What we would like to do?

We predict the bounds on KK scale M_{KK} in 7 types of 6D UED models by *current LHC data and electroweak precision data.*

How we can calculate?

We calculate Higgs signal strength and S,T parameters by using 4 dimensional effective Lagrangian

$$\mathcal{L}_{\mathrm{SM}} + \sum_{\mathrm{KK}} \mathcal{L}_{\mathrm{KK}}$$

below the UV cutoff scale.

Our result

- Bounds on KK scale by ATLAS and CMS data vs KK contributions
  → $MKK > 1000 - 1600GeV$
- Bounds on KK scale by S,T parameters vs KK contributions
  → $MKK > 1000 - 1500GeV$
  at 2 σ arrowed.

What's types of 7 models?

Deferences are compactification and orbifolding method

T^2 based type

3 types
- T^2/Z_2
- $T^2/Z_2 \times Z_2'$
- T^2/Z_4

S^2 based type

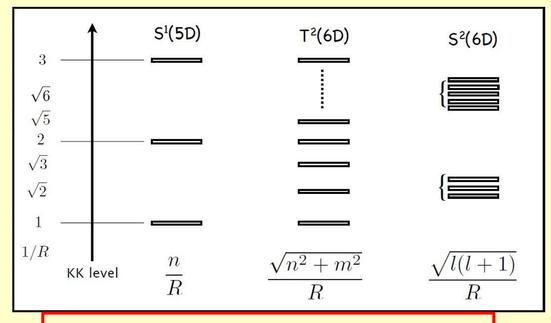
2 types
- S^2
- S^2/Z_2

KK mass spectrum: $\frac{\sqrt{n^2+m^2}}{R}$, $\frac{\sqrt{l(l+1)}}{R}$ With some degeneracy for each l

Same KK mass spectrum as T^2 : RP^2 (Real Projective Plane)

Projective UED — 2 types

Same KK mass spectrum as S^2 : PS (Projective Sphere)



In 4D effective theory, differences are summarized in structure of KK towers

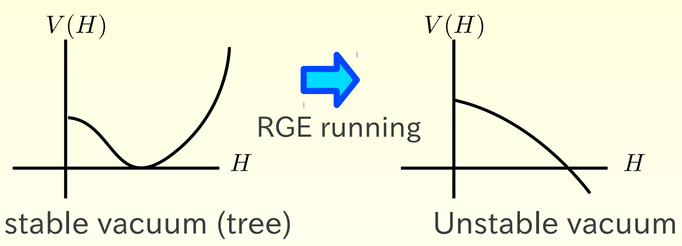
We must be careful to this structures

How we estimate UV cutoff?

We estimate the upper bound on cutoff by *vacuum stability bound* in solving *RGE*.

Vacuum stability bound

The scale where effective Higgs potential get to be negative = the scale Higgs quarticinteraction $\lambda = 0$



We need cutoff Λ below this scale for calculable theory

→ We put Λ just below vacuum stability bound (in this poster)

RGE running in UED models

RGE for λ in UED models

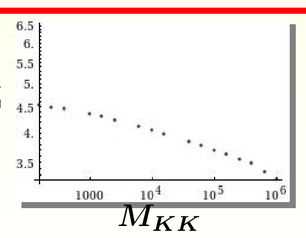
$$16\pi^2 \mu \frac{d}{d\mu}\lambda = \beta^{SM} + \sum_{KK\,state} \theta(\mu - M_{KK})\beta^{KK}$$

By solving RGE, we can find vacuum stability bound as

$$\Lambda_{max} = N M_{KK}$$

Coefficient N is almost invariant in $M_{KK} = \mathcal{O}(TeV)$

ex.) S^2/Z_2 case →



Upper bounds on N for each models

NEW!!

S^2	$l = 1\ ,\ 2\ ,\ 3$
S^2/Z_2 **PS**	$l = 1\ ,\ 2\ ,\ 3\ ,\ 4$
RP^2	$m^2 + n^2 < 4.4^2$
T^2/Z_2	$m^2 + n^2 < 5.8^2$
T^2/Z_4 , $T^2/Z_2 \times Z_2'$	$m^2 + n^2 < 7.7^2$

Then we can construct our effective lagrangian

$$\mathcal{L}_{\mathrm{SM}} + \sum_{\mathrm{KK}}^{\mathrm{N}} \mathcal{L}_{\mathrm{KK}}$$

→ let's analyze !!

Bounds on 6D UED models from *current LHC data* and S,T parameters with *vacuum stability*

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In collaboration with..
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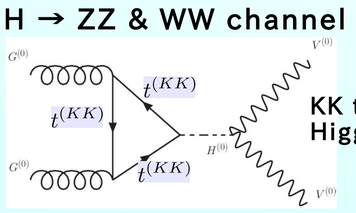
Higgs signals in LHC

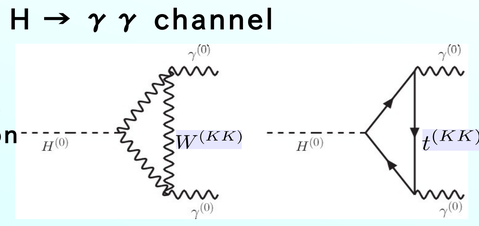
KK pools at LHC

H → ZZ & WW channel



KK top increase Higgs production

H → $\gamma\gamma$ channel



KK top and KK W suppress Higgs → $\gamma\gamma$ decay

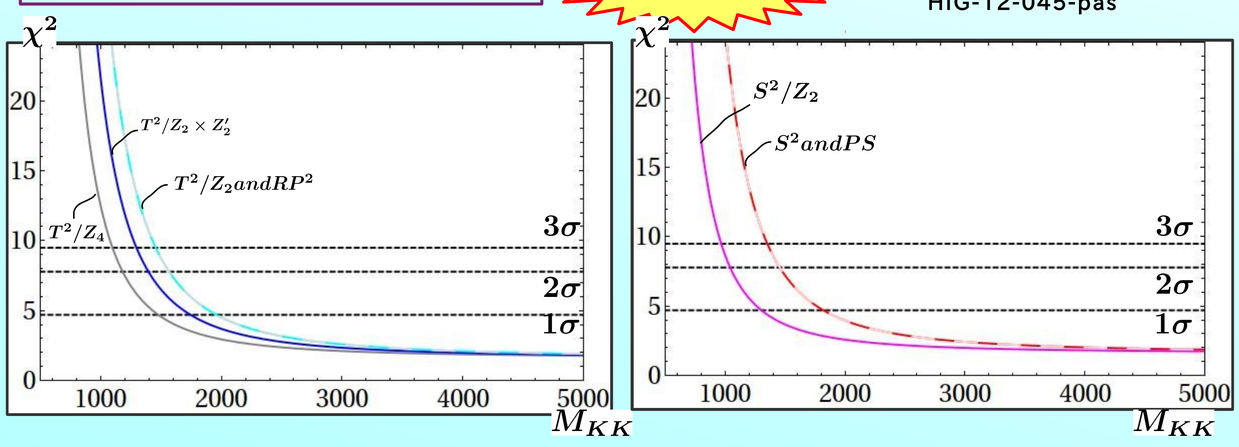
Signal strength $\frac{\sigma_{gg\to H\to ZZ,WW}}{\sigma^{SM}_{gg\to H\to ZZ,WW}} \sim 1.5$ @M_{KK}~1TeV case

Signal strength $\frac{\sigma_{gg\to H\to \gamma\gamma}}{\sigma^{SM}_{gg\to H\to \gamma\gamma}} \sim 1.35$ @M_{KK}~1TeV case

χ^2 fit for H → ZZ, WW combine

Preliminary

CMS, ATLAS combine
ATLAS-CONF-2012-170
HIG-12-045-pas



Comment for $\gamma\gamma$ and other channels

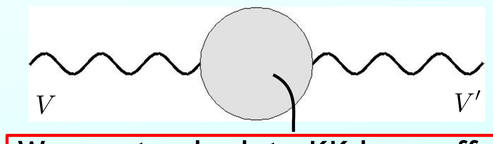
- Precision data for H → $\gamma\gamma$ signal in each event category and production channels, but error in each category is very large → we only can find the lower bound on KK scale ~ 100-200GeV ...
- H → $\tau\tau$, Vbb channel also have large error → no bound from these

S,T parameters

S,T parameters

S : combination of wave function renormarization for neutral current

T : combination of mass correction for gauge bosons

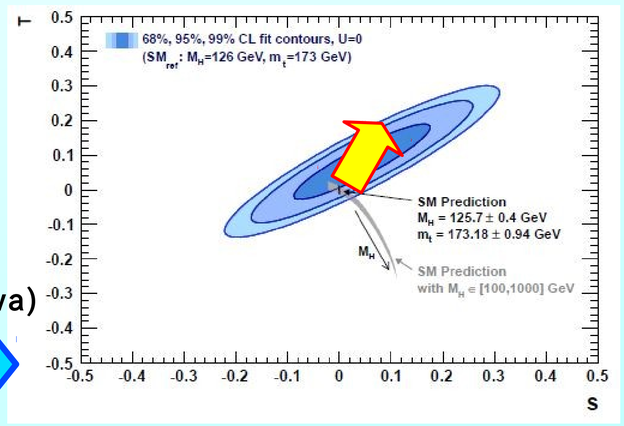


We must calculate KK loop effects for gauge two point function

S,T by KK loops

- Dominant contribution : KK top loops → *increase S,T*
- KK Higgs, Z, W and γ (bosons) : *small negative* contribution
- We