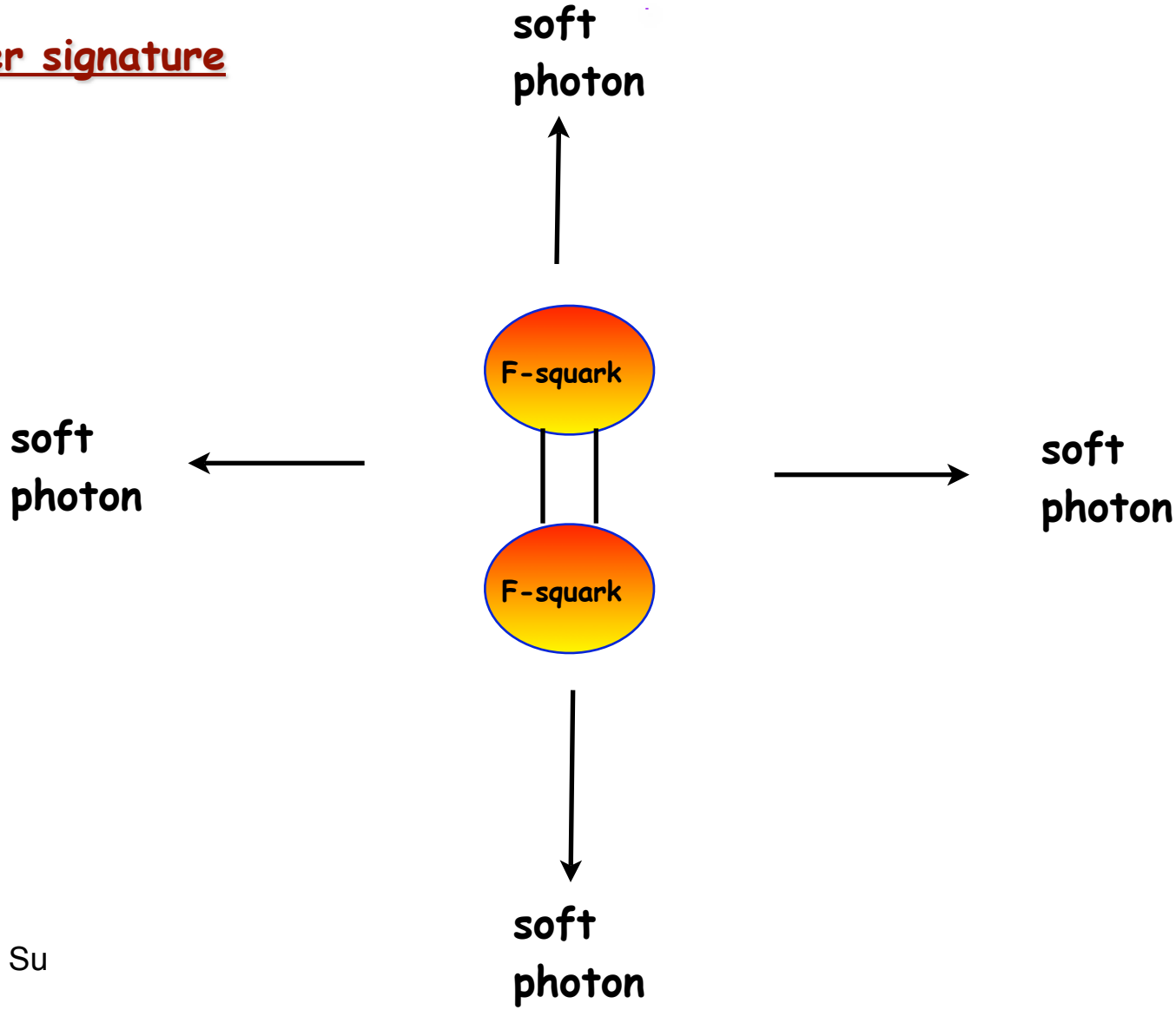

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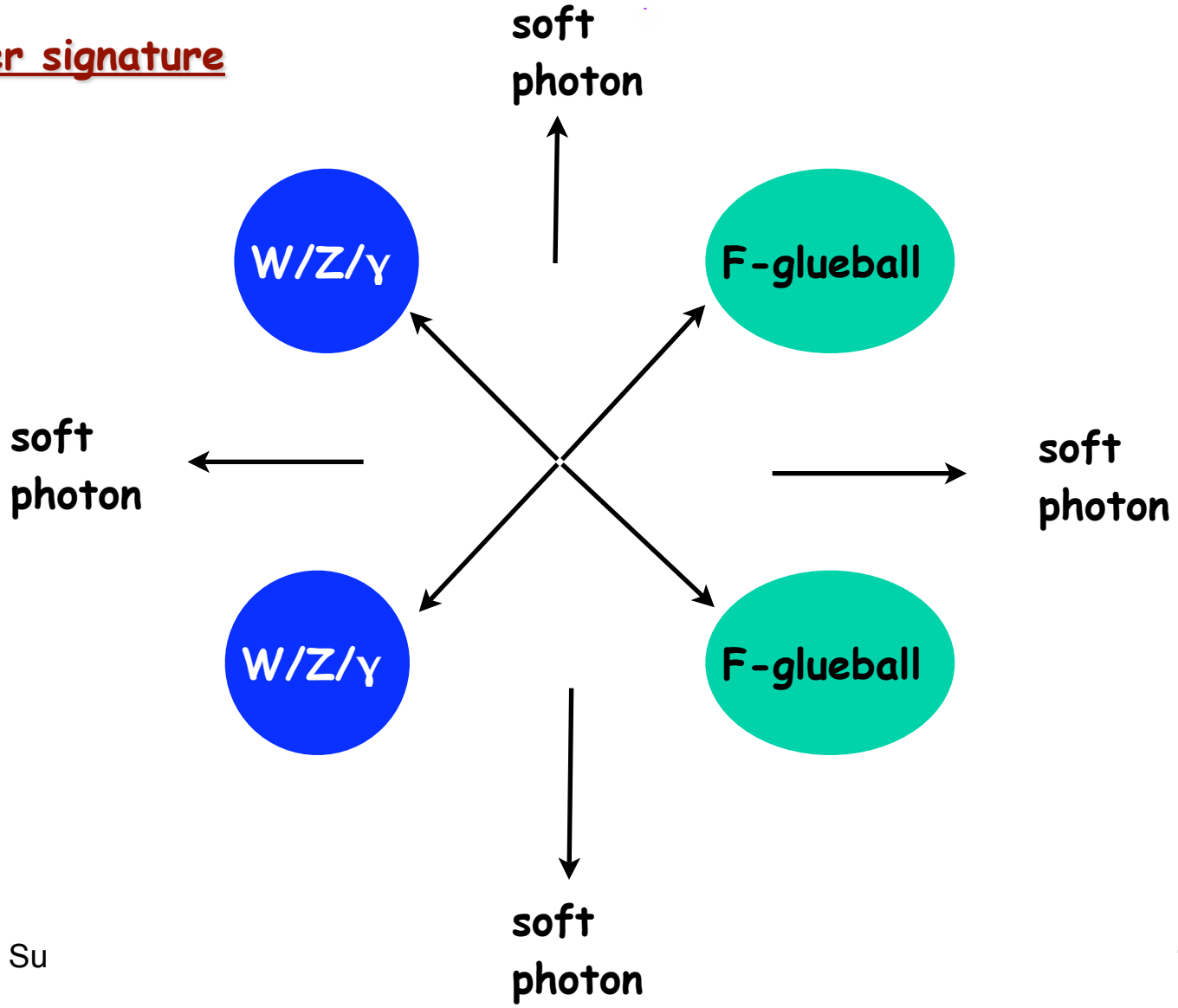


ADD

Large Extra Dimensions

ADD

Arkani-Hamed, Dimopopulos, Dvali, hep-ph/9803315

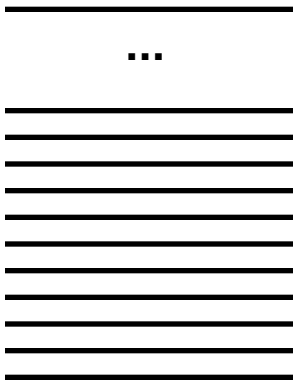
$$M_*^{n+2} R^n = M_{pl}^2$$

~ TeV — 10^{19} GeV

$$\delta m_H^2 \sim \frac{3y_t^2}{4\pi^2}\Lambda^2 \log(\Lambda/m_t)^2$$

$\sim$ EW scale

M_* ~ TeV	δ=1	δ=2	δ=3	δ=4	δ=5	δ=6
R (m)	3E13	2E-3	1E-8	2E-11	5E-13	4E-14
1/R (GeV)	6E-30	8E-14	2E-8	9E-6	4E-4	4E-3



- gravity live in δ+4 dimensions
- massless mode: 4D graviton
  massive mode: KK tower of graviton

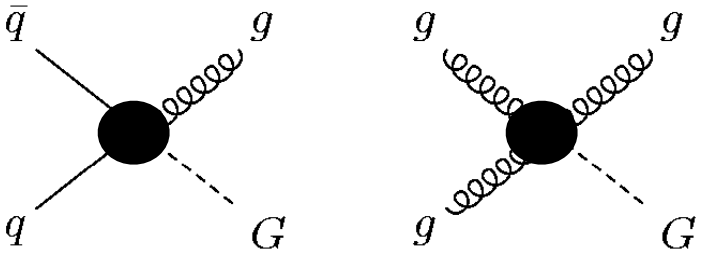
$m_G^{KK} = n/R$, n=1,2,... small mass splitting

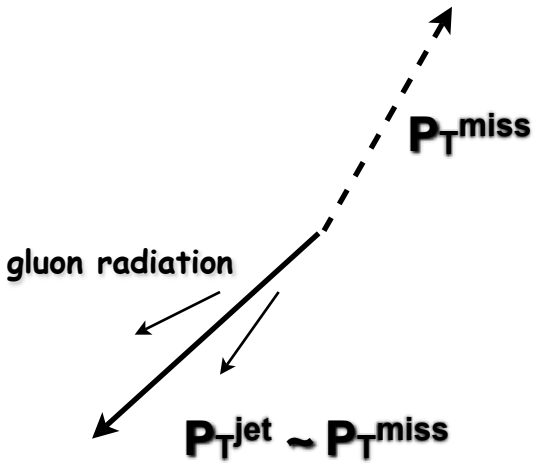
ADD

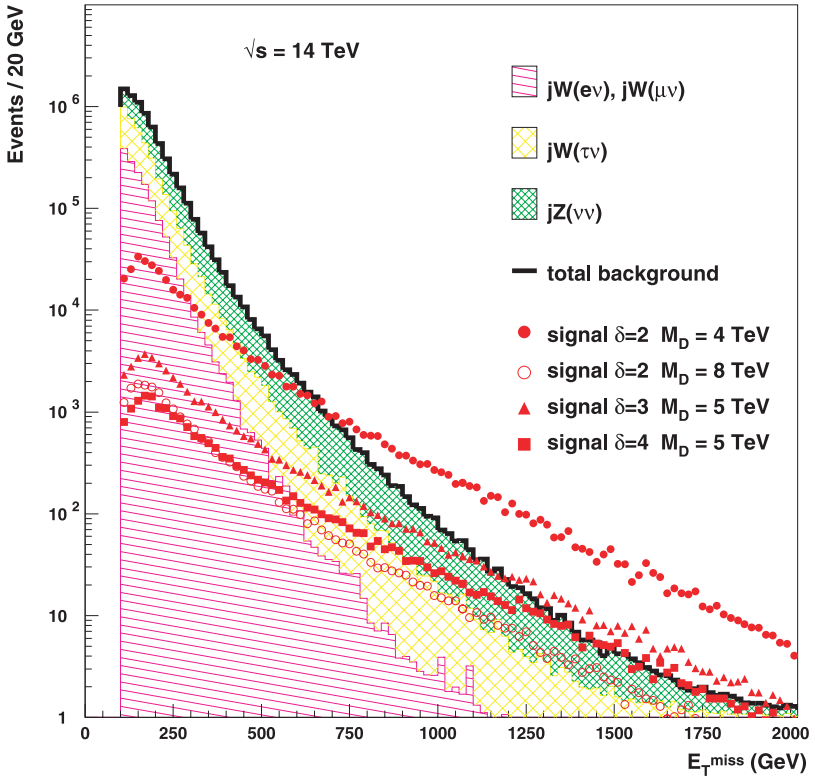
Single Jet/Photon + MET

- KK graviton: appear as missing E_T
- Signatures: Single gluon/photon + large missing E_T

Vacavant and Hinchliffe, 2001







M_D=7-9 TeV for L=100fb^{-1}

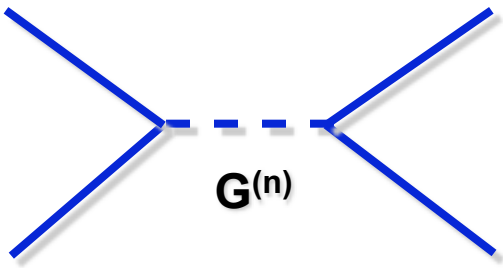
S. Su

ADD

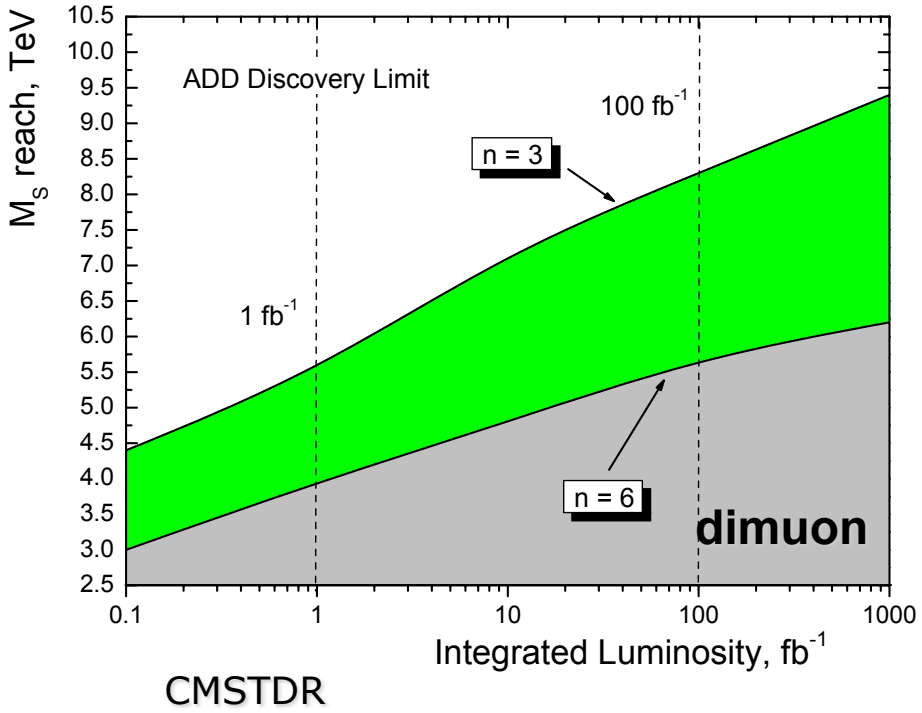
2 → 2 Scattering

Virtual Graviton Exchange in 2→2 scattering

- deviations in SM process with difermions
- new production process absent in SM at tree level, e.g. $gg \to l^+l^-$

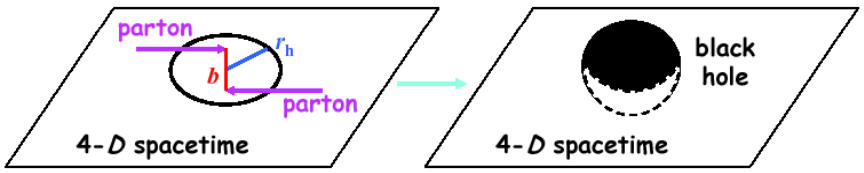


$$\mathcal{M} \sim \frac{i^2\pi}{M_{\rm Pl}^2} \sum_{\vec{n}=1}^{\infty} \frac{1}{s - m_{\vec{n}}^2} \to \frac{\lambda}{M_H^4}$$



ADD

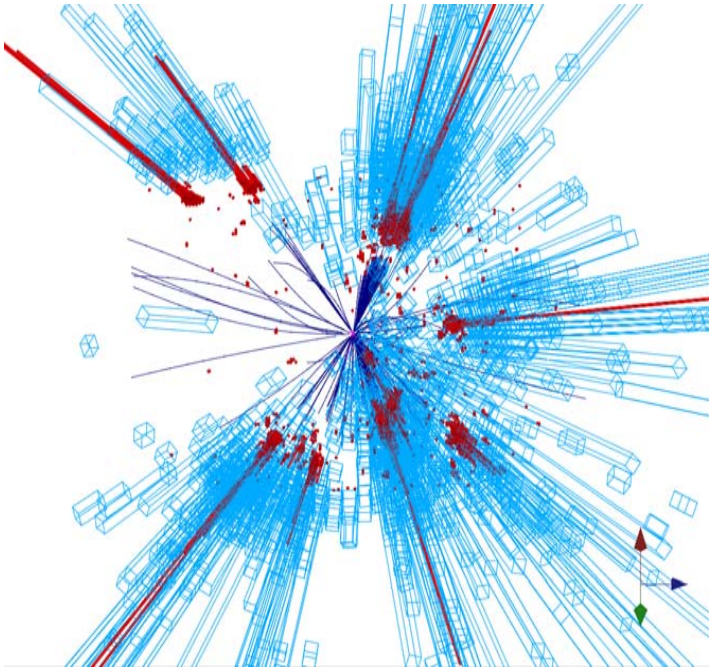
Black Hole Production



Semi-classical approach:

$$\sigma(M_{\mathrm{BH}}) = \pi r^2_{s(4+n)}$$

M_D~ 2 TeV, σ ~ pb



from Albert De Roeck

ADD

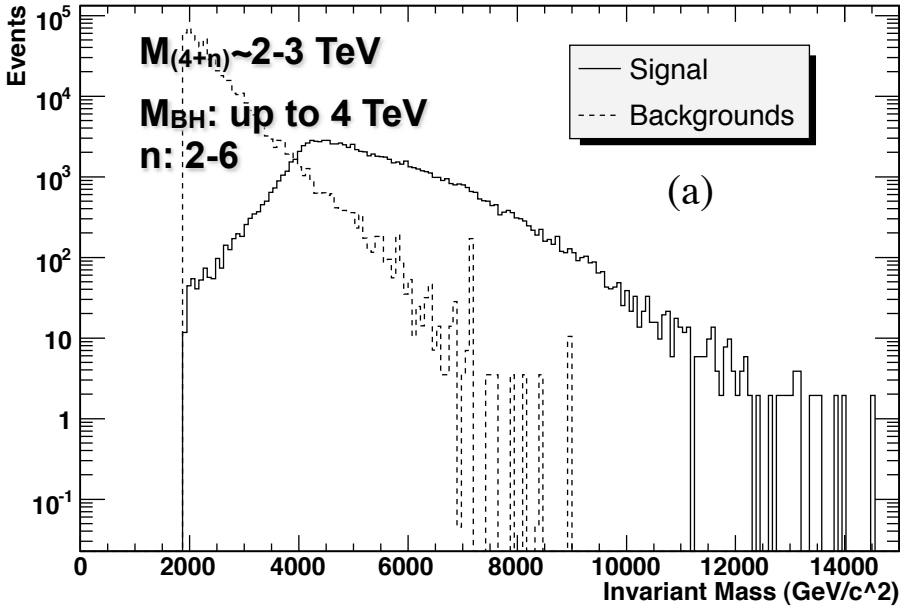
Black Hole Production

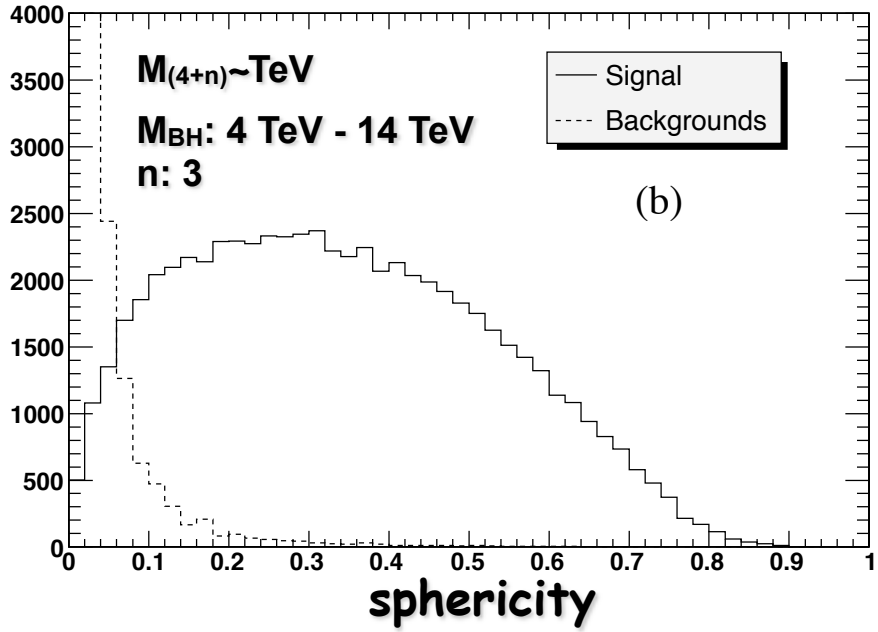
Signatures:

- high multiplicity of final state particles
- spherical distribution

Dominant background: QCD jets, top, boson+jets,

CMSTDR





Little Higgs

Little Higgs

Little Higgs Models

for review, see Perelstein, hep-ph/0512128;
Schmaltz and Tucker-Smith, hep-ph/0502182;

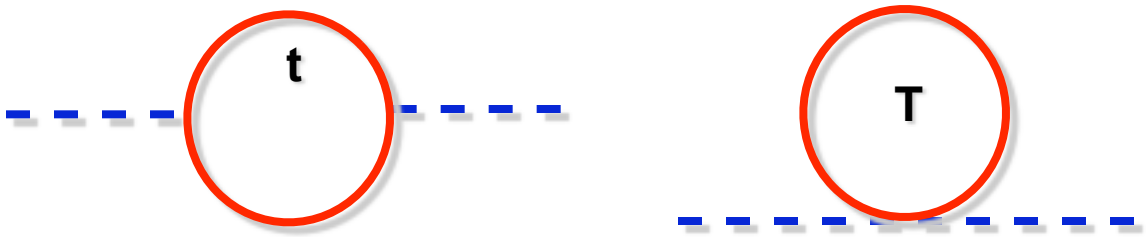
- Higgs is a Goldstone boson of spontaneous global symmetry breaking
- obtain mass from interactions explicitly breaking global symmetry
  - gauge interaction, Yukawa interaction
- 1-loop quadratic divergence protected via collective symmetry breaking

e.g. Littlest Higgs model
global symmetry: $SU(5) \rightarrow SO(5)$
gauge symmetry: $[SU(2)XU(1)]^2 \rightarrow [SU(2)XU(1)]_{SM}$

- Higgs mass is zero if either of the gauge coupling is zero.
- One loop contribution is at most logarithmically divergent.

Good for Λ up to about 10 TeV

Little Higgs Models



Cancellation of Λ^2 by partners of the same spin.

New particles:

- New gauge bosons: W_H, Z_H , A_H
- New heavy quarks: T, ...
- Extra Higgses

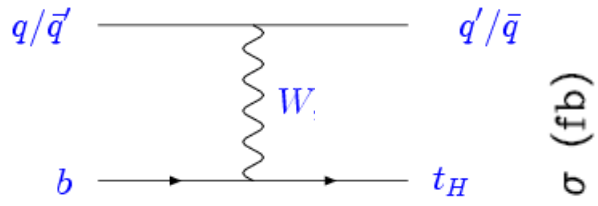
masses ~ TeV

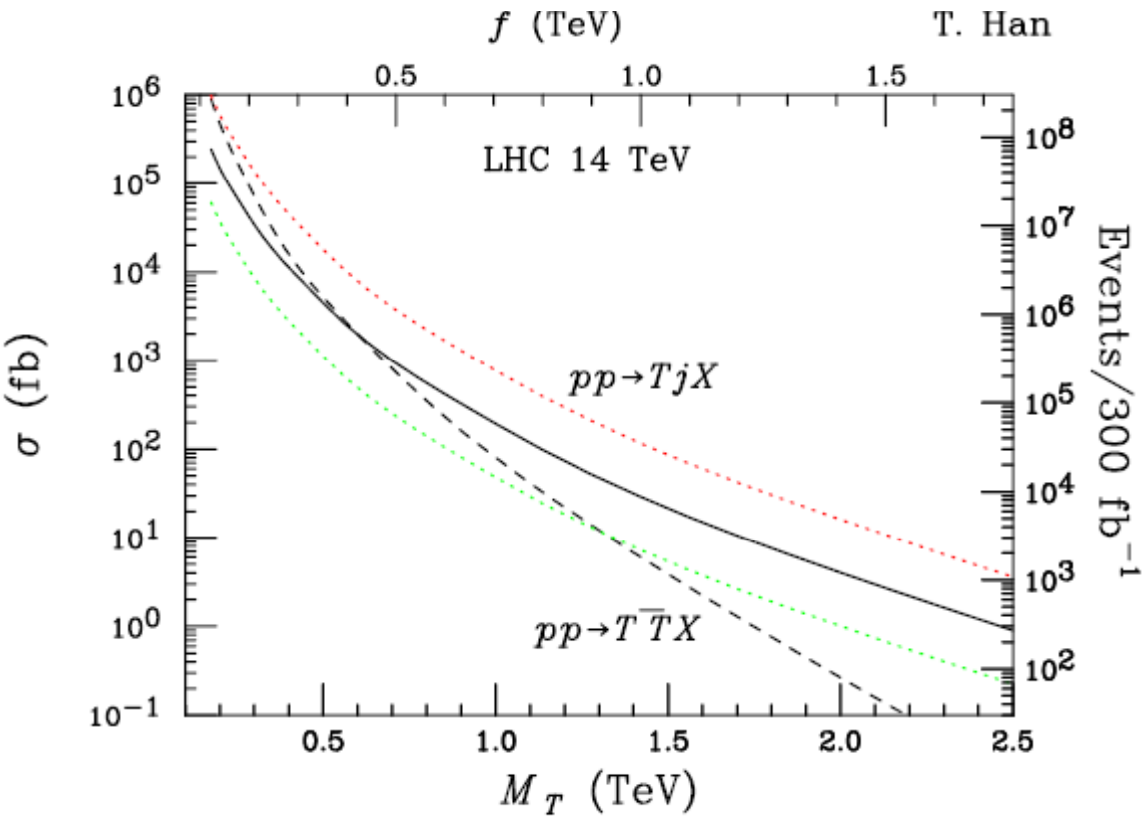
Little Higgs

Heavy Top in Littlest Higgs Model

Heavy top production

Han, McElrath, Logan, Wang, hep-ph/0301040

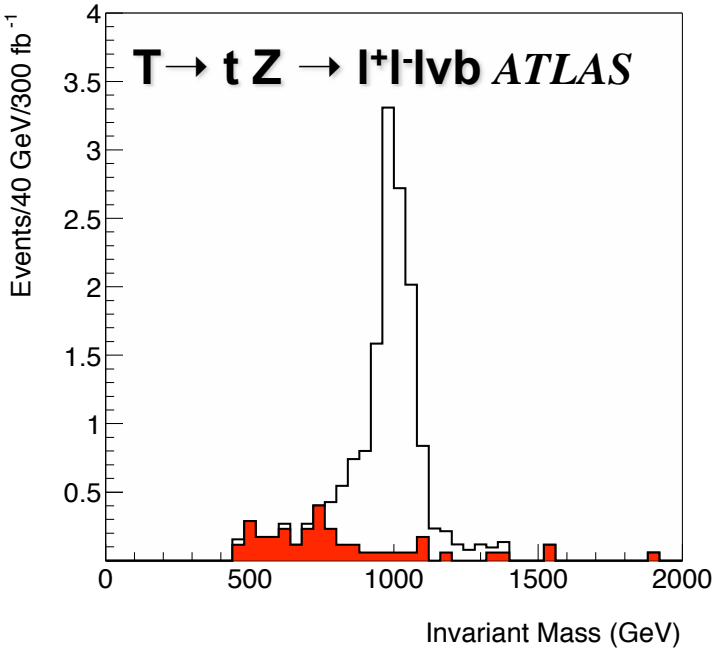




Little Higgs

Signatures in the LH Models

$$\Gamma(T \to tZ) = \Gamma(T \to t\ h) = \frac{1}{2}\Gamma(T \to bW) = \frac{\kappa_T^2}{32\pi} M_T \qquad \kappa_T = \lambda_1^2 / \sqrt{\lambda_1^2 + \lambda_2^2}$$



Azuelos et. al., hep-ph/0402037

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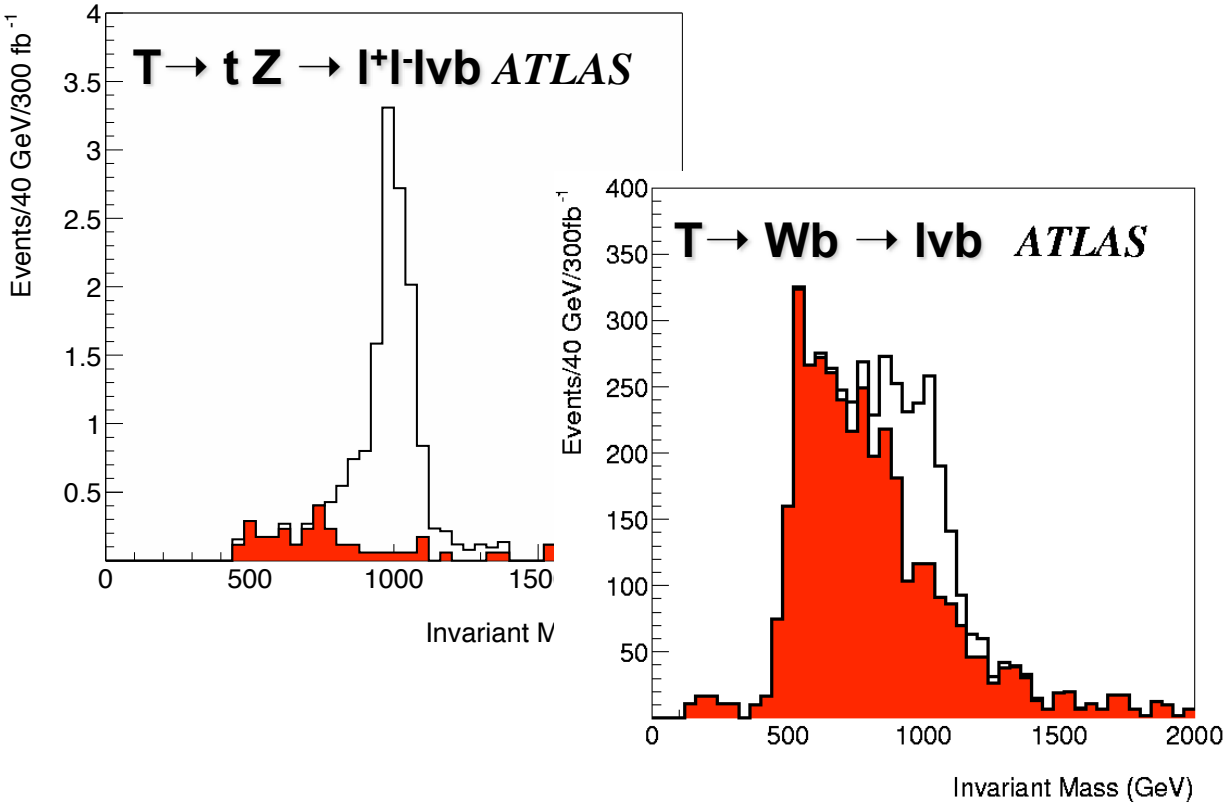

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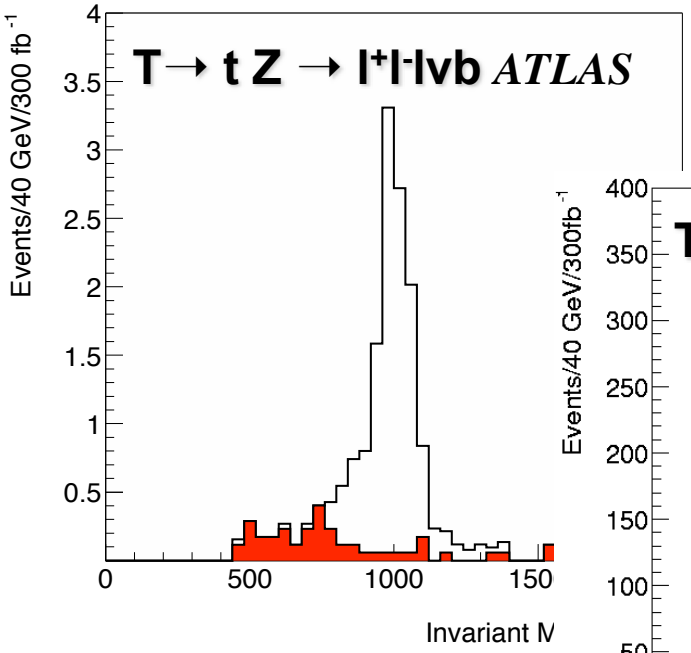
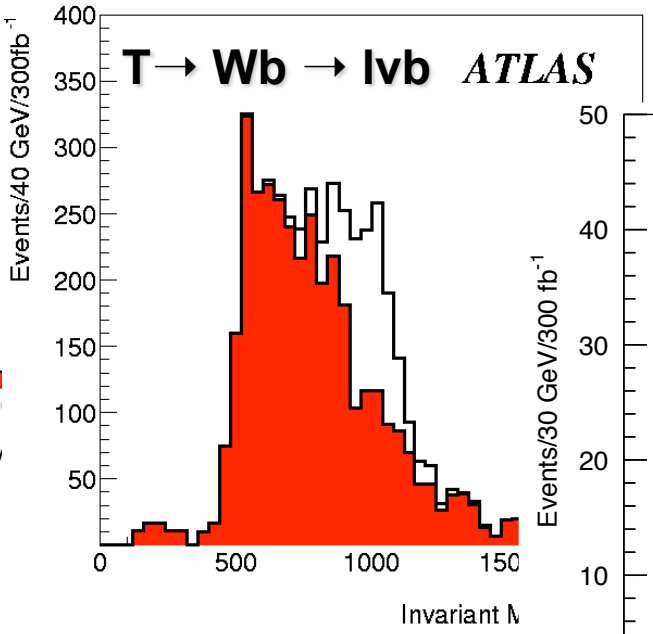
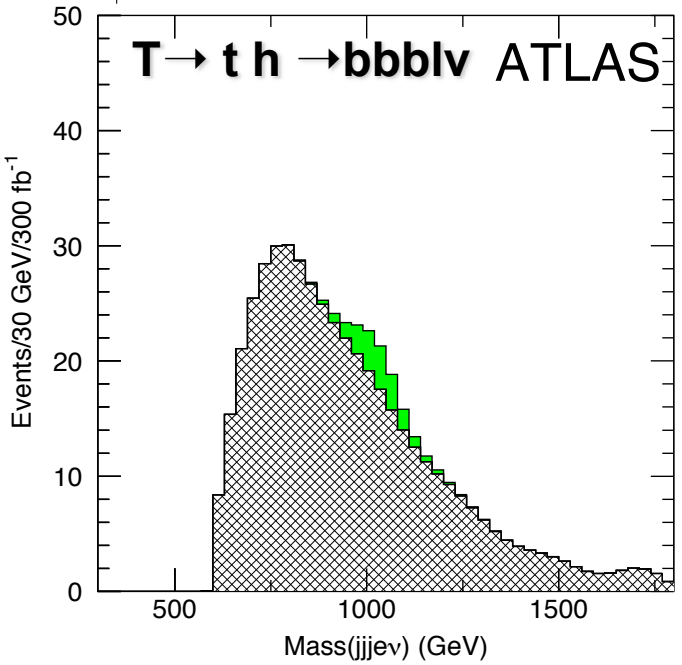






Azuelos et. al., hep-ph/0402037

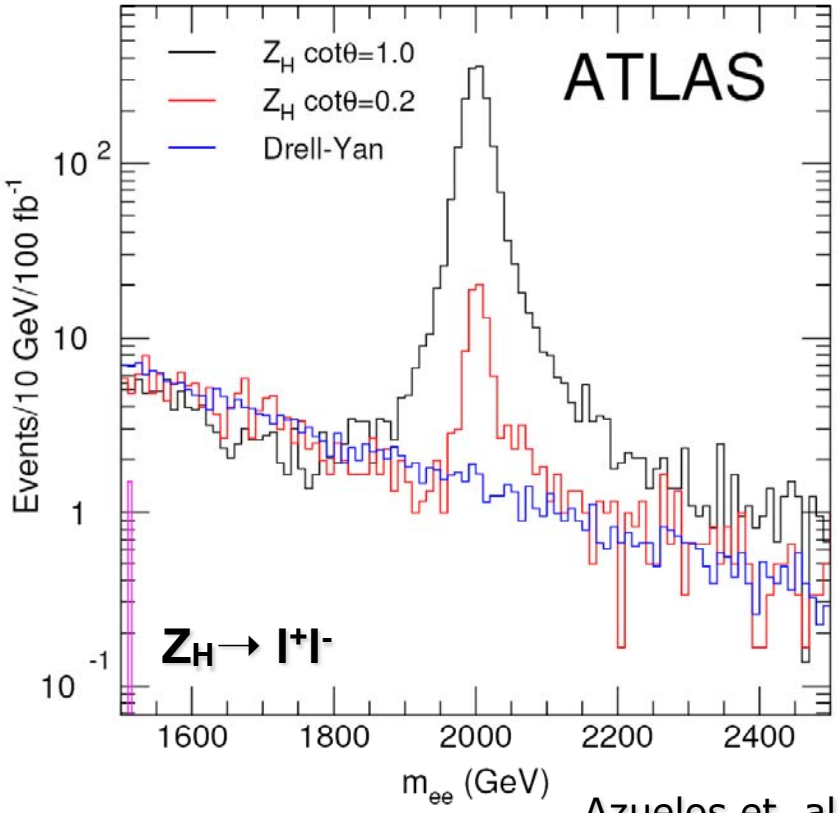
S. Su

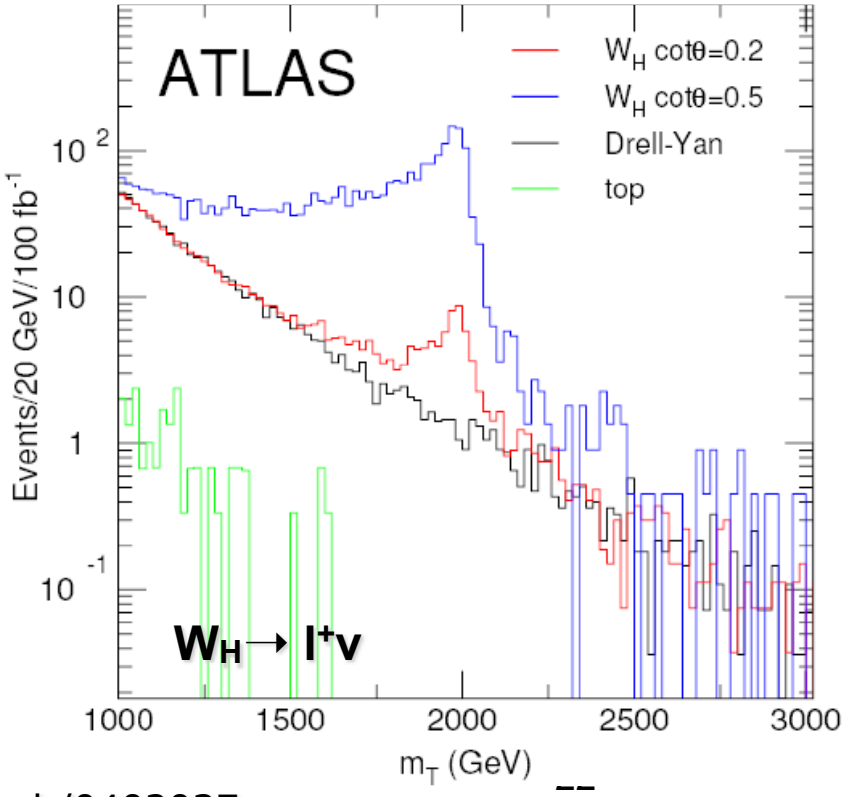
Little Higgs

Heavy Guage Bosons in LH

Signatures:

- Drell-Yan production
- Decays into dilepton, dijets, dibosons

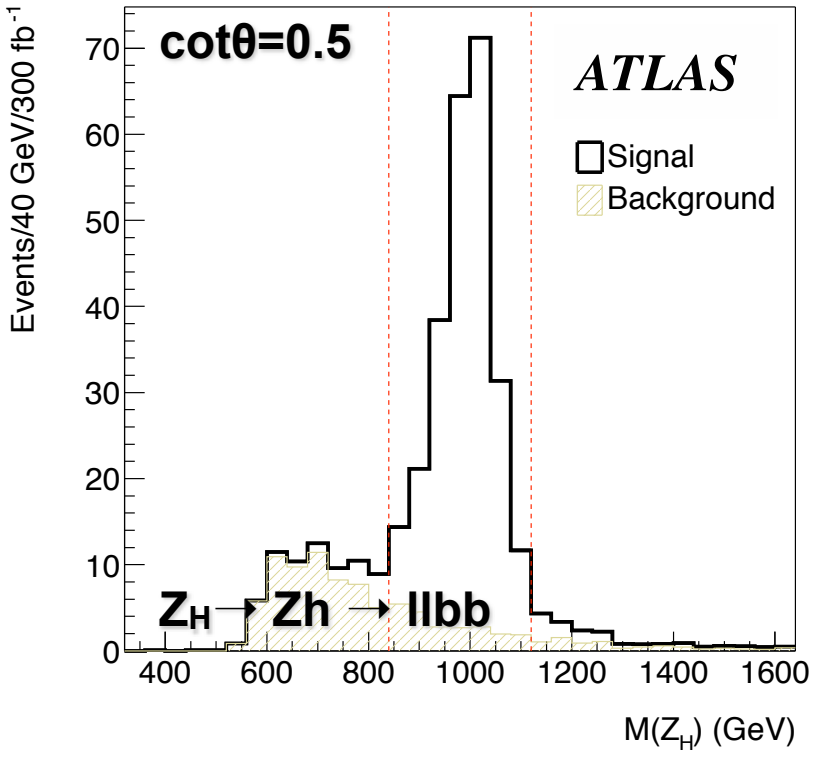


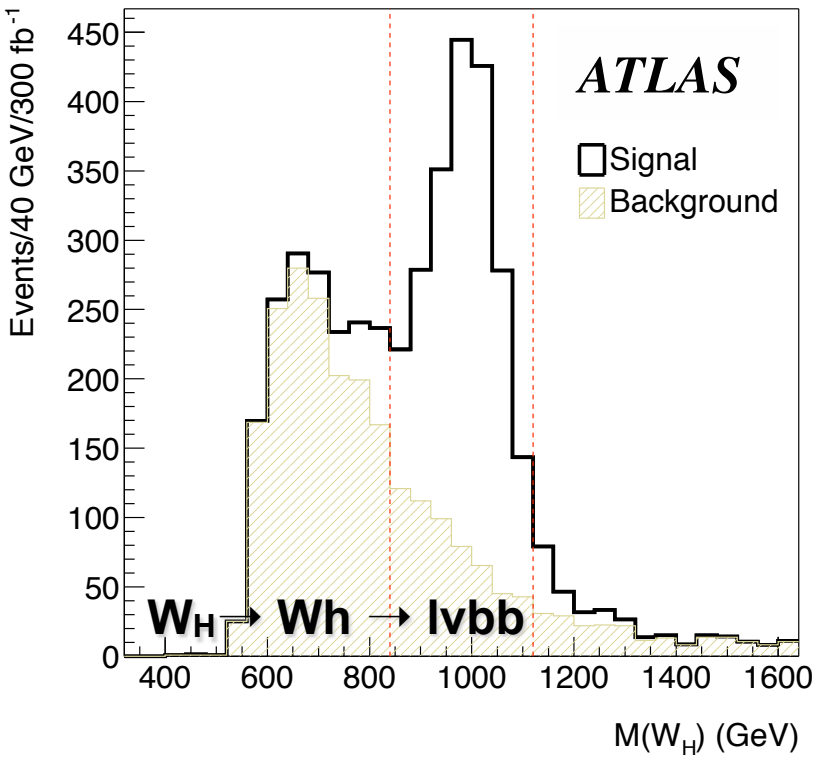


Azuelos et. al., hep-ph/0402037

Heavy Gauge Bosons in LH

Diboson signals





Little Higgs with T-parity

- EWPT ⇒ f large
- T-parity (similar to R-parity in SUSY)
  - contribution to SM process only appears at loop level, allow small f
- T-odd partners for SM particles (T-quarks, T-leptons, ...)
- lightest T-odd particle: stable, most likely, A_H
- SUSY-like signals

	even	odd
New gauge bosons		A_H (LTP) W_H, Z_H
New heavy quarks	T_+	T_- q_-,l_-

However, as C. Hill and R. Hill told us yesterday, T-parity is broken by topological effects ...

Twin Higgs

Twin Higgs

Twin Higgs mechanism

Chacko, Goh, Harnik, hep-ph/0506256
Chacko, Nomura, Papucci, Perez, hep-ph/0510273
Chacko, Goh, Harnik, hep-ph/0512088

Higgs as pseudo-Goldstone boson of a global symmetry

Its mass is protected against radiative correction via discrete symmetry

e.g., left-right Twin Higgs Models

- Global U(4) , with subgroup $SU(2)_L \times SU(2)_R \times U(1)_{B-L}$ gauged
- Left-right symmetry: $g_L = g_R$ ($y_L = y_R$)

$$H = \begin{pmatrix} H_L \\ H_R \end{pmatrix}$$

SM Higgs doublet

3 eaten by heavy gauge bosons

$$\langle H \rangle = \begin{pmatrix} 0 \\ 0 \\ 0 \\ f \end{pmatrix}$$

$U(4) \to U(3)$ **7 GB**

$SU(2)_L \times SU(2)_R \times U(1)_{B-L} \to SU(2)_L \times U(1)_Y$

Twin Higgs mechanism

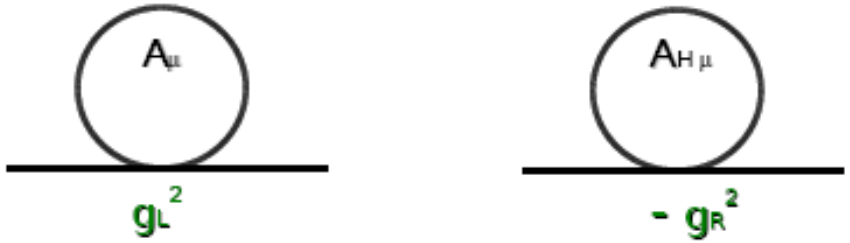
Quadratic divergence forbidden by left-right symmetry

$$\Delta V = \frac{9}{64\pi^2} g_L^2 \Lambda^2 H_L^\dagger H_L + \frac{9}{64\pi^2} g_R^2 \Lambda^2 H_R^\dagger H_R$$

$g_L = g_R = g$

$$\Delta V = \frac{9}{64\pi^2} g^2 \Lambda^2 (H_L^\dagger H_L + H_R^\dagger H_R) = \frac{9}{64\pi^2} g^2 \Lambda^2 H^\dagger H$$

U(4) invariant, does not contribute to the mass of GB



Log contribution: $\Delta V = \frac{g^4}{16\pi^2} \log\left(\frac{\Lambda}{gf}\right) (|H_L|^4 + |H_R|^4)$

$m_H \sim g^2 f / (4\pi)$, natural for $f \sim$ TeV

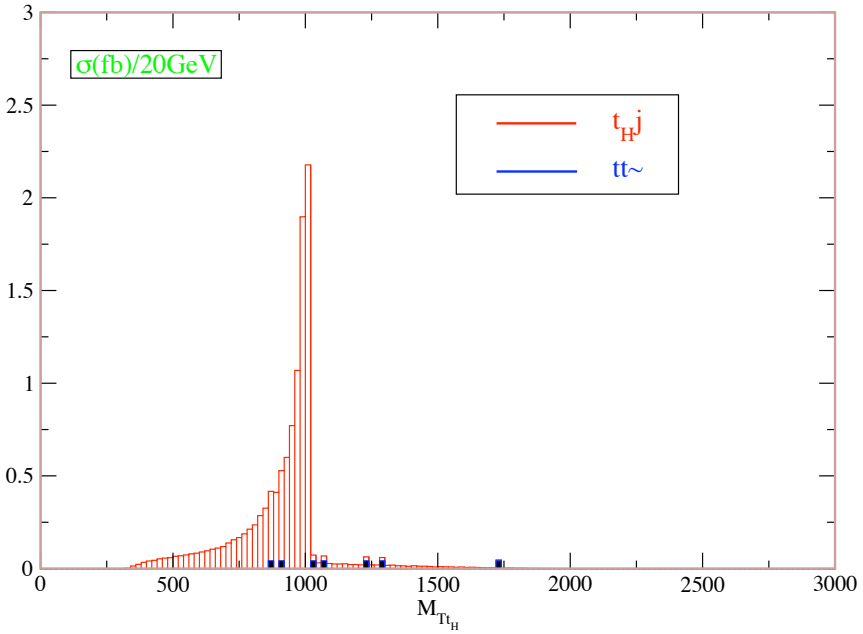
Little Higgs

New particles

- Heavy top: t_H

  Single production $t_H j$

$t_H \rightarrow b\Phi^{\pm} \rightarrow bbt \rightarrow bbblv$



- Heavy gauge bosons: W_H, Z_H

- Drell-Yan production
- Decays into dilepton, dijets (similar to LR model)
- $Z_H \rightarrow tt$, $W_H \rightarrow tb$, ...

RS

RS

Randall-Sundrum Scenario

$$ds^2 = e^{-2ky}\eta_{\mu\nu}dx^\mu dx^\nu - dy^2$$

$$\Lambda_\pi \equiv \overline{M}_{\rm Pl} e^{-kR_c\pi}$$

Λ_π ~ TeV for kR_c ~ 11-12

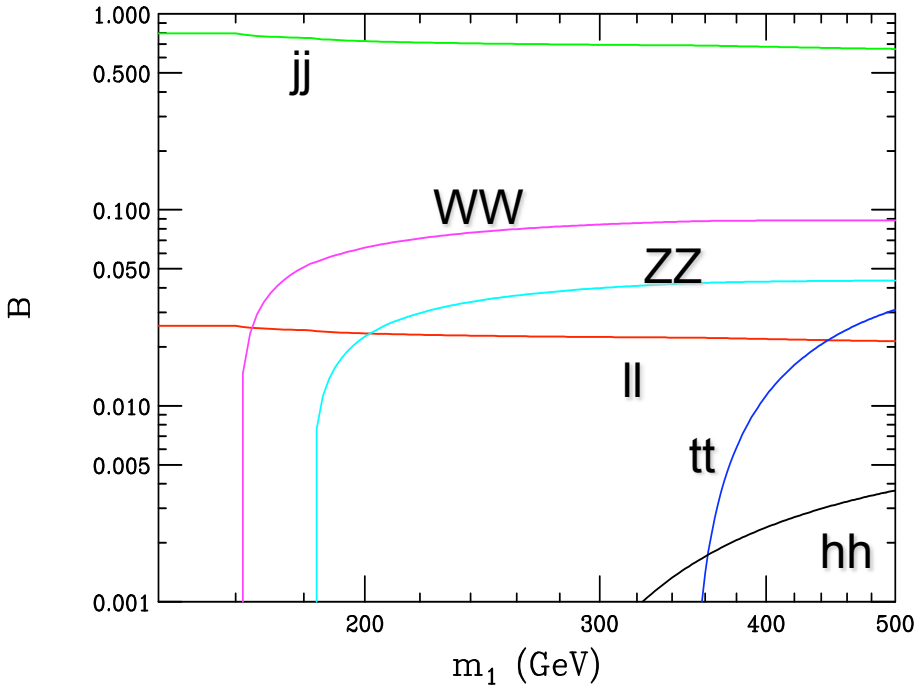
New particles: KK tower of graviton

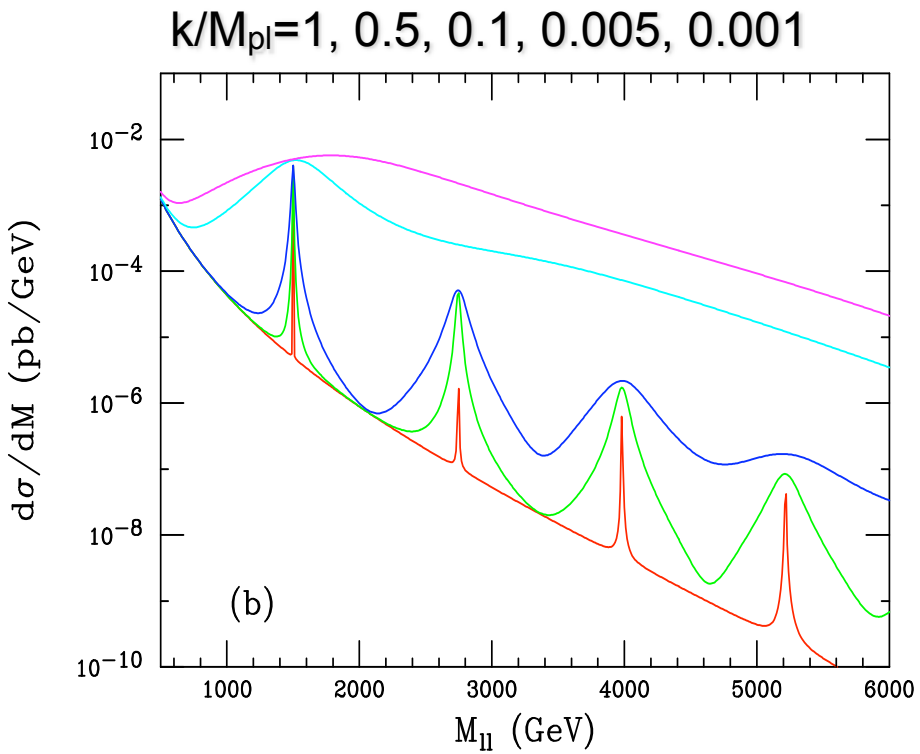
Interactions: $\mathcal{L} = \frac{-1}{\overline{M}_{Pl}} T^{\mu\nu}(x) h^{(0)}_{\mu\nu}(x) - \frac{1}{\Lambda_\pi} T^{\mu\nu}(x) \sum_{n=1}^{\infty} h^{(n)}_{\mu\nu}(x)\,.$

Ads/CFT dual: Higgs in TeV brane @5D ⇔ composite Higgs @4D

RS Graviton

Collider signature: resonance in dilepton, dijet, diboson, tt

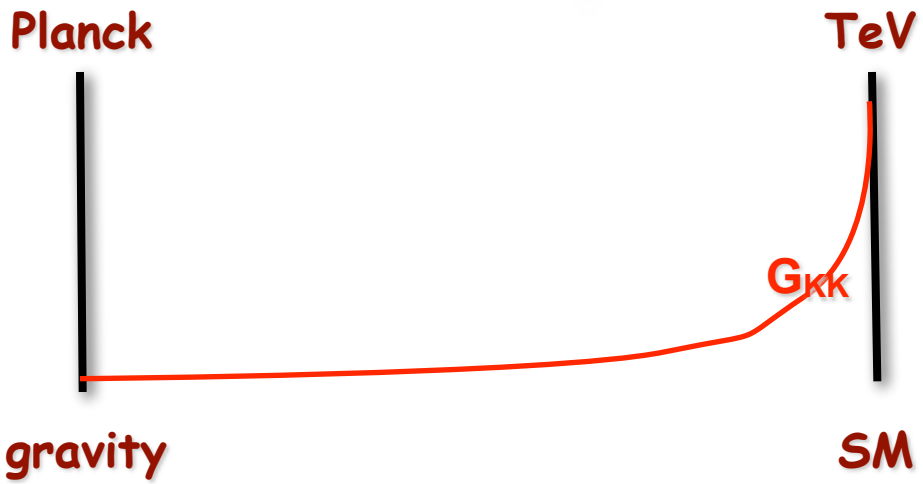




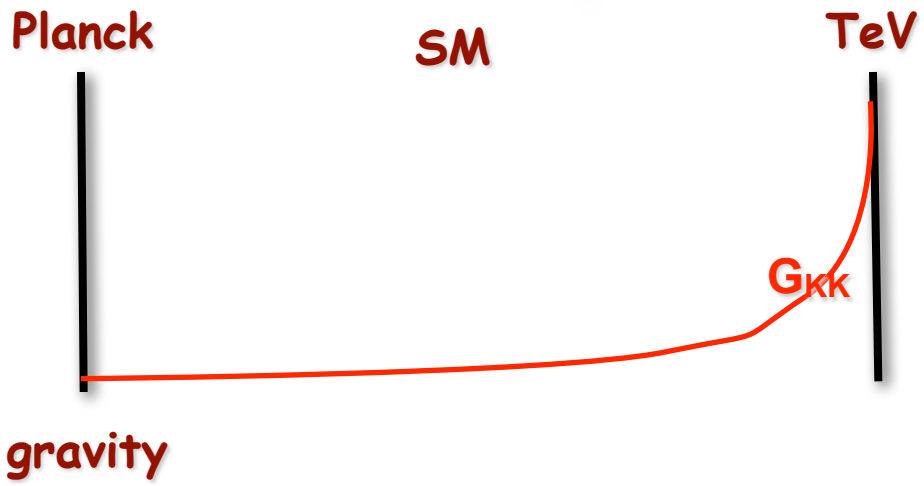
Davoudiasl, Hewett and Rizzo, 0006041

RS graviton (Variation)

RS graviton (Variation)

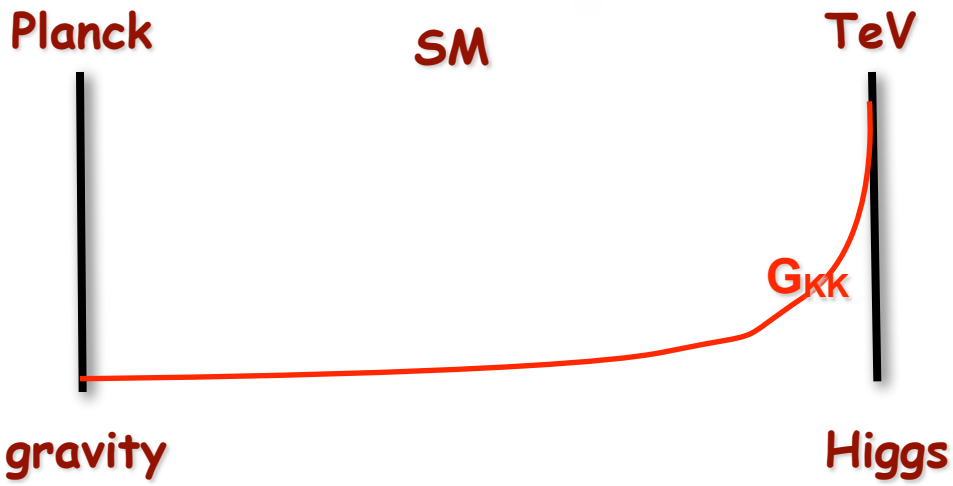


RS graviton (Variation)

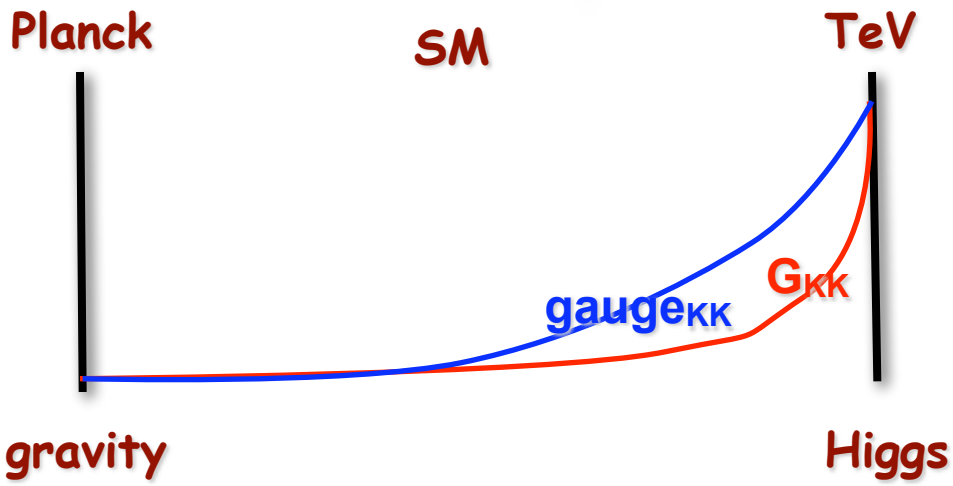


RS

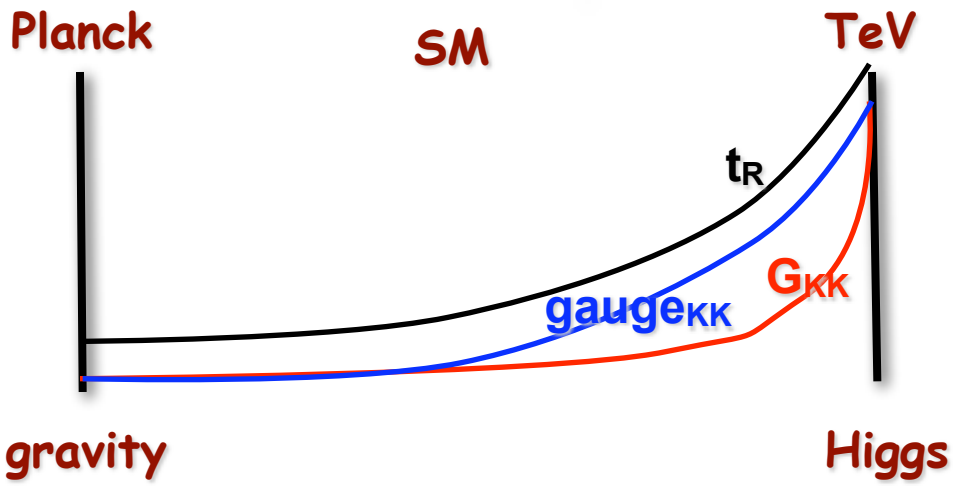
RS graviton (Variation)



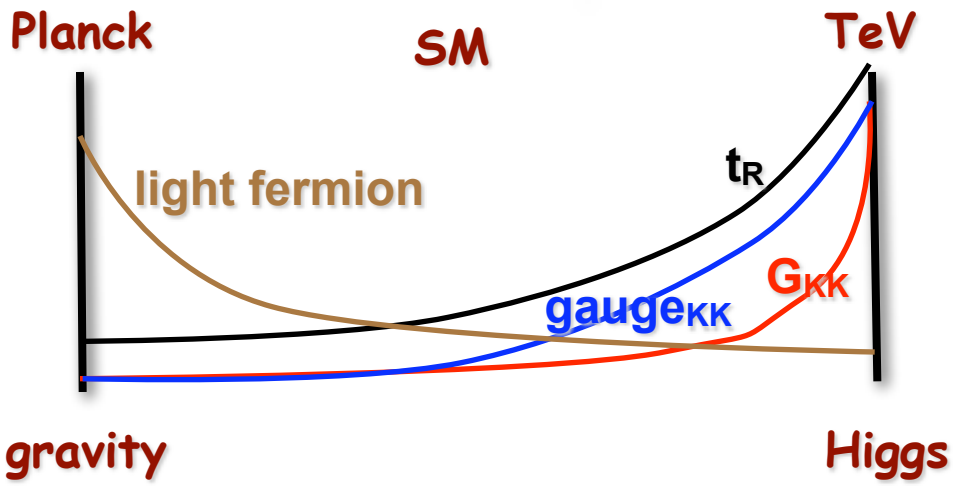
RS graviton (Variation)



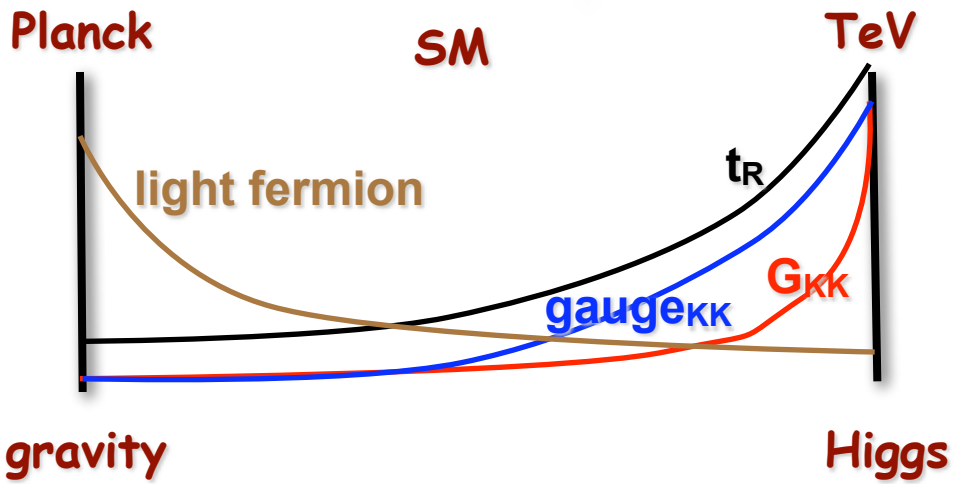
RS graviton (Variation)



RS graviton (Variation)

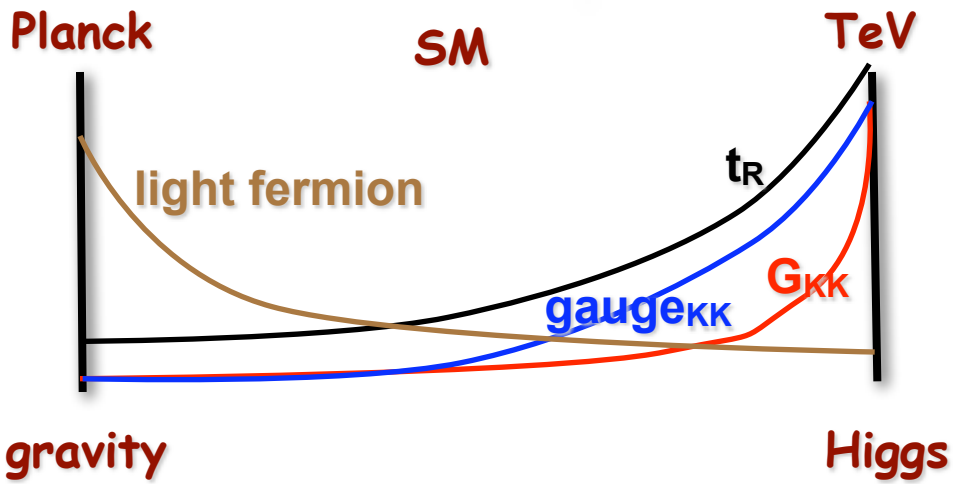


RS graviton (Variation)



Agashe, Delgado, May and Sundrum, hep-ph/0308036

RS graviton (Variation)



Agashe, Delgado, May and Sundrum, hep-ph/0308036

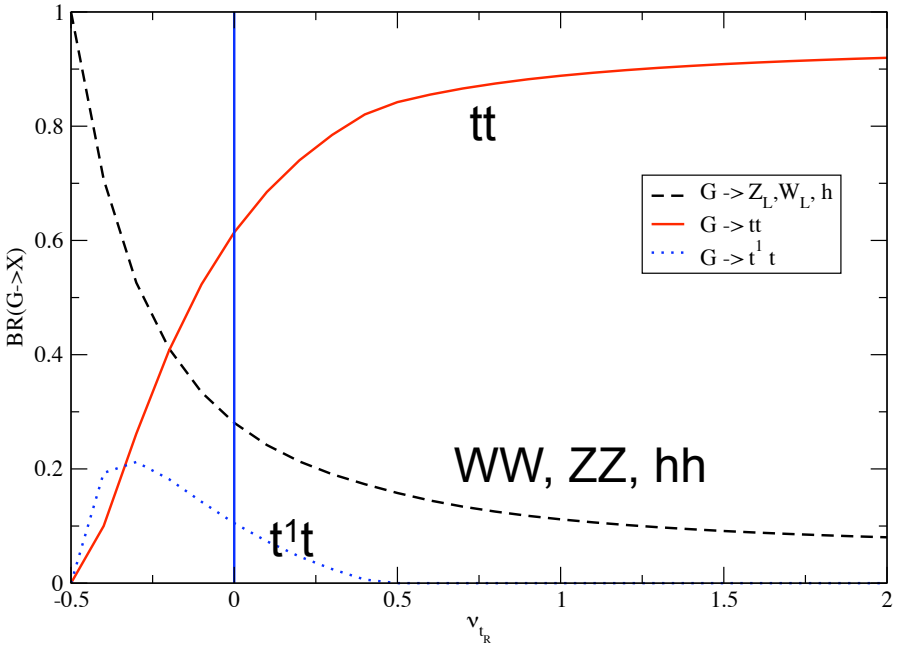
KK graviton

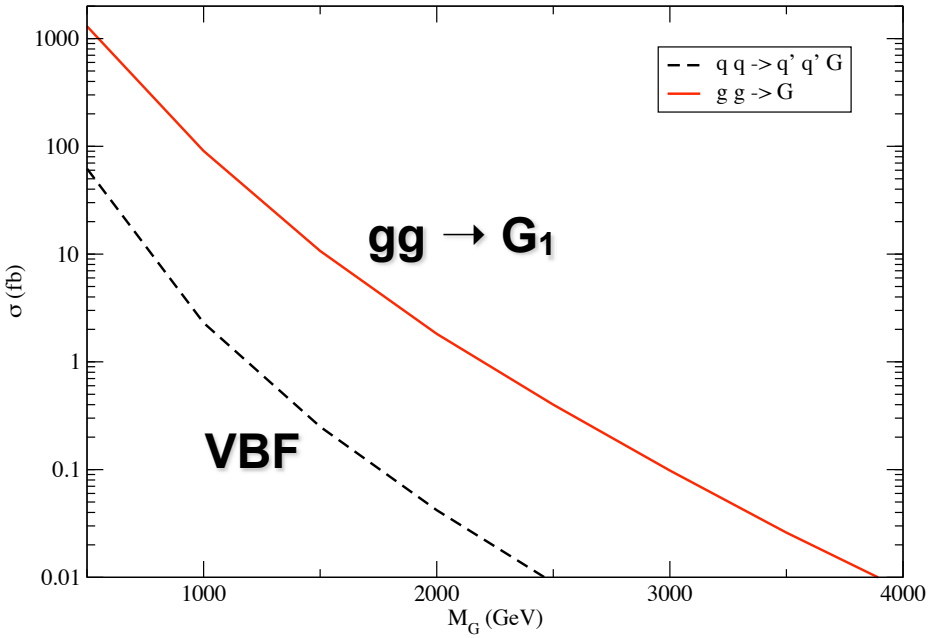
- couple strongly to H, t_R, V_{KK} (composite fields)
- less to light quarks, leptons (fundamental fields)

RS

RS graviton

Signatures: resonance in tt, diboson





Fitzpatrick, Kaplan, Randall and Wang, hep-ph/0711150

gg →G^1→ZZ→ 4l, L=300 fb^{-1}

$c \equiv k/\bar{M}_P$	0.5	1.0	1.5	2.0
m_1^G (TeV)	< 1.5	1.6	1.9	2.2
$S/\sqrt{B}$	–	7.0	6.1	6.1

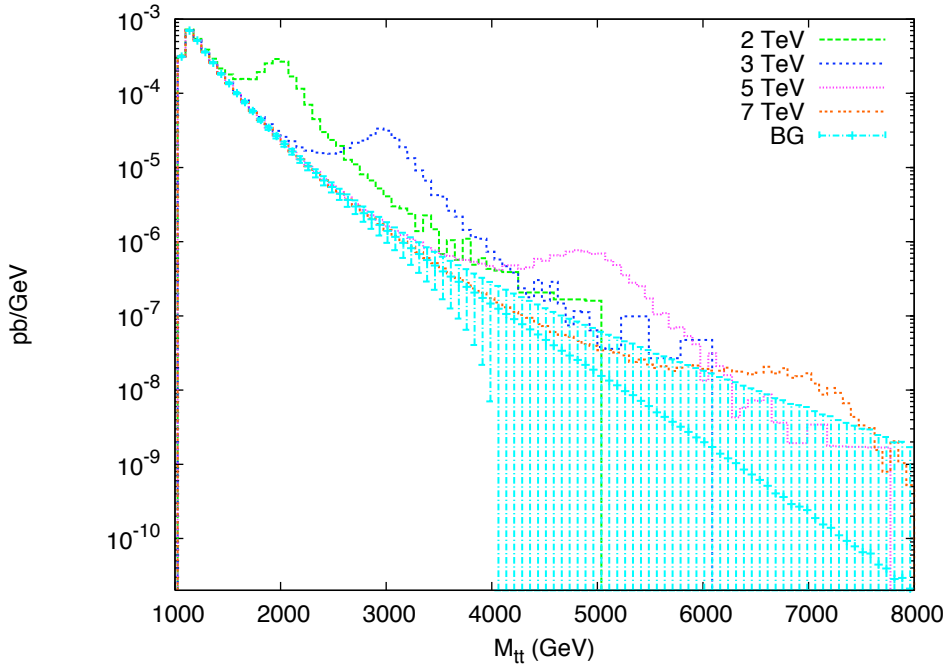
Agashe, Davoudiasl, Perez and Soni, hep-ph/0701186

RS

KK Gluon

New particles: KK gluon

Signatures: resonance in tt



Lillie, Randall and Wang, hep-ph/0701166

Technicolor

Technicolor

Similar to QCD chiral symmetry breaking ...

- new non-abelian gauge symmetry: Technicolor
- additional massless fermions: technifermion
- formation of techifermion condensate break electroweak symmetry

New particles

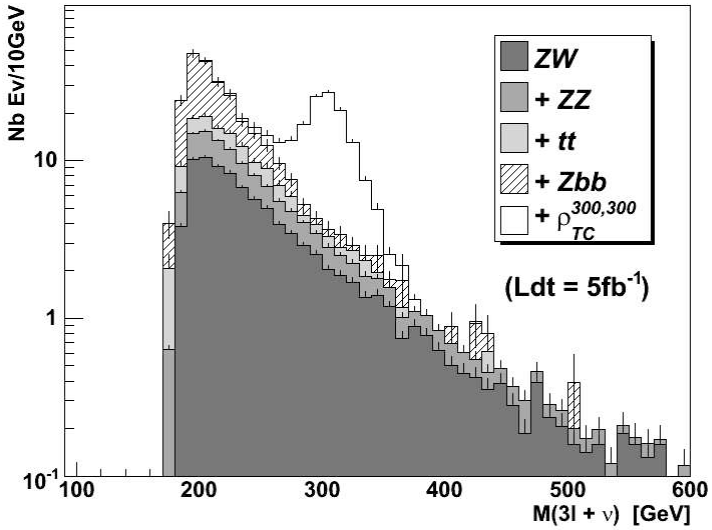
- color singlet sector: spin 0 π_{TC}, spin 1 ρ_{TC}, etc.

Technicolor

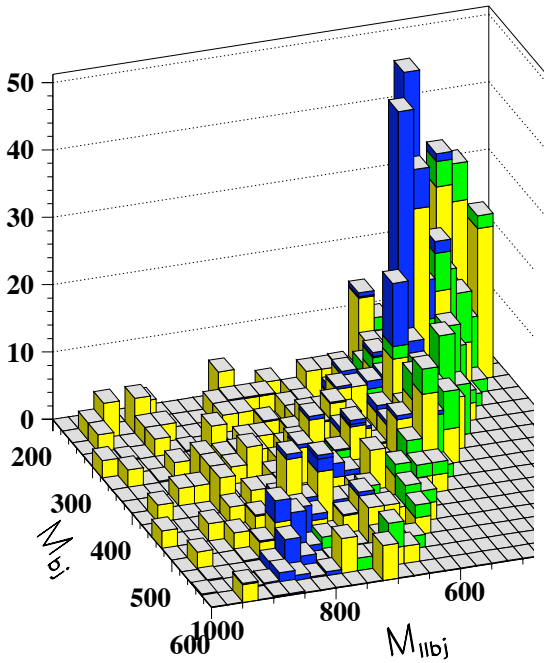
Signature

- diboson resonance

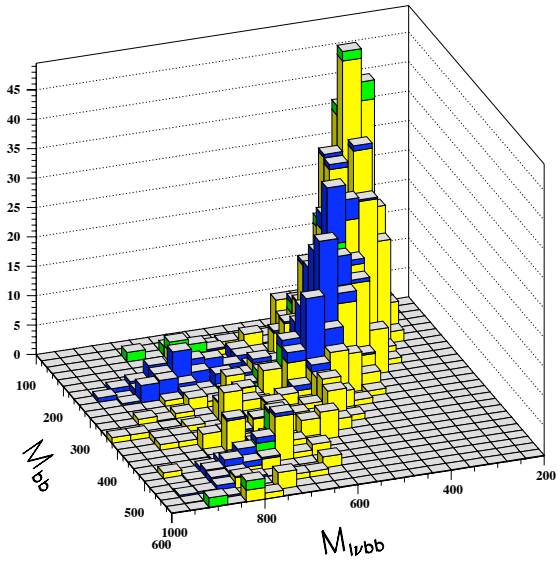
$\rho_{TC} \rightarrow WZ \rightarrow 3l\nu$



$\rho_{TC} \rightarrow \pi_T Z \rightarrow bqll$



$\rho_{TC} \rightarrow \pi_T W \rightarrow bbl\nu$



Kreuzer, CMS notes 2006/135

- enhanced $W_L W_L$ scattering for heavy ρ_{TC}

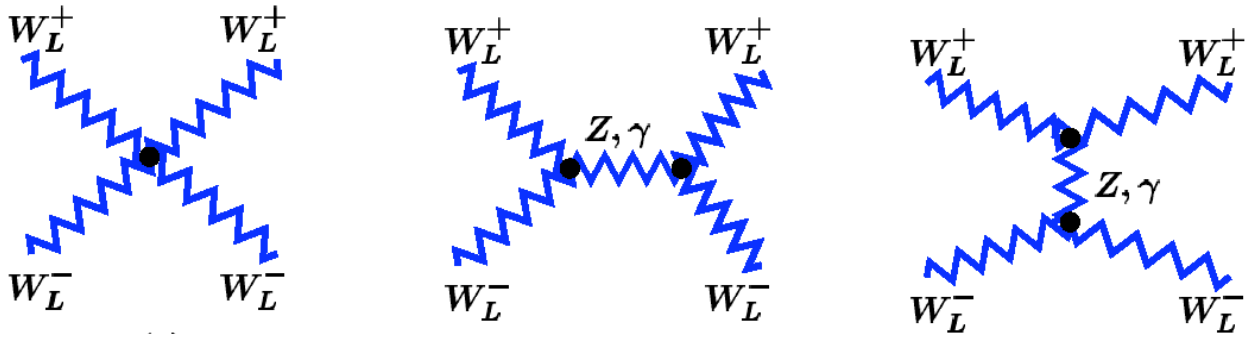
Higgsless

Higgsless

Csaki, Grojean, Murayama, Pilo, Terning
Chivukula, He, Kurachi, Simmons, Tanabashi, Matsuzaki;
Foadi, Gopalkrishna, Schmidt (deconstruction)
Georgi

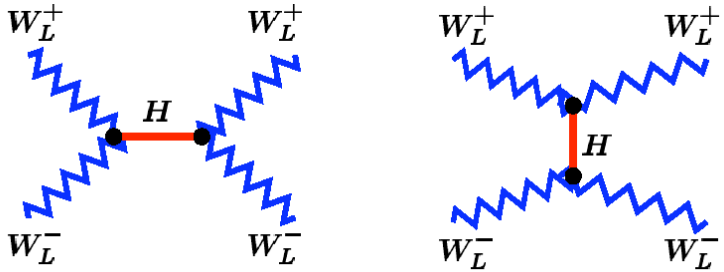
Inspired by deconstruction, warped extra dimension ...

Unitarity



No Higgs $\Rightarrow \mathcal{O}(E^2) \Rightarrow E < \sqrt{8\pi}v \simeq 1.2\,\mathrm{TeV}$

SM



From S. Chivukula

Higgsless

RS Higgsless

Csaki, Grojean, Murayama, Pilo, Terning

Planck

TeV

$SU(2)_L \otimes SU(2)_R \otimes U(1)_{B-L}$

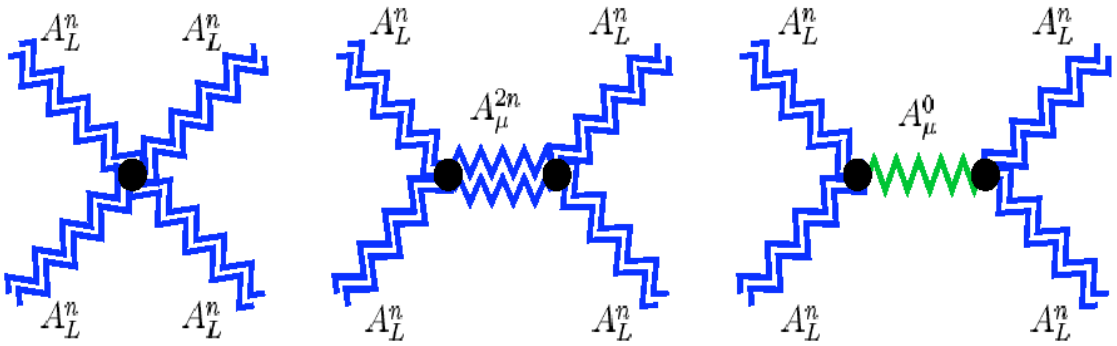
dual to
walking technicolor model

AdS_5

$SU(2)_R \otimes U(1)_{B-L} \rightarrow U(1)_Y$

$SU(2)_L \otimes SU(2)_R \rightarrow SU(2)_D$

- electroweak symmetry is broken by boundary conditions
- Unitarity fixed by exchange of KK tower of gauge boson



From S. Chivukula

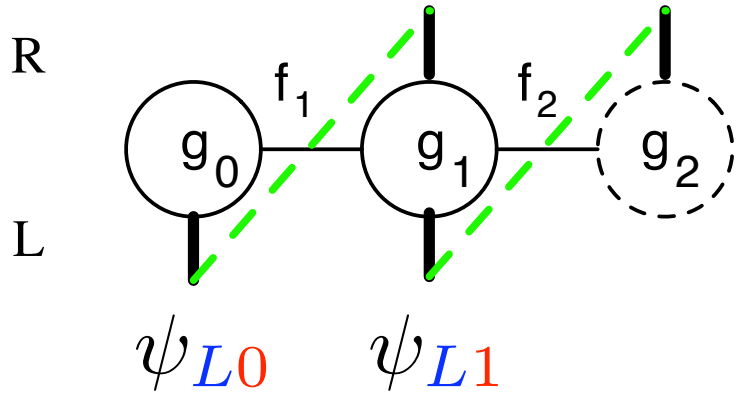
Higgsless

3-site Model Higgsless

Chivukula, He, Kurachi, Simmons, Tanabashi, Matsuzaki

$SU(2) \times SU(2) \times U(1)$

ψ_{R1} t_{R2}, b_{R2}



ψ_{L0} ψ_{L1}

From S. Chivukula

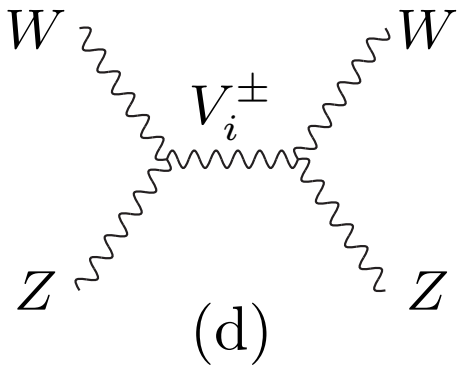
- Unitarity fixed by exchange of extra gauge boson

Higgsless

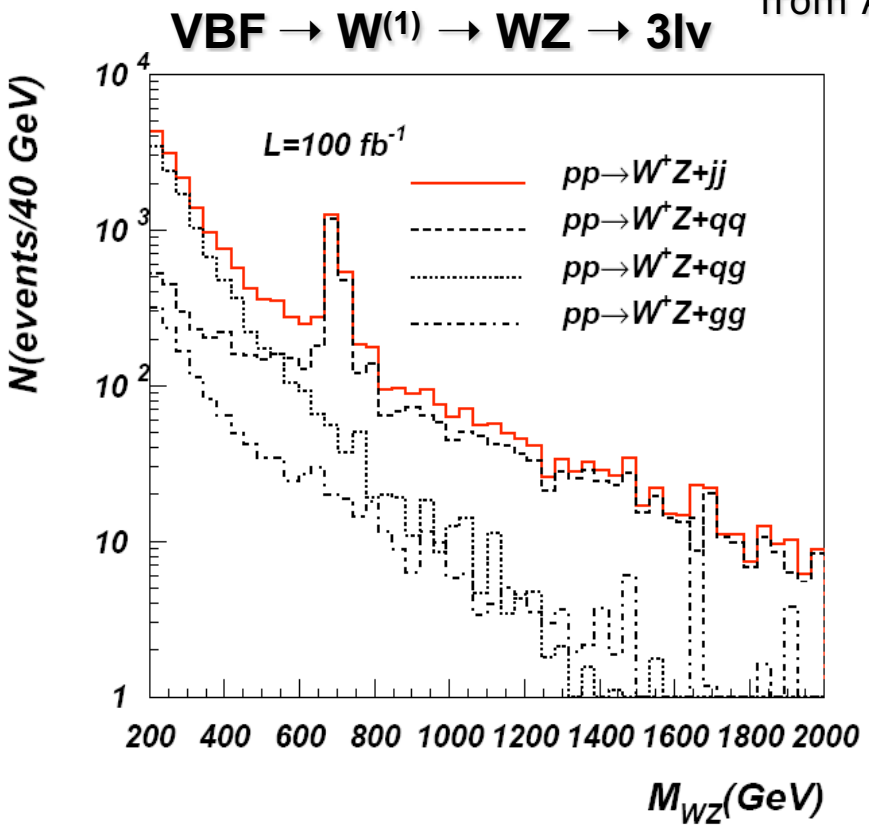
Signatures of Higgsless models

New particles: Massive gauge bosons

Signatures: VBF → diboson resonance



from A. Belyaev



S. Su

Higgsless

Signatures of Higgsless models

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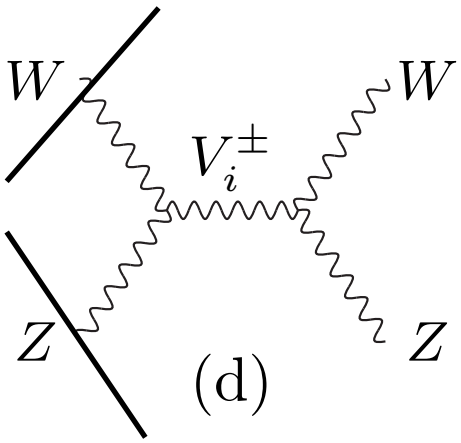
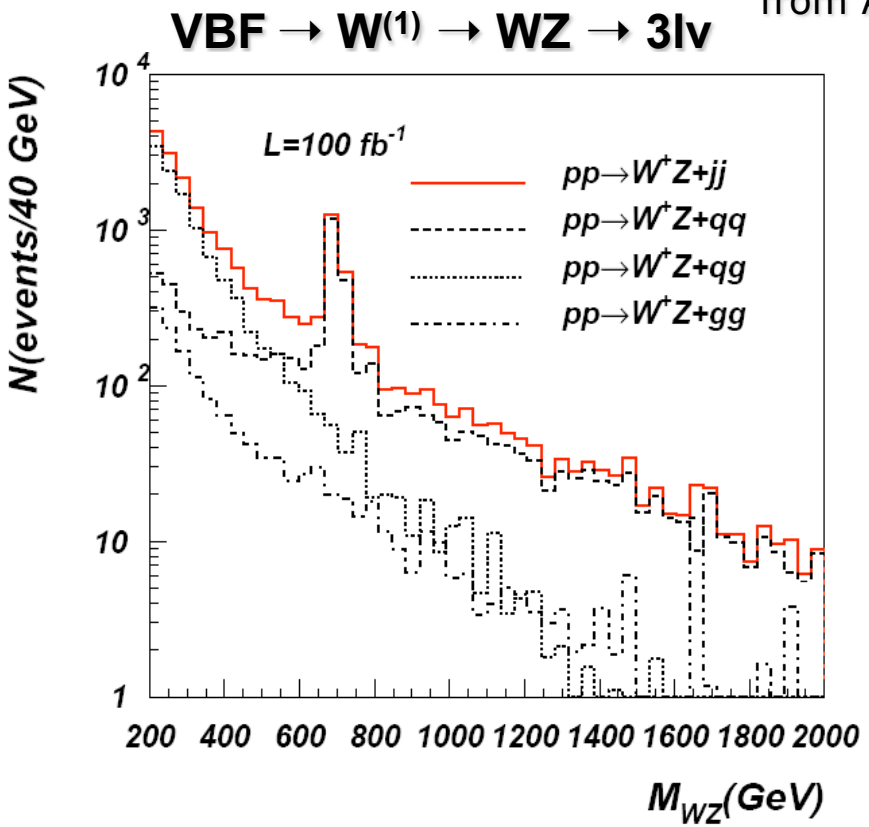


from A. Belyaev



SUSY

ADD

little Higgs

twin Higgs

RS

Technicolor

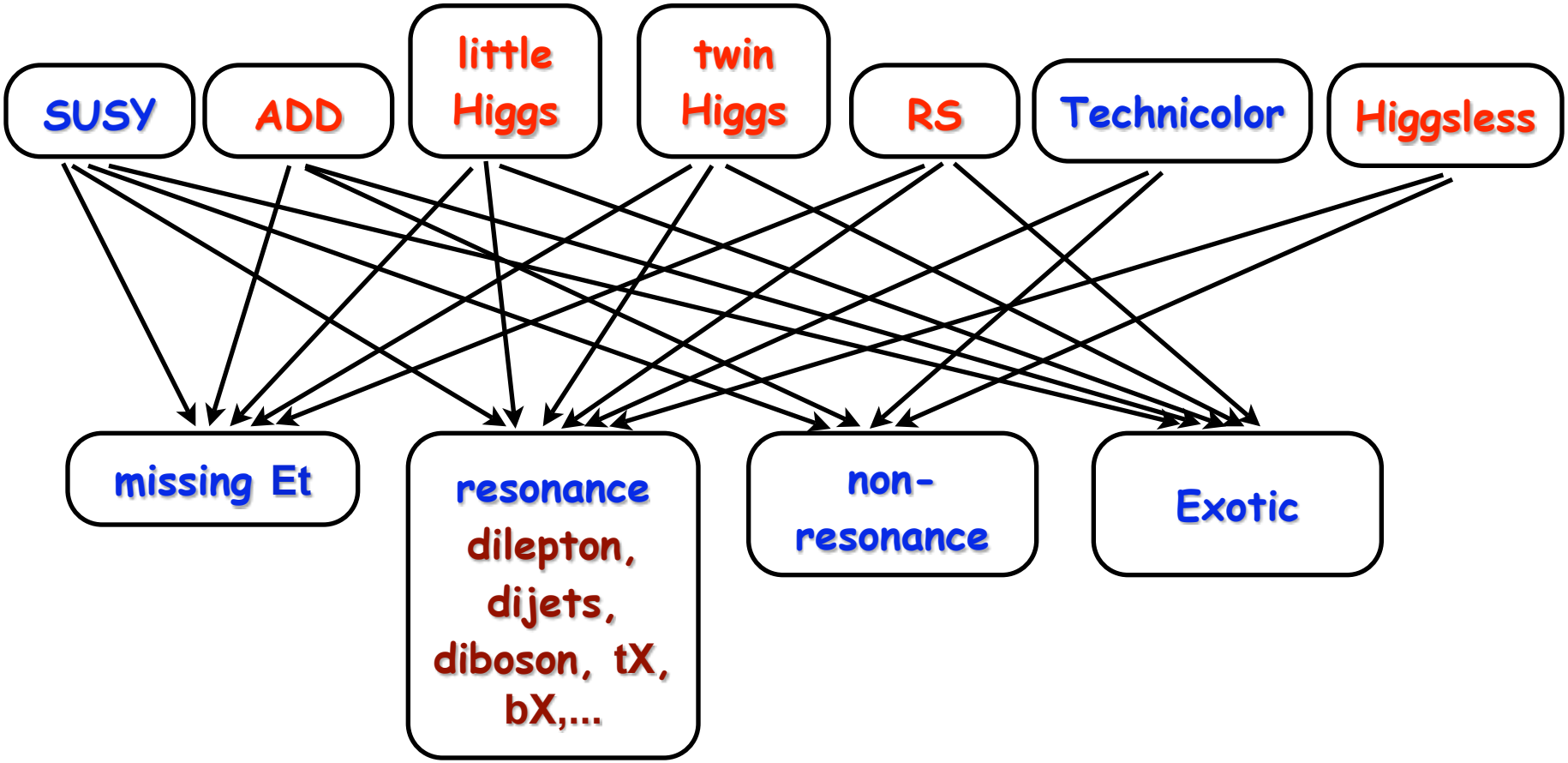
Higgsless

missing Et

resonance dilepton, dijets, diboson, tX, bX,...

non-resonance

Exotic


SUSY
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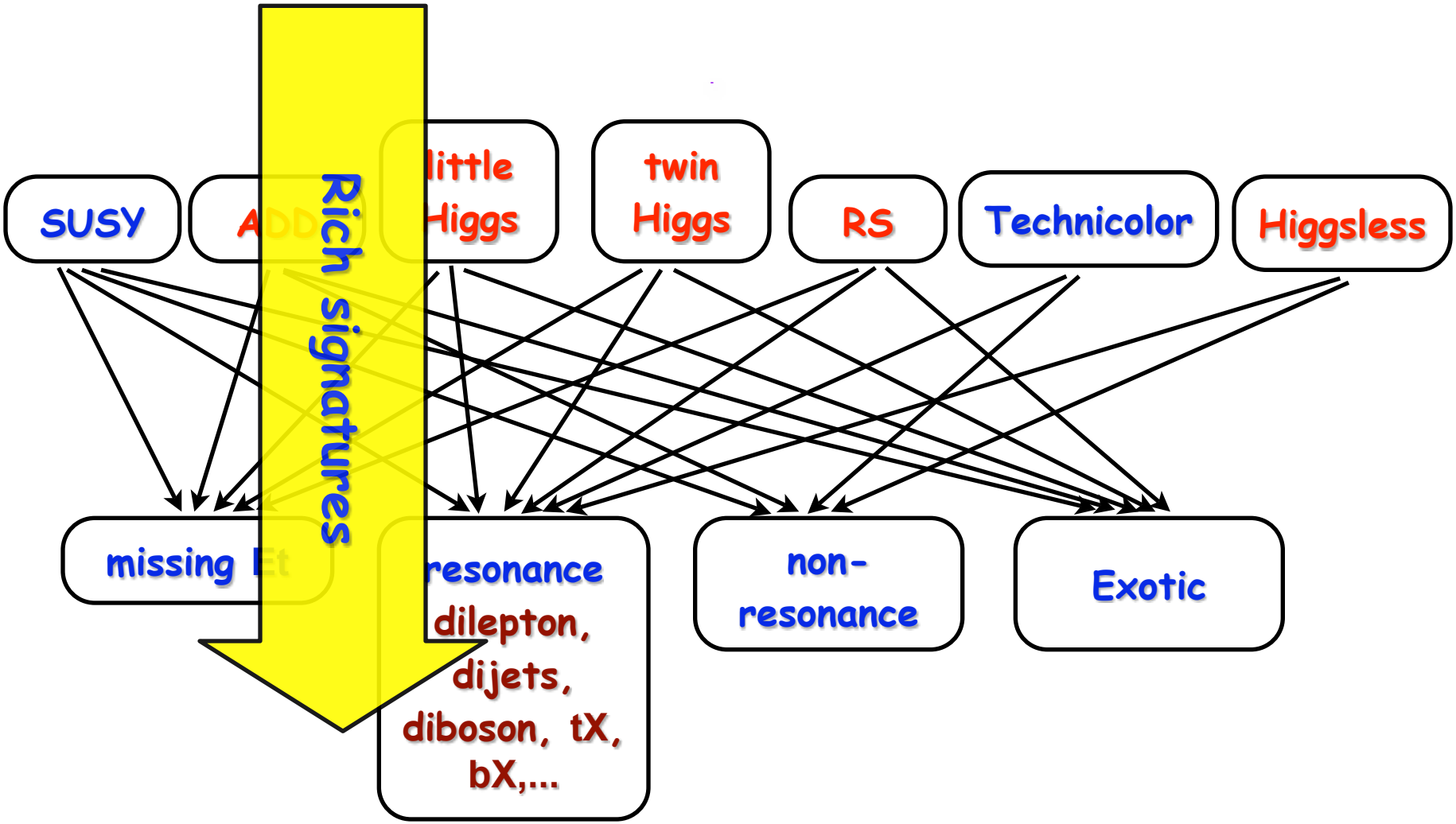
SUSY
ADD
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Technicolor
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Rich signatures
missing Et
resonance
dilepton,
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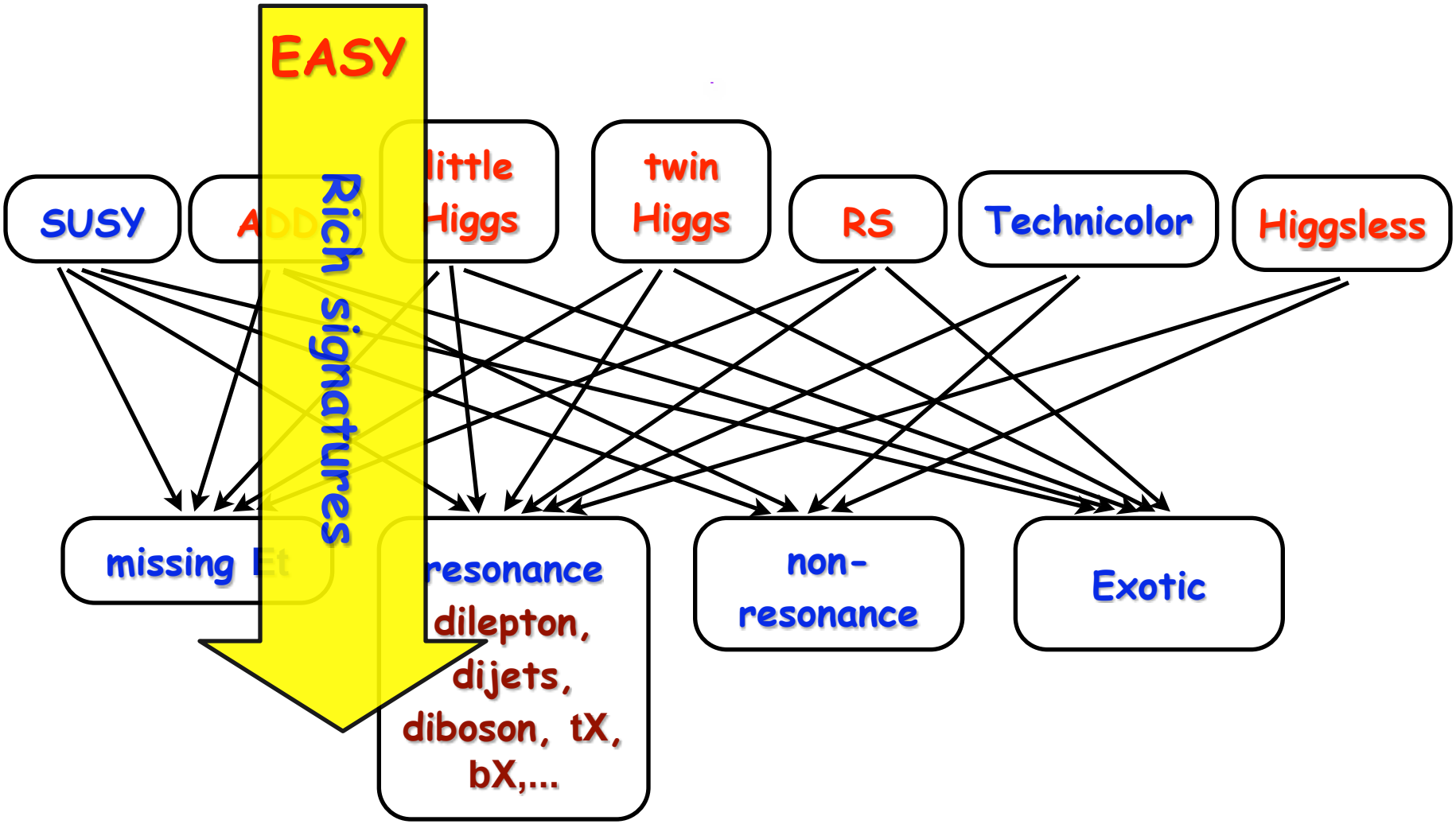
diboson, tX,
bX,...
non-resonance
Exotic


EASY
Rich signatures
SUSY
ADD
little Higgs
twin Higgs
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Technicolor
Higgsless
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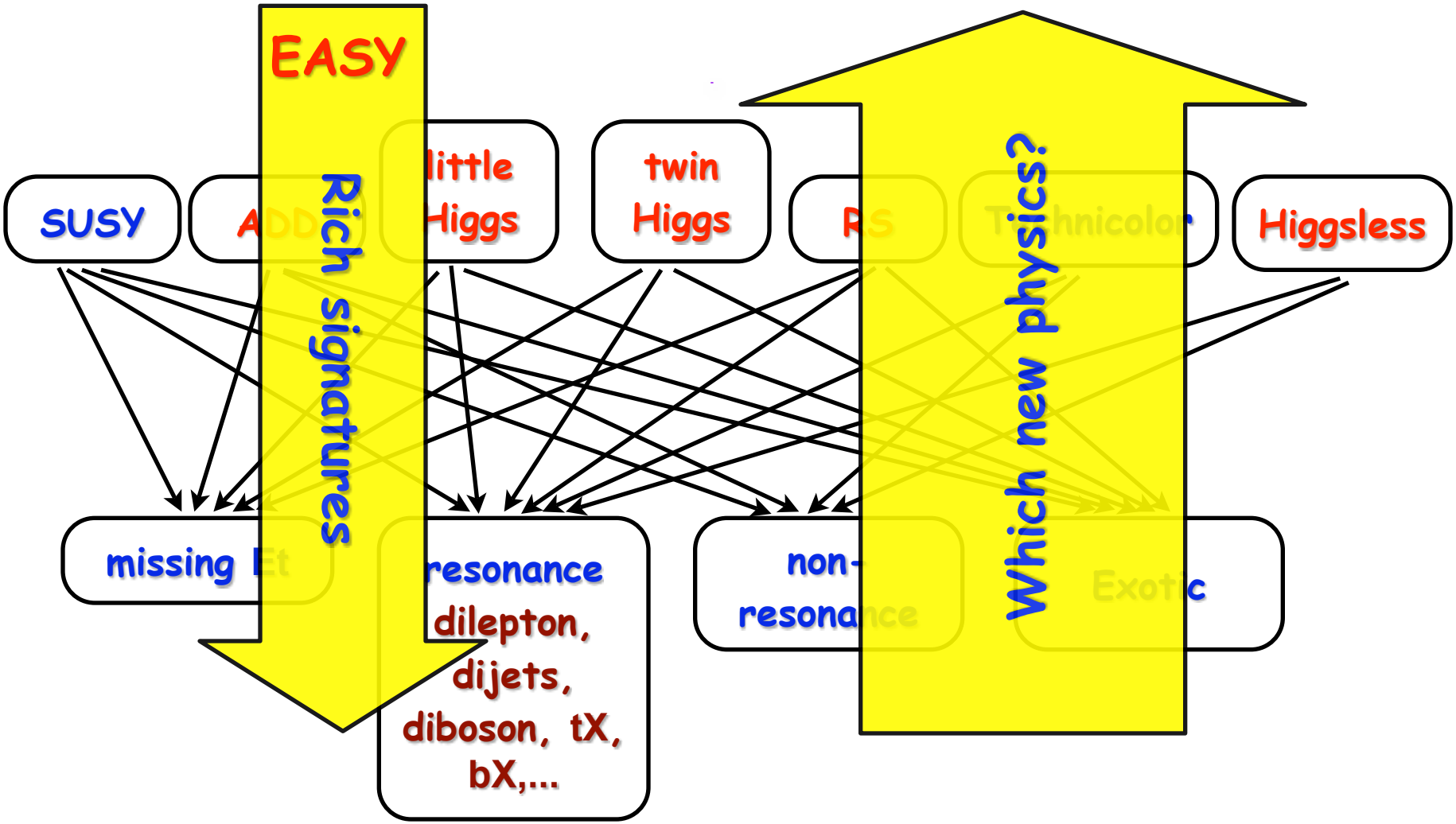
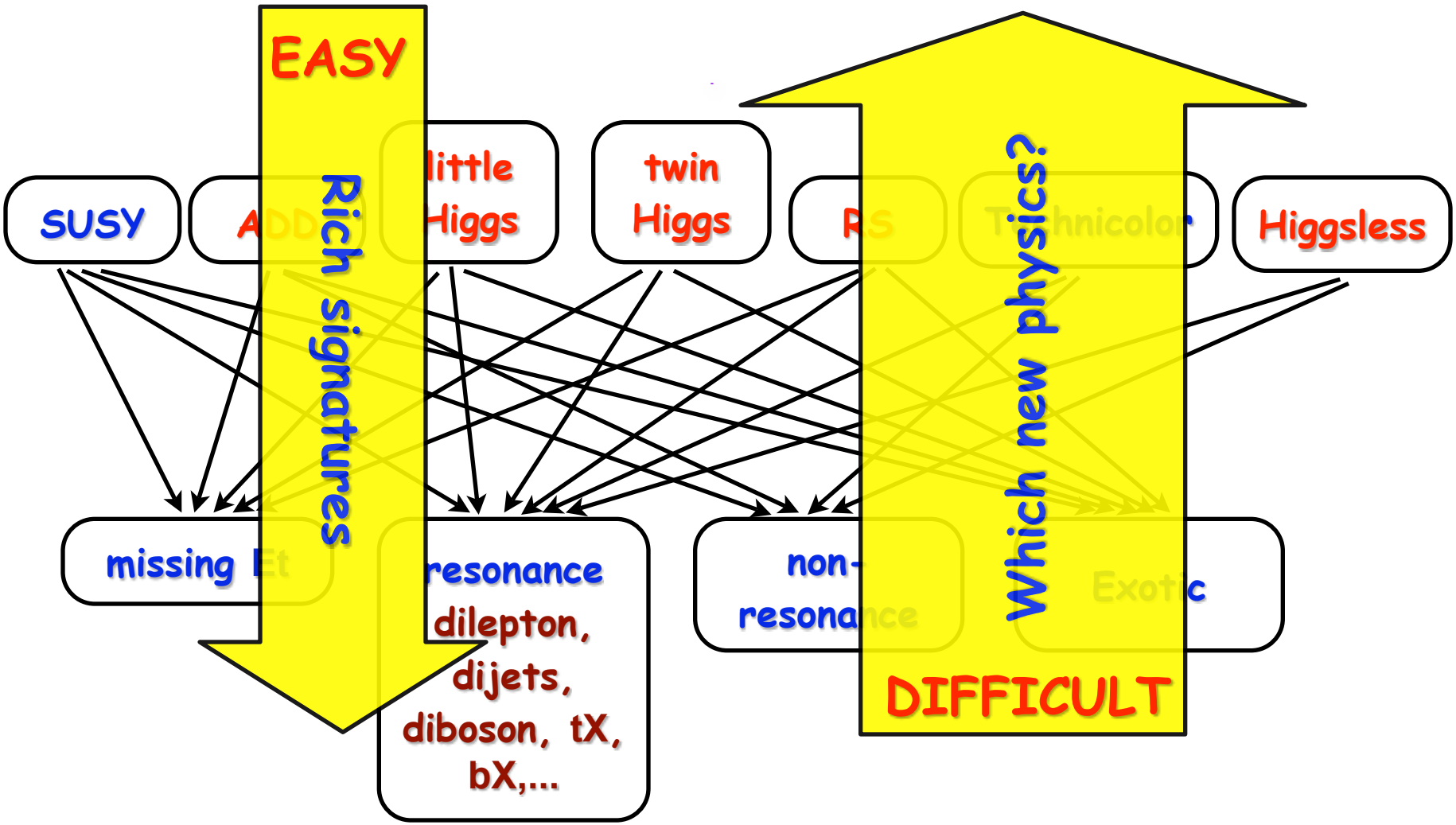
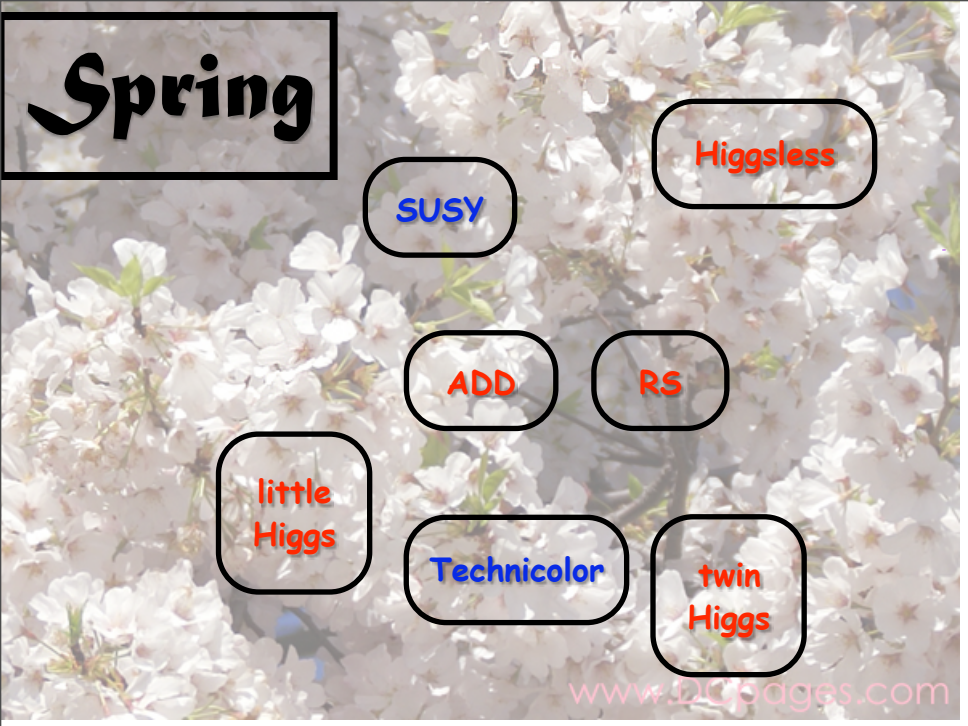
resonance
dilepton,
dijets,
diboson, tX,
bX,...
non-resonance
Exotic


EASY
Rich signatures
Which new physics?
SUSY
ADD
little Higgs
twin Higgs
RS
Technicolor
Higgsless
missing Et
resonance
dilepton,
dijets,
diboson, tX,
bX,...
non-resonance
Exotic


EASY
Rich signatures
SUSY
ADD
little Higgs
twin Higgs
RS
Technicolor
Higgsless
missing Et
resonance
dilepton,
dijets,
diboson, tX,
bX,...
non-resonance
Exotic
Which new physics?
DIFFICULT

Spring

S. Su


Spring
Higgsless
SUSY
ADD
RS
little Higgs
Technicolor
twin Higgs

S. Su

Spring

Higgsless

SUSY

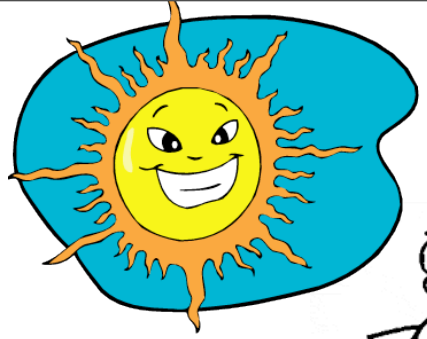
ADD

RS

little Higgs

Technicolor

twin Higgs



Summer

S. Su

Spring

Higgsless

SUSY

ADD

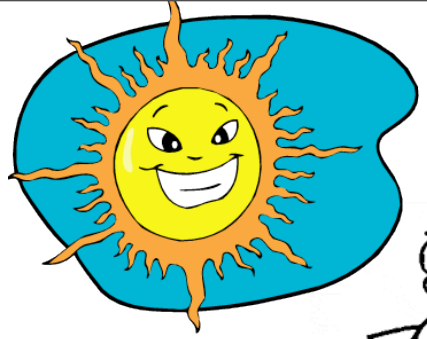
RS

little Higgs

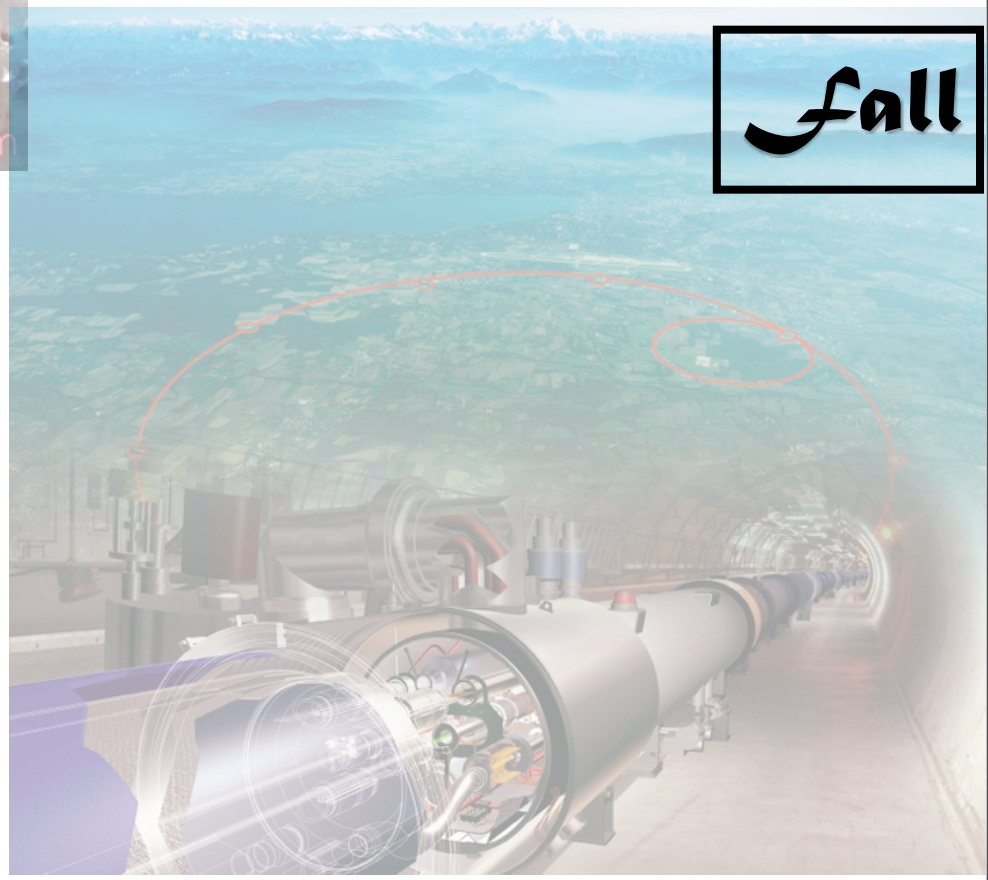
Technicolor

twin Higgs

Summer



Fall



S. Su

Spring

Higgsless

SUSY

ADD

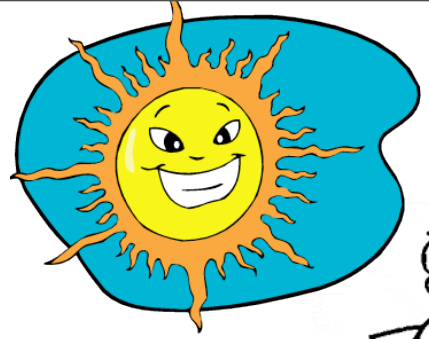
RS

little Higgs

Technicolor

twin Higgs

Summer



Fall

S. Su

Spring

Higgsless

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little Higgs

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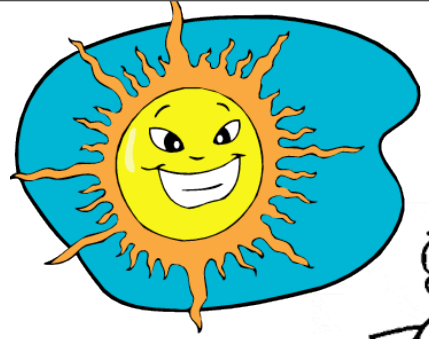
twin Higgs

Summer



Winter

Fall

Let's hope it never come ...

S. Su

Backup Slides

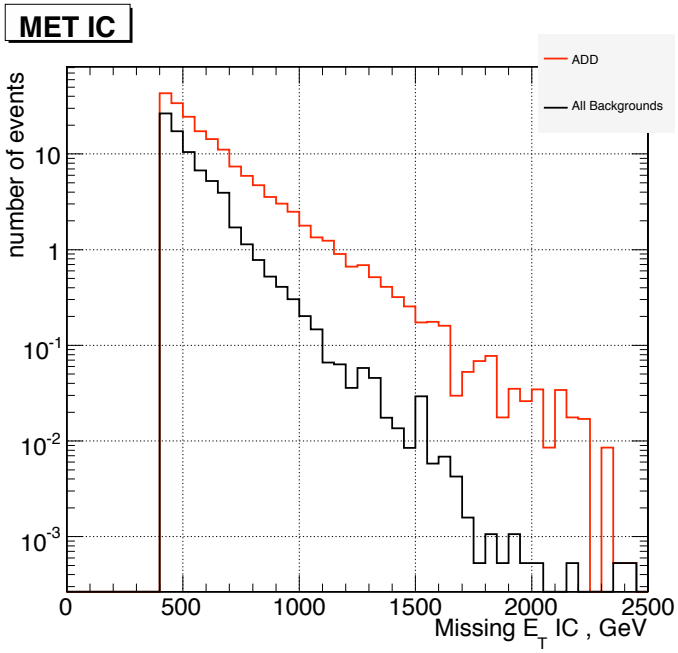
Single Photon + MET

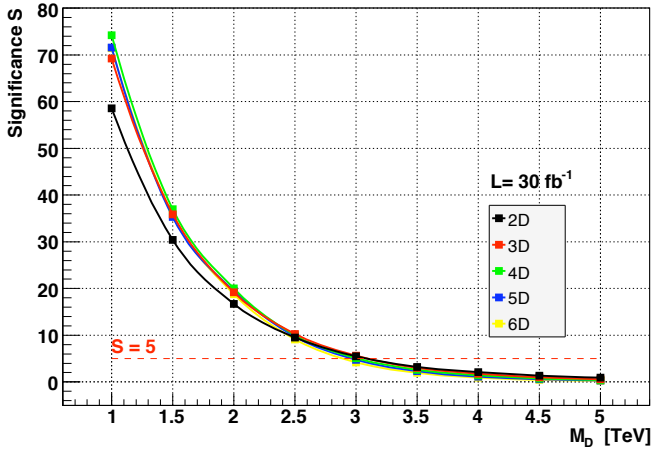
KK graviton bremsstrahlung

$$\sigma \sim \frac{1}{M_{\mathrm{Planck}}^2}(ER)^n \sim \frac{1}{M_*^2}(EM_*)^n$$

Signal: Single photon + large missing ET

Dominant background: Zγ, W, Wγ, γ+jets, QCD, diγ, Z+jets



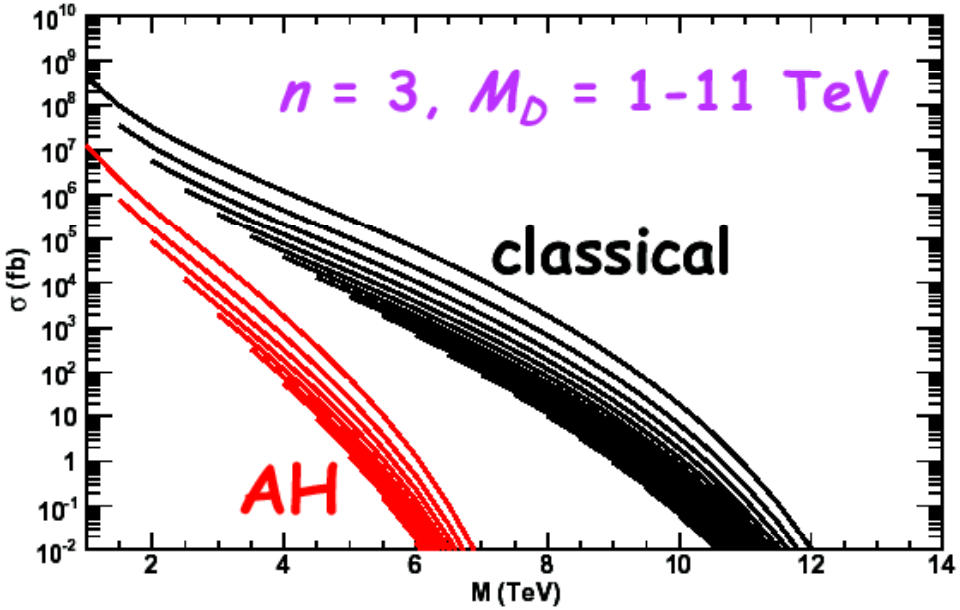


pT>400 GeV, MET> 400 GEV

MD=2.5 TeV, n=2, L=30fb^{-1}

Black Hole Production

Warning: cross section could be much less than optimistic estimates



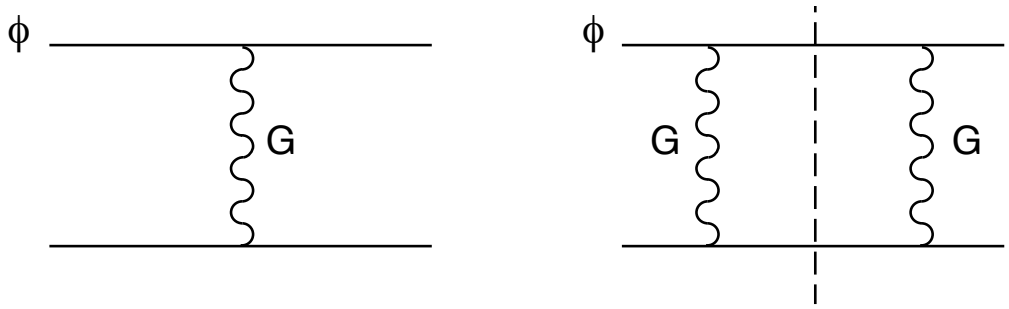
$$\sigma_{BH} \sim \pi r_h^2$$

For 10 fb^{-1}

- Classical approximation to cross-section: large! Black Holes up to 8-10 TeV
- Apparent horizon (AH), not all energy trapped; see eg. hep-ph/0609055 Black holes up to 4-5 TeV

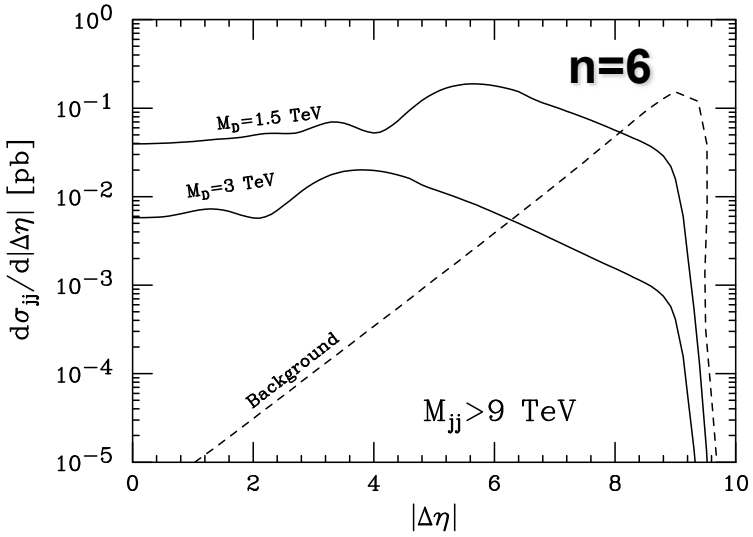
Dijets with large Mjj

Elastic scattering in transplanckian region with small momentum transfer

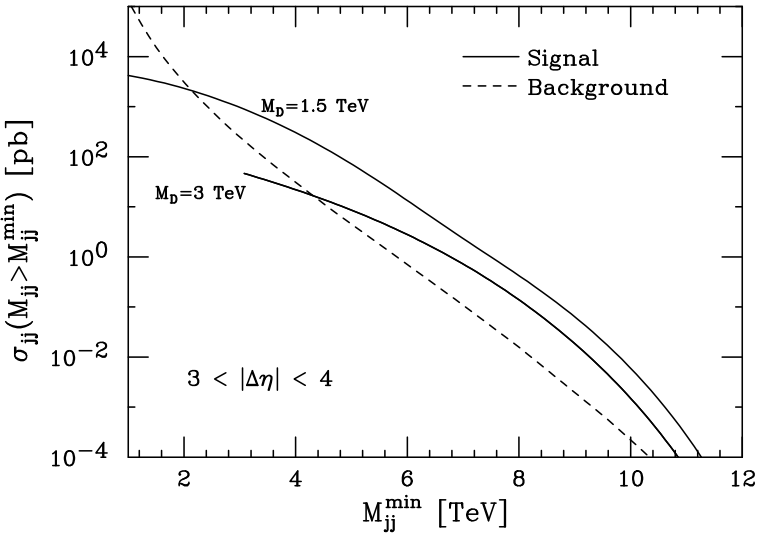


Signal: dijets with large M_{jj}

jet-jet production at small angle with large center of mass energy



S. Su



Giudice, Rattazzi and Wells, hep-ph/0112161

Little Higgs Models

$$\lambda_1(iQht_r + fT_Lt_r - \frac{1}{2f}T_Lt_rhh^\dagger) + \lambda_2 f(T_LT_R)$$

Mass eigenstates: T and tSM

parameters: f, λ_1 , λ_1 → mt, mT, λ_1/λ_2

$$\Gamma(T \to tZ) = \Gamma(T \to t\ h) = \frac{1}{2}\Gamma(T \to bW) = \frac{\kappa_T^2}{32\pi}M_T \qquad \kappa_T = \lambda_1^2/\sqrt{\lambda_1^2+\lambda_2^2}$$

Little Higgs Models

Azuelos et. al., hep-ph/0402037

ATLAS

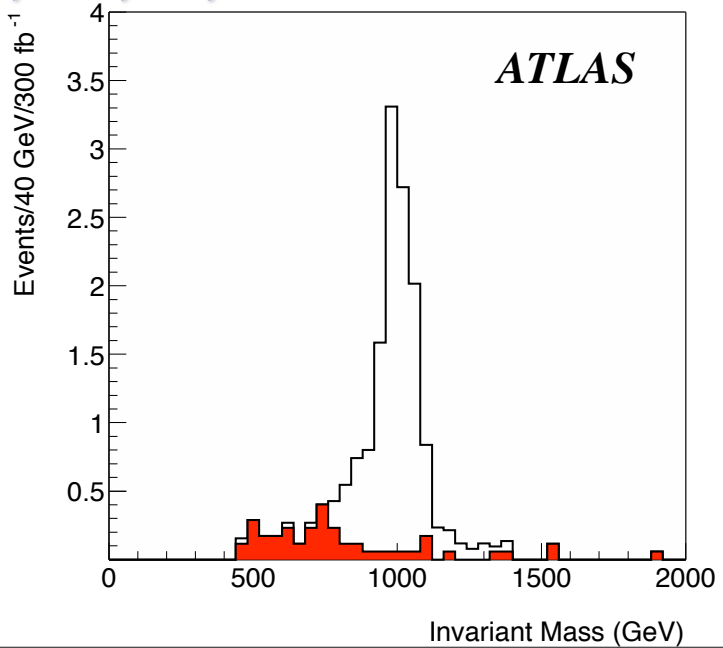
$$\Gamma(T \to tZ) = \Gamma(T \to t\ h) = \frac{1}{2}\Gamma(T \to bW) = \frac{\kappa_T^2}{32\pi} M_T$$

$$\kappa_T = \lambda_1^2 / \sqrt{\lambda_1^2 + \lambda_2^2}$$

T→ t Z → l+l-lvb, with leptonic decay of Z and W

3 high pt leptons, one b-tagging, and large MET

BG: WZ, ZZ, tt, tbZ



low number of signal events, 10 for 300 fb-1

mT=1 TeV

λ_1/λ_2 =1

5 σ reach:

300 fb^{-1}, mT<1050 (1400) GeV

λ_1/λ_2 =2

Little Higgs Models

0405156

ATLAS

$$\Gamma(T \to tZ) = \Gamma(T \to t\ h) = \frac{1}{2}\Gamma(T \to bW) = \frac{\kappa_T^2}{32\pi} M_T$$

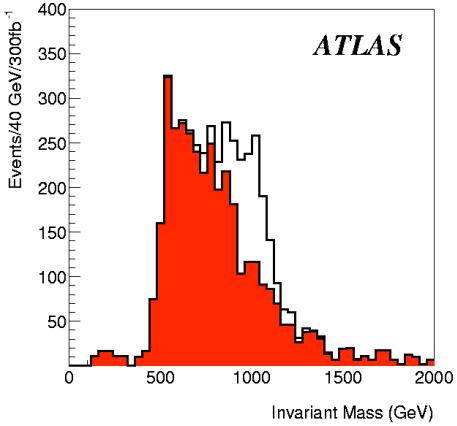
$$\kappa_T = \lambda_1^2 / \sqrt{\lambda_1^2 + \lambda_2^2}$$

T→ Wb, with leptonic decay of Z and W

one high pt leptons, two jets (one b-tagging), and large MET

BG: Wbb, tt, single top

$$\lambda_1 = \lambda_2 = 1.$$



5 σ reach for 300 fb^{-1},
λ_1/λ_2 =1(2)
mT< 2000 (2500) GeV

Little Higgs Models

0405156

ATLAS $\Gamma(T \to tZ) = \Gamma(T \to t\ h) = \frac{1}{2}\Gamma(T \to bW) = \frac{\kappa_T^2}{32\pi} M_T$

$\kappa_T = \lambda_1^2 / \sqrt{\lambda_1^2 + \lambda_2^2}$

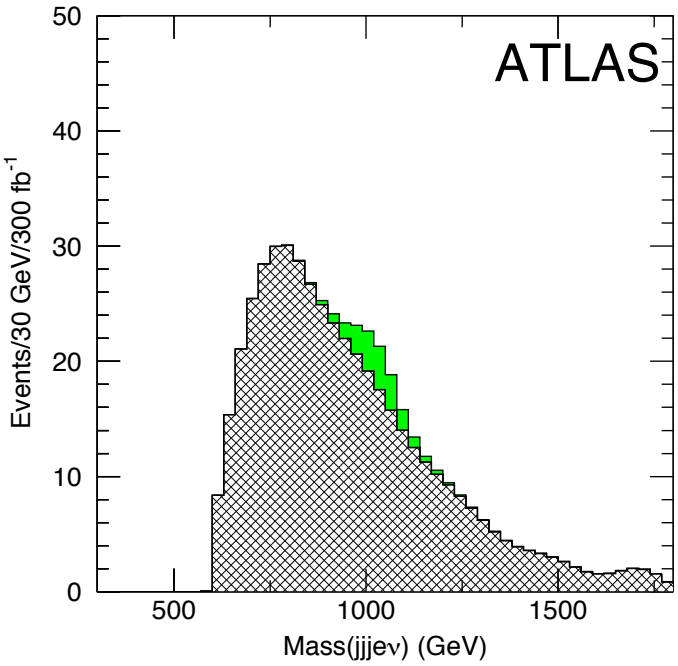
5 σ reach:

150 fb^{-1}

T→ ht, with h->bb, with leptonic decay of Z and W

one isolated leptons, three jets (one b-tagging), and MET

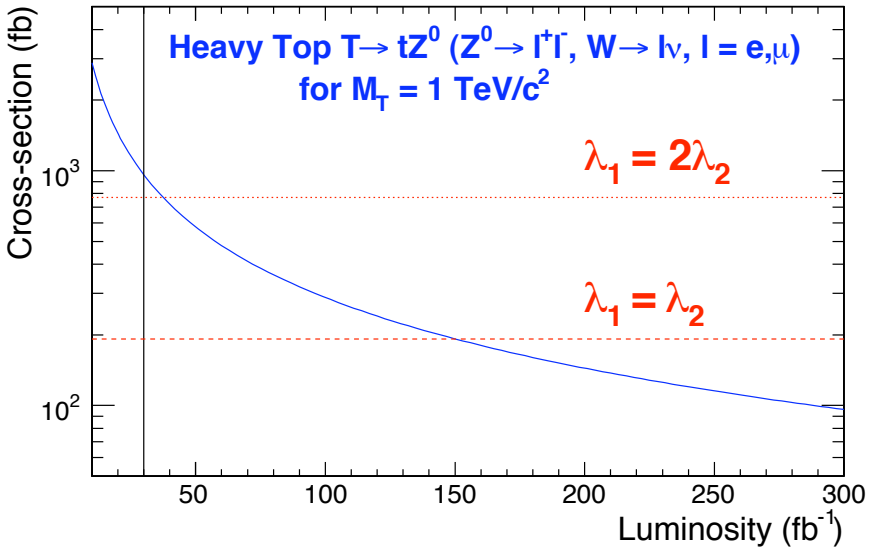
BG: tt, difficult



Little Higgs Models

Ref. 756, CMS

CMS: $T \rightarrow t\,Z$, with leptonic decay of Z and W



5 σ reach:

40 fb^{-1}

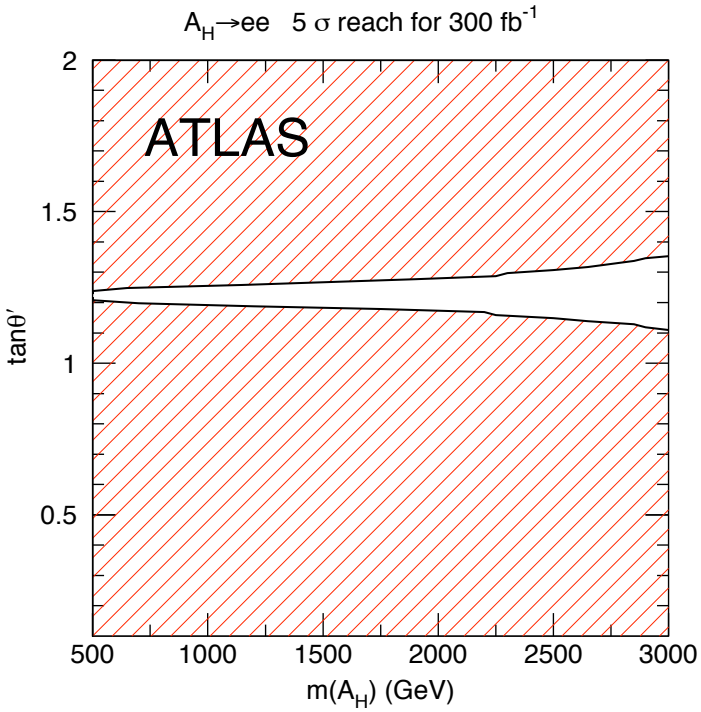
150 fb^{-1}

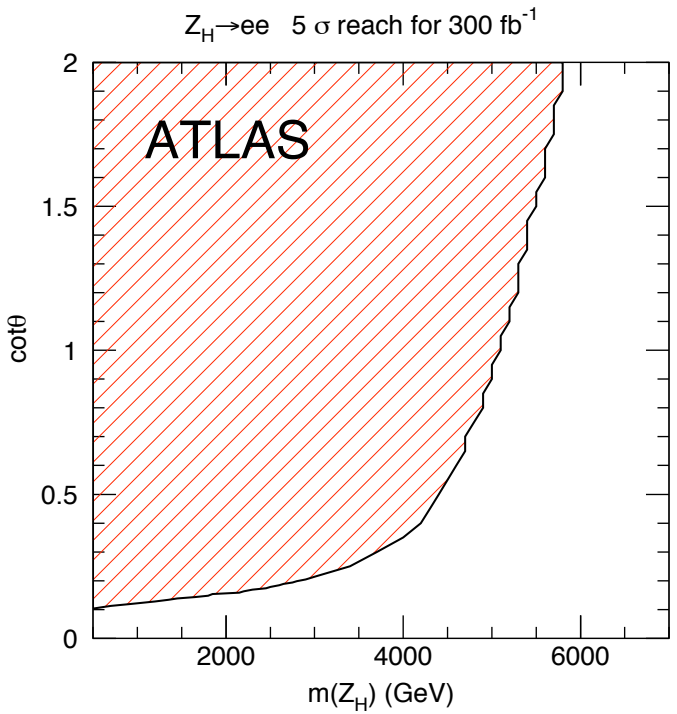
Heavy Guage Boson in the Littlest Higgs

WH, ZH, AH arise from [SU(2)⊗U(1)]2 ➞ SU(2)⊗U(1)

2 mixing angles: θ for ZH, θ' for AH

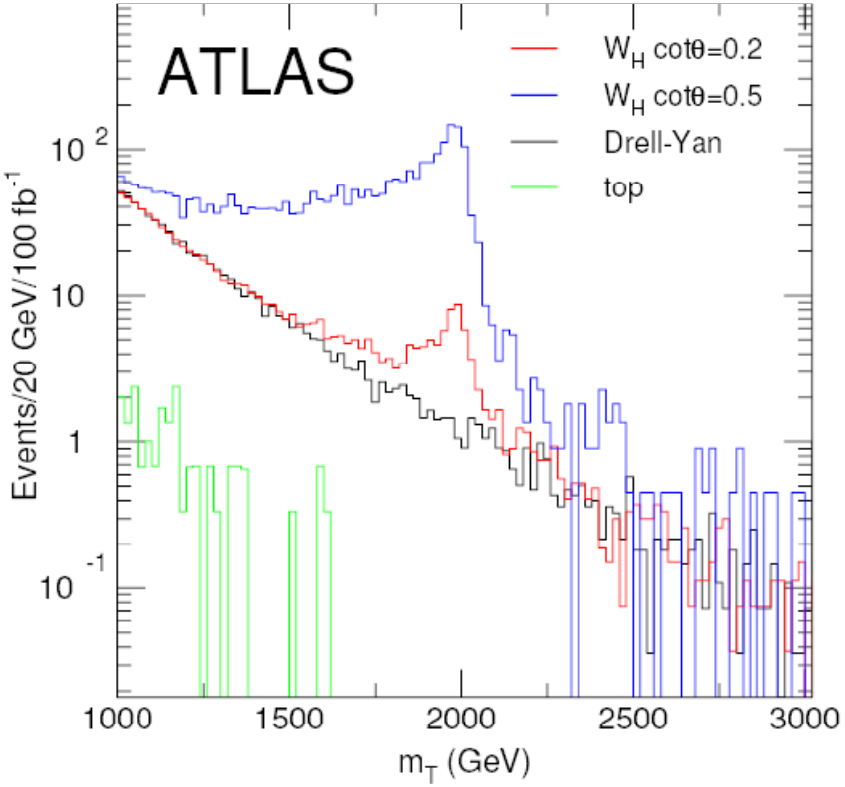
ZH→ ee, μμ rise with cotθ to about 4%

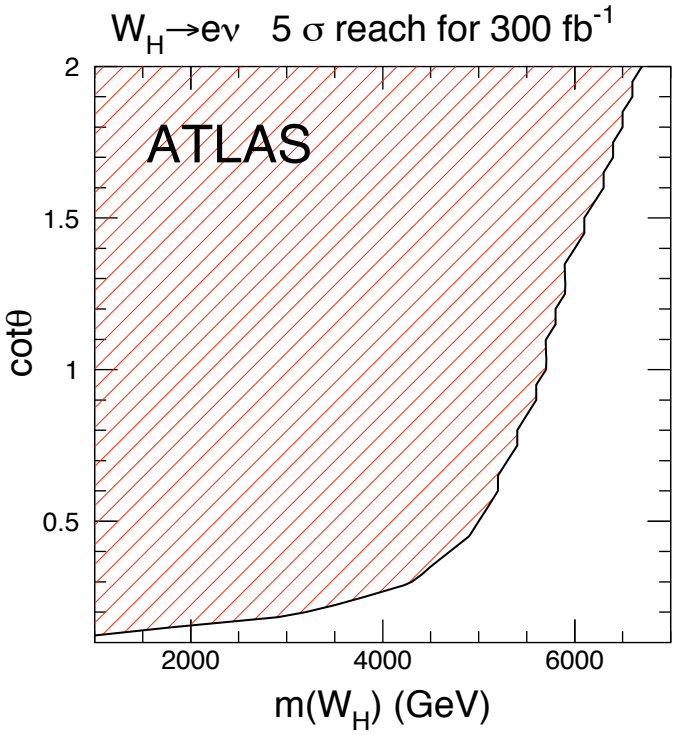




Little Higgs Models

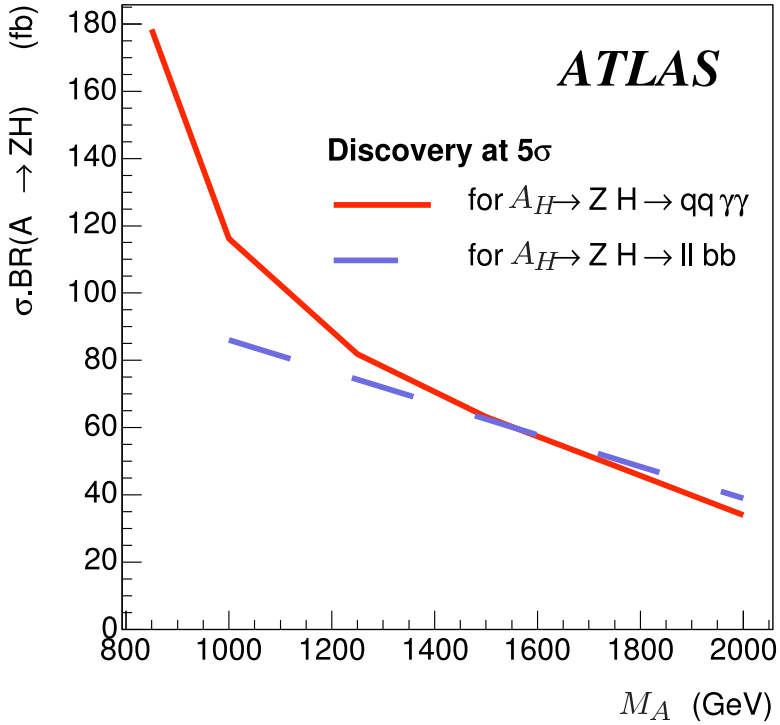
WH→ eν, μν (slightly better)





Little Higgs Models

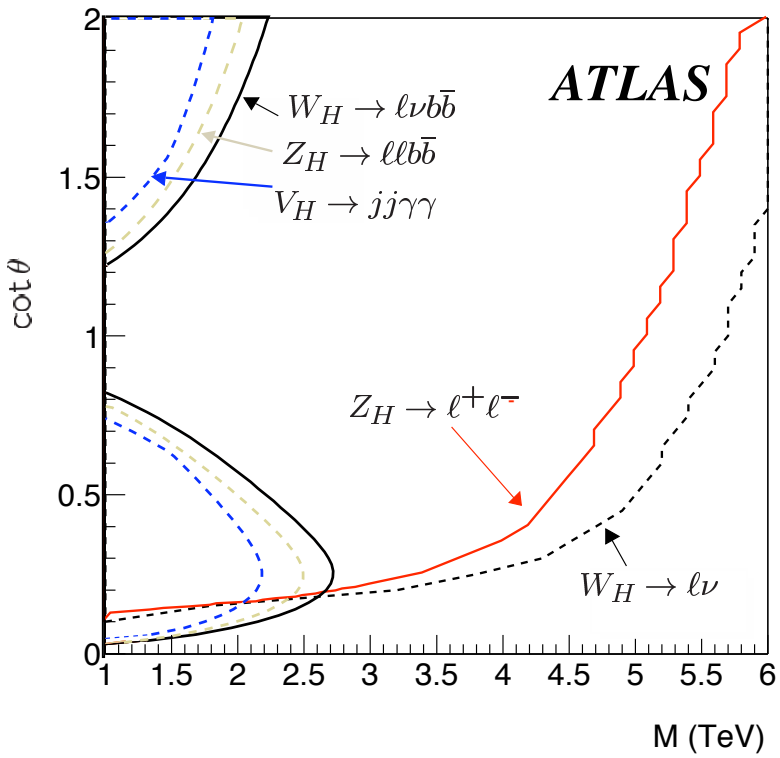
AH



LH

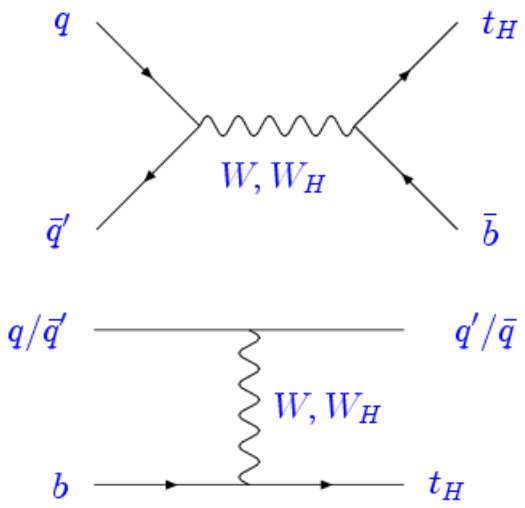
300 fb-1

5 σ


ATLAS
$W_H \to \ell\nu b\bar{b}$
$Z_H \to \ell\ell b\bar{b}$
$V_H \to jj\gamma\gamma$
$Z_H \to \ell^+\ell^-$
$W_H \to \ell\nu$
cot θ
M (TeV)
0
0.5
1
1.5
2
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6

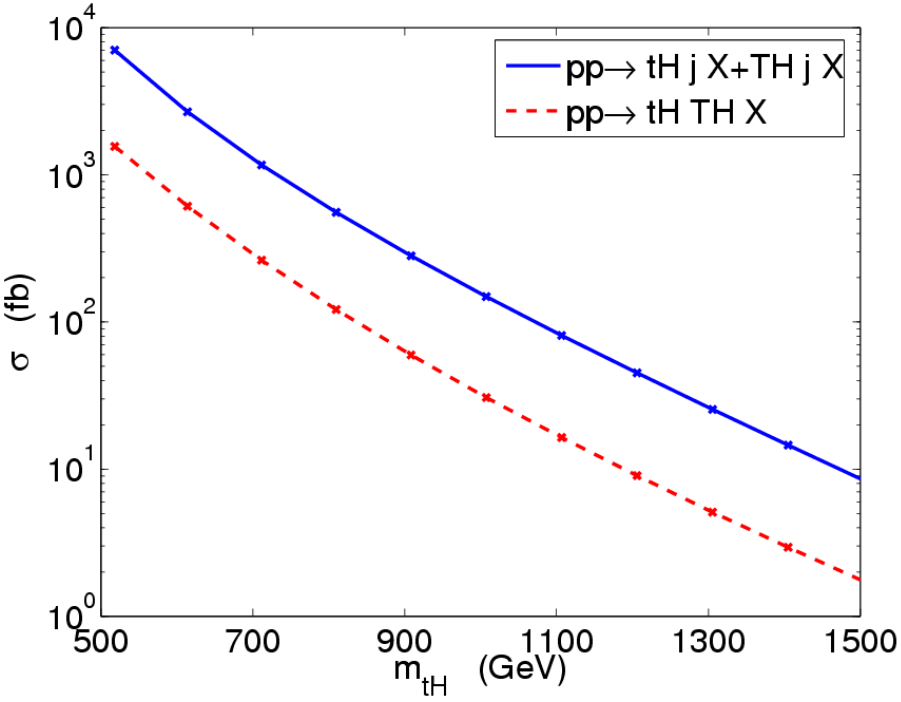
Heavy top t_H production

- **single heavy top production**



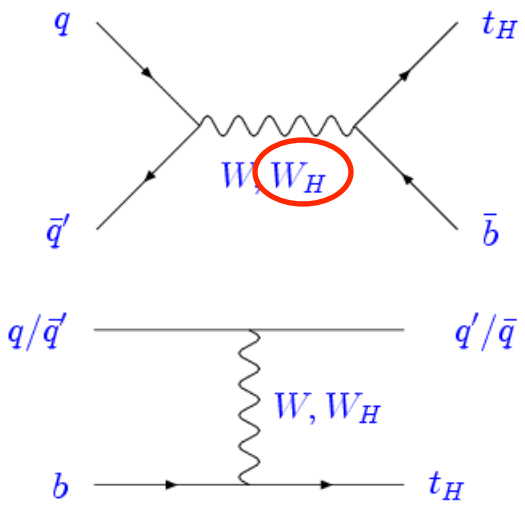
- **heavy top pair production**

$$gg, q\bar{q} \rightarrow t_H \bar{t}_H$$



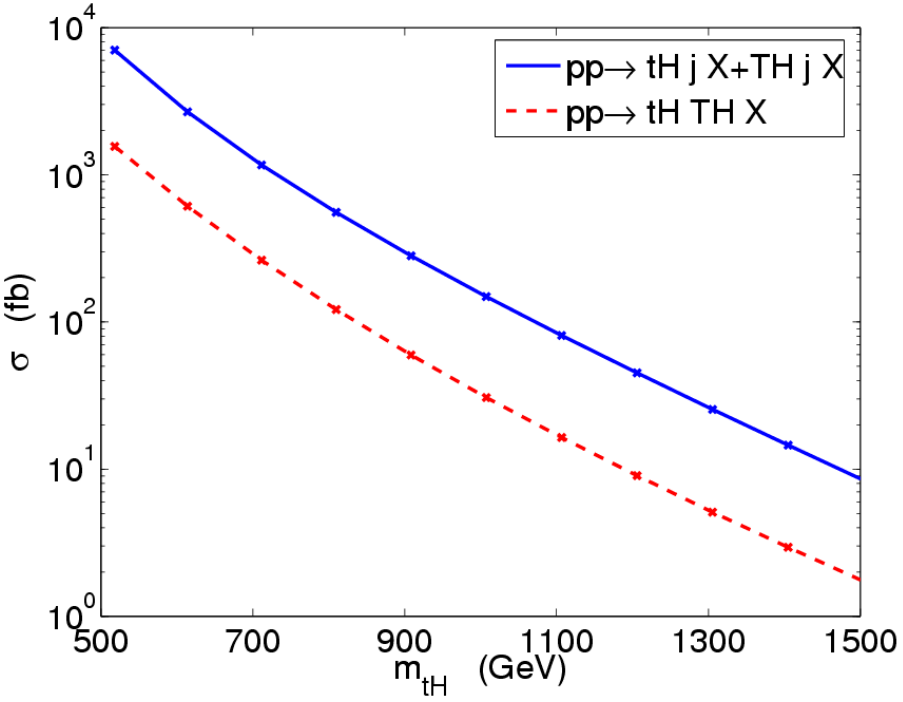
Heavy top t_H production

- **single heavy top production**

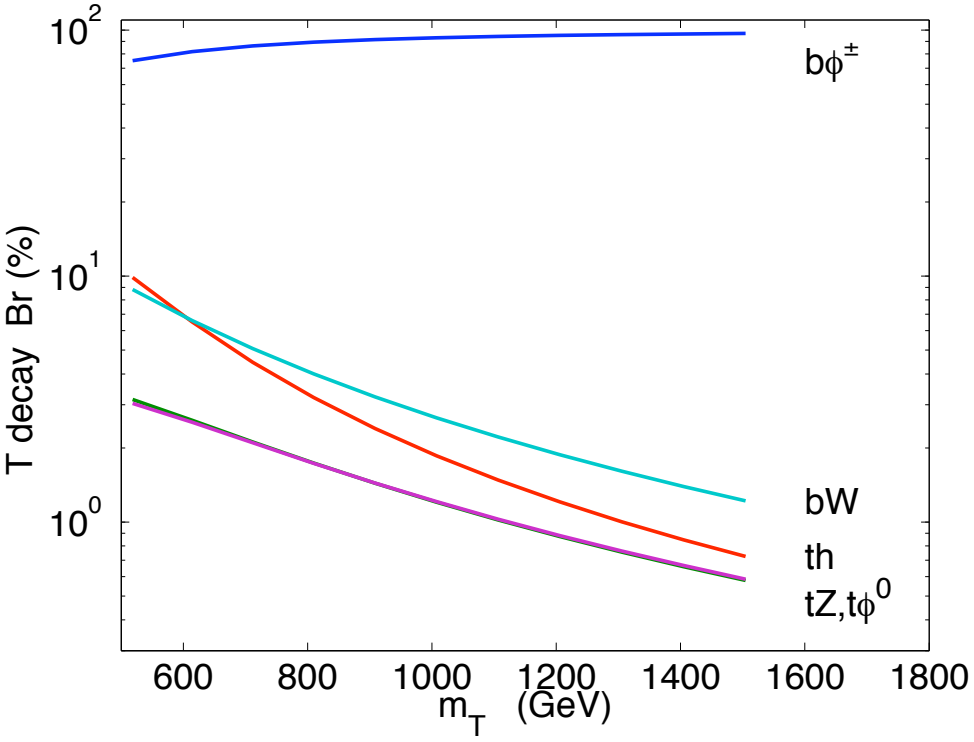


- **heavy top pair production**

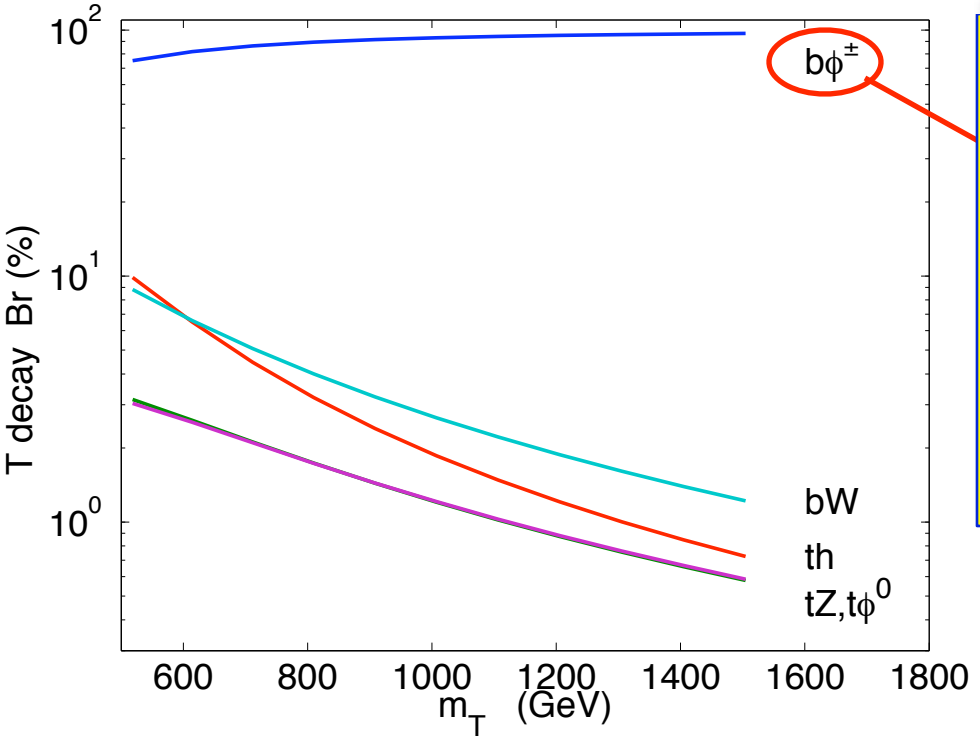
$$gg, q\bar{q} \rightarrow t_H \bar{t}_H$$

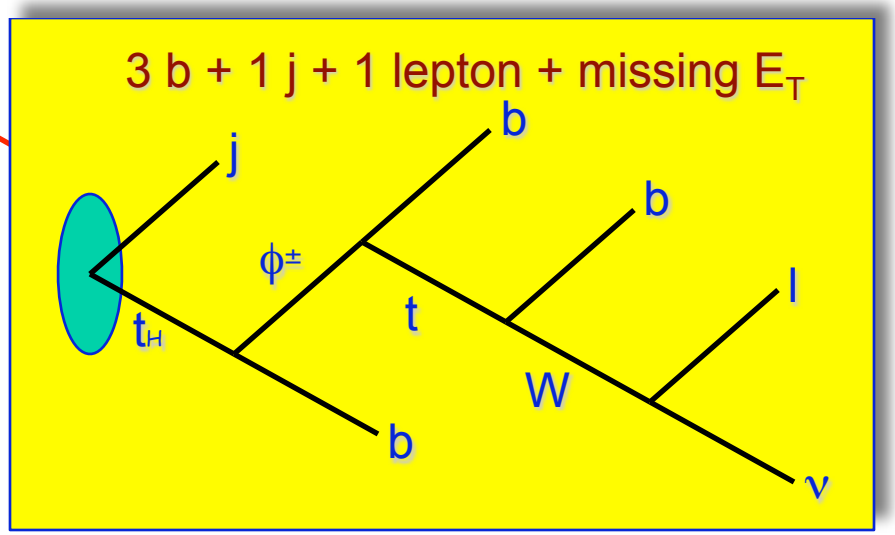


Heavy top t_H decay

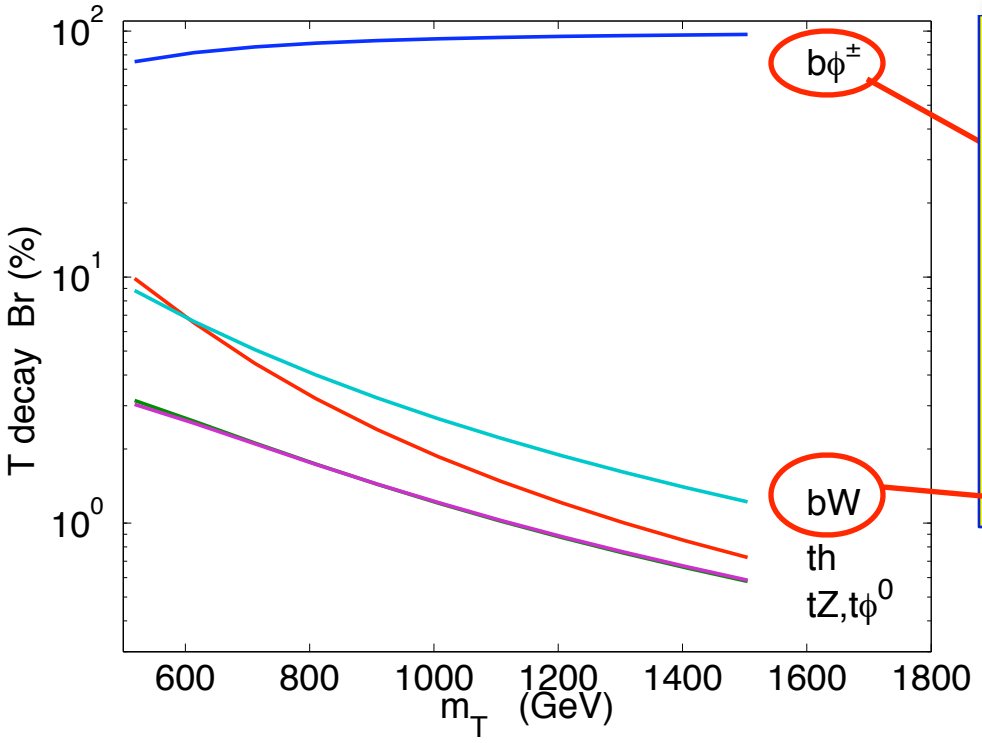


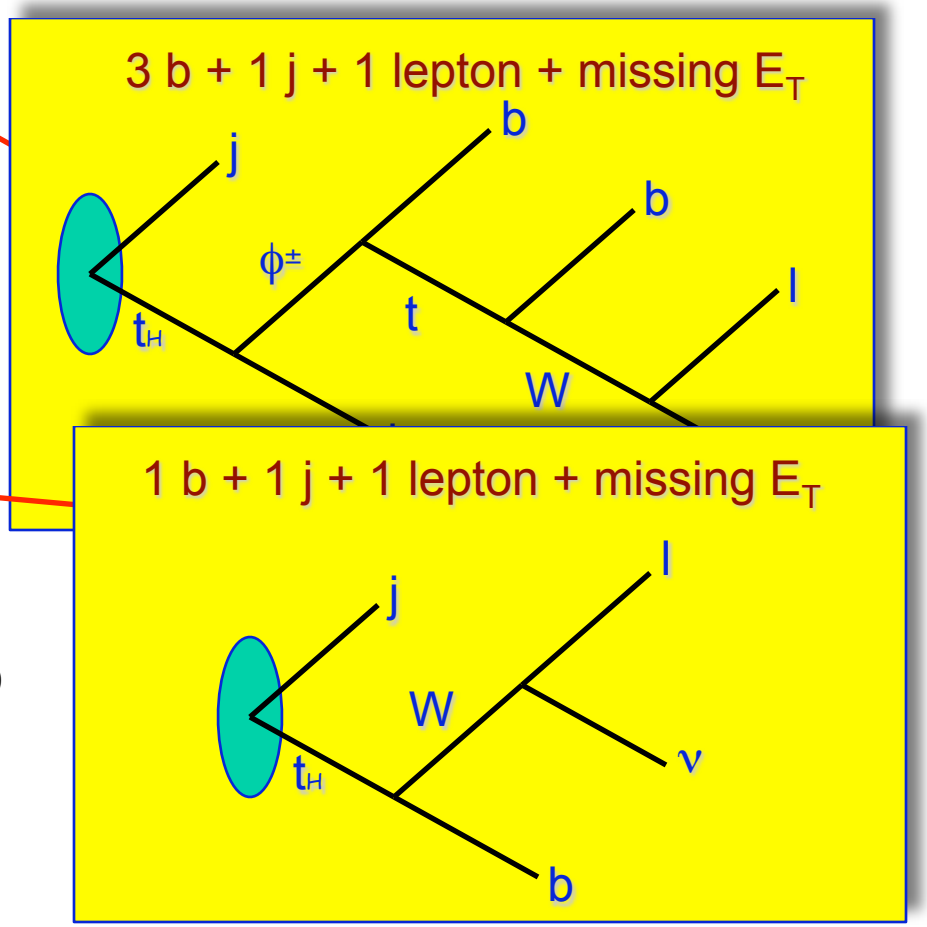
Heavy top t_H decay





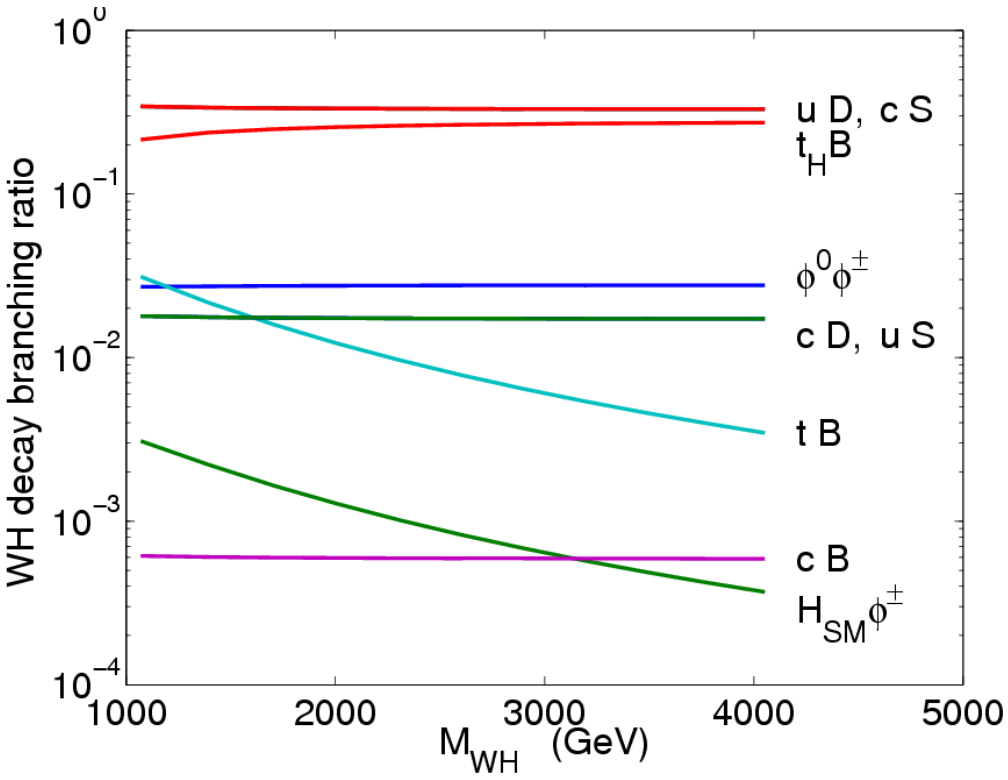
Heavy top t_H decay





W_H decay

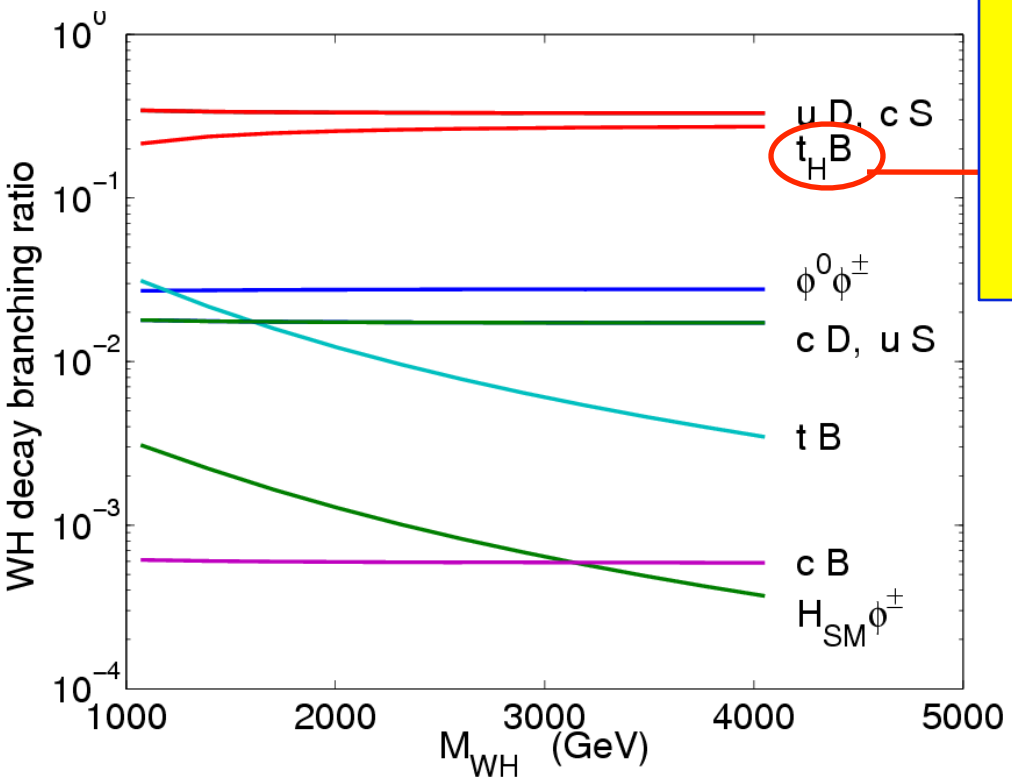
- W_H ($m_{\nu R} > m_{WH}$)



- W_H ($m_{\nu R} < m_{WH}$), $W_H \rightarrow l\ \nu_R$, Br ~ 9%

W_H decay

- W_H ($m_{\nu R} > m_{WH}$)



$t_H \rightarrow b\phi^\pm$: 4b + 1 lepton + missing E_T

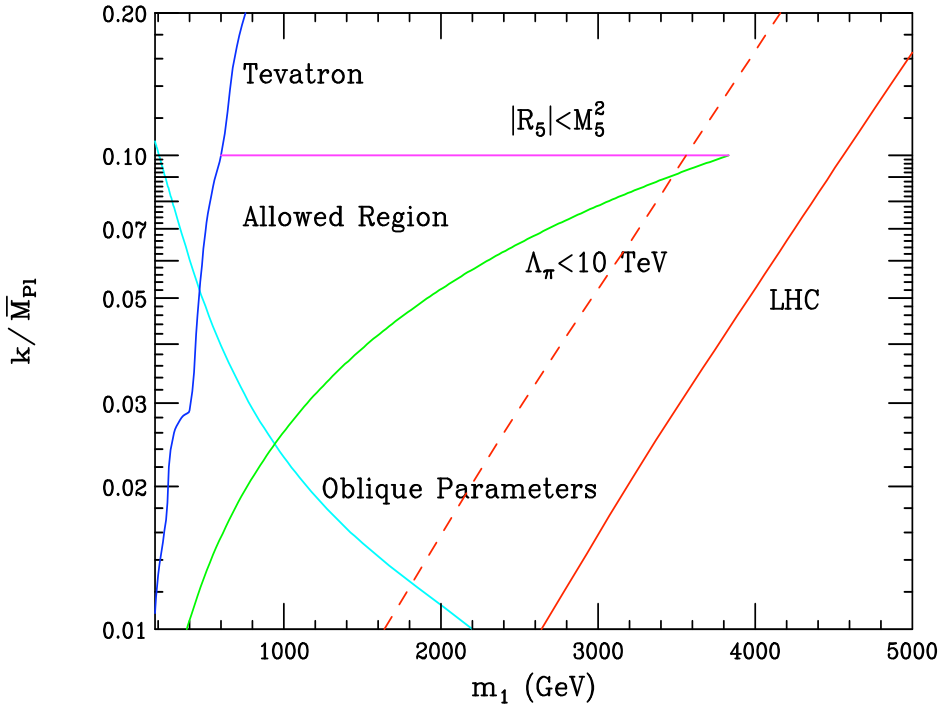
$t_H \rightarrow bW$: 2b + 1 lepton + missing E_T

$t_H \rightarrow tZ$: 2b + 3 lepton + missing E_T

- W_H ($m_{\nu R} < m_{WH}$), $W_H \rightarrow l\ \nu_R$, Br ~ 9%

Randall-Sundrum

Collider signature: resonance in drell-yan and dijets

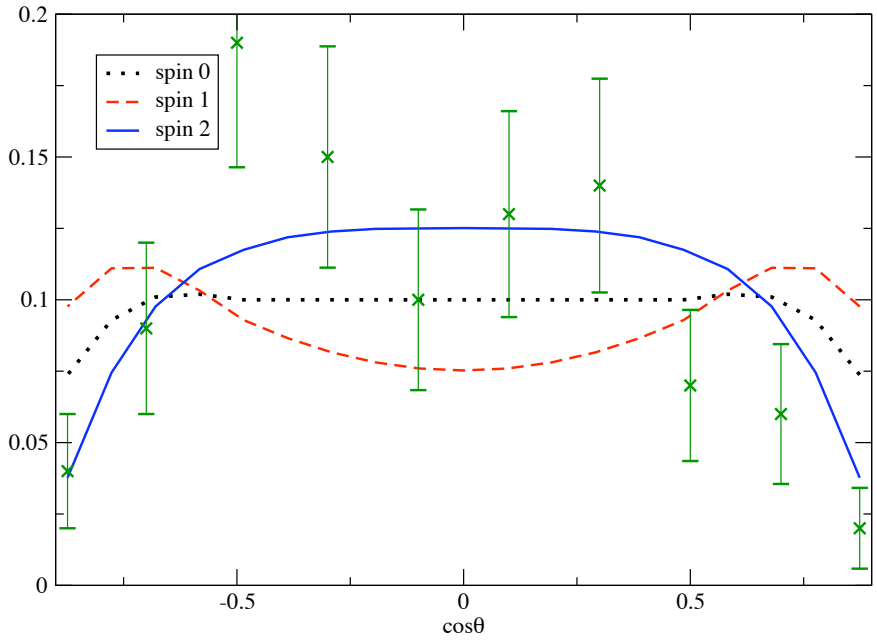


Hewett, Spirolulu, hep-ph/0205156

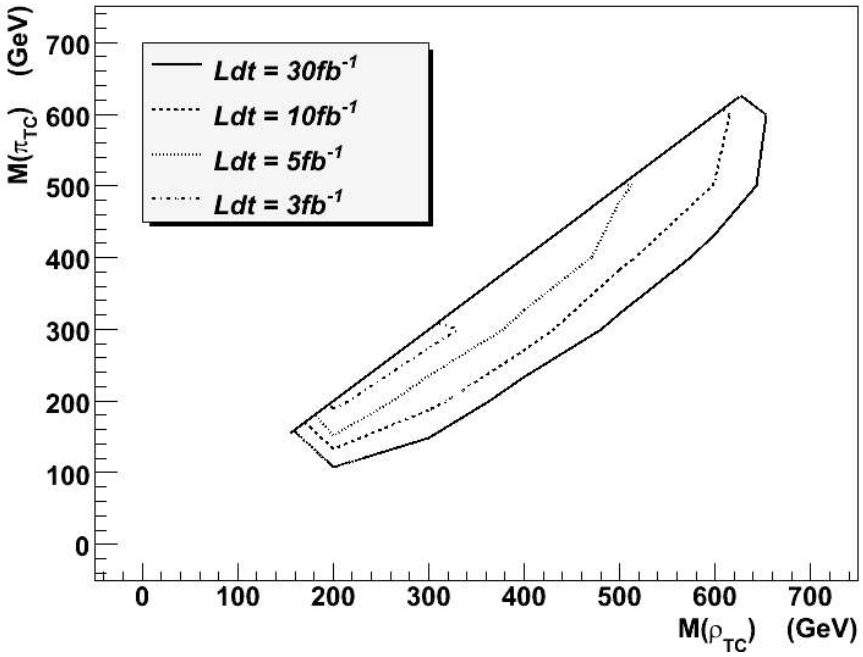
RS graviton

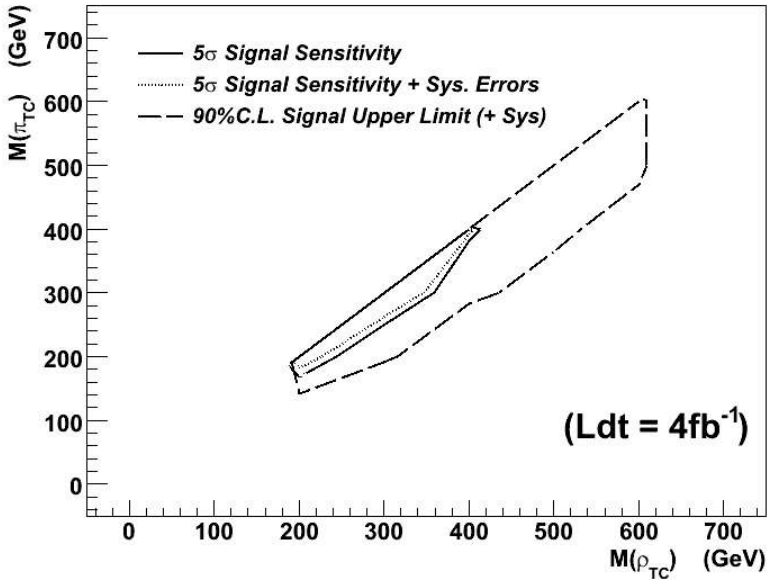
gg->G1->tt

Fitzpatrick, Kaplan, Randall and Wang, hep-ph/0711150



Focus of This Talk



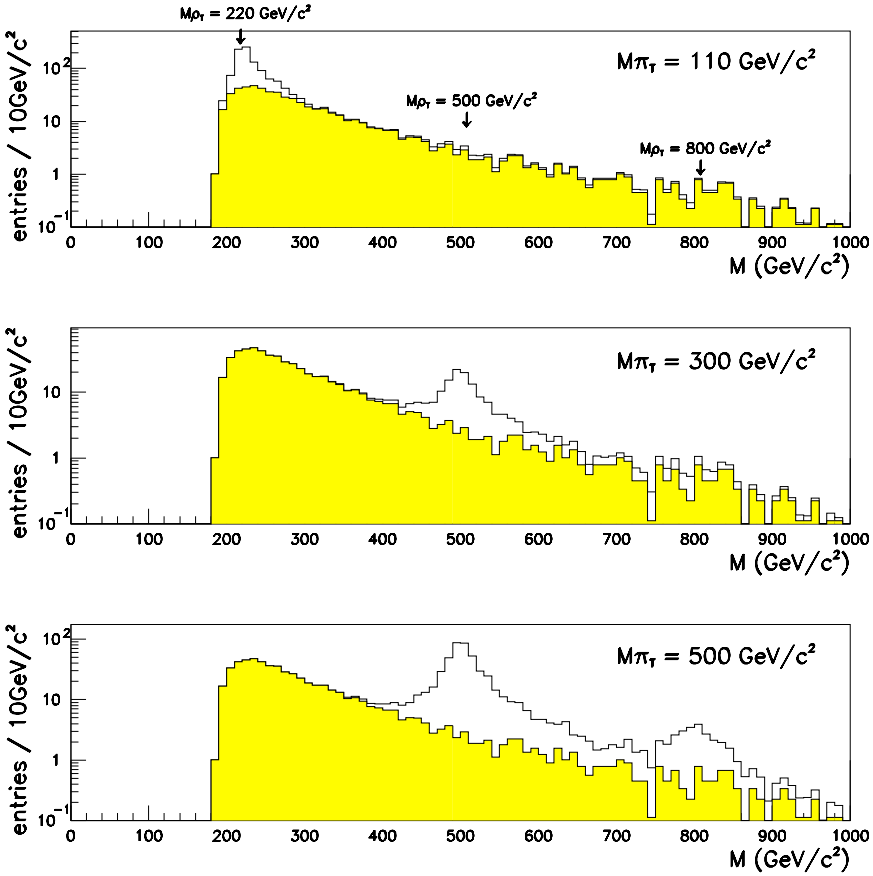


Focus of This Talk

technicolor: leptons or lepton+ jets

ATL-PHYS-99-020

Case	$m\rho_T$ (GeV)	$m\pi_T$ (GeV)	$\Gamma\rho_T$ (GeV)	BR ($\rho_T \rightarrow WZ$)
(a)	220	110	0.93	0.13
(e)		110	67	0.014
(b)	500	300	4.5	0.21
(f)		500	1.1	0.87
(g)		110	130	0.013
(d)		250	77	0.022
(h)	800	300	52	0.032
(c)		500	7.6	0.22



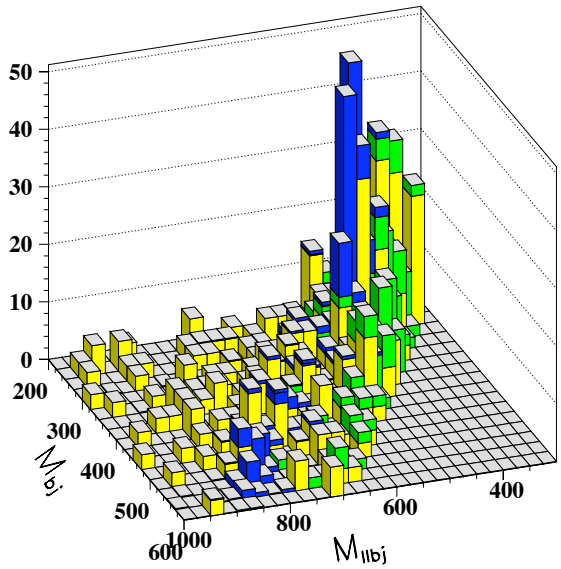
Focus of This Talk

technicolor: leptons or lepton+ jets

ATLAS TDR

L=30fb-1

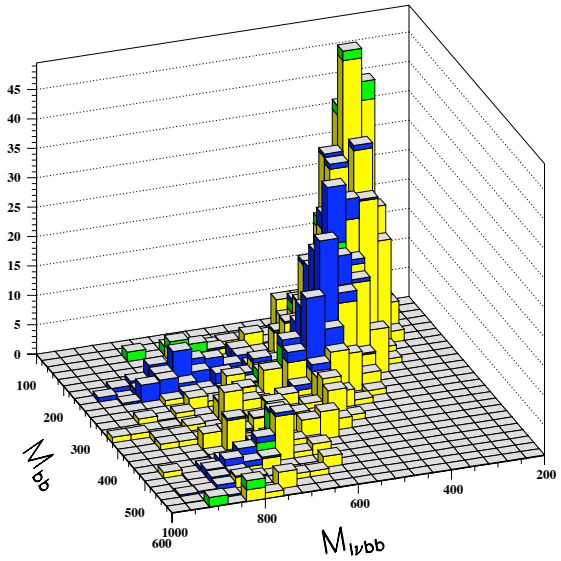
$\rho_{TC} \rightarrow \pi_{TC} Z \rightarrow bqll$



	case (b): $m(\rho_T)$=500, $m(\pi_T)$=300 GeV	case (c): $m(\rho_T)$=800, $m(\pi_T)$=500 GeV	case (d): $m(\rho_T)$=800, $m(\pi_T)$=250 GeV
Number of events	115/148/17	48/43/2	11.5/49/0
$S/\sqrt{B}$	8.9	7.1	1.6
σ x BR model	0.104	0.018	0.0059
σ x BR for 5σ	0.058	0.013	0.018

Technicolor

$\rho_{TC} \rightarrow \pi_{TC} W \rightarrow bb\ell\nu$



	case (b) $m(\rho_T)$=500, $m(\pi_T)$=300 GeV	case (c) $m(\rho_T)$=800, $m(\pi_T)$=500 GeV	case (d) $m(\rho_T)$=800, $m(\pi_T)$=250 GeV
Number of events	86/165/5	24/118/10	12/5/0
$S/\sqrt{B}$	6.6	2.1	5.3
σ x BR (pb), model	0.336	0.064	0.021
σ x BR (pb), 5σ	0.255	0.15	0.02

Technicolor

L=30 fb-1

$\eta_8 \rightarrow b\bar{b}$

$m_{b\bar{b}}$	p_{Tmin} (b_1/b_2)	p_{T3} (max)	σ_m (GeV)	σ x BR (5σ) (pb)
300	75/75	100	37	13
500	180/50	50	60	7.0
1000	200/100	100	70	0.57
2000	300/200	100	160	0.11

$\eta_8 \rightarrow t\bar{t} \rightarrow l\nu bbjj$

$m(t\bar{t})$ [GeV]	$\Gamma(t\bar{t})$ [GeV]	$\sigma \times$ BR [pb] 10 fb^{-1}	100 fb^{-1}
500	57	17.0	5.5
750	107	12.0	3.8
1000	152	5.0	1.6

$\omega_{TC} \rightarrow \pi_{TC}\gamma \rightarrow bb\gamma$

	$m(\omega_T)$= 500 GeV	$m(\omega_T)$=800 GeV
Number of events	612/105	174/24
$S/\sqrt{B}$	60	35
$\sigma \times$ BR (pb), model	0.161	0.033
$\sigma \times$ BR (pb) 5σ	0.013	0.0046

VBF with $\rho_{TC} \rightarrow \pi_{TC} W \rightarrow bbl\nu$, complementary to qq fusion, not discovery channel unless 10 fb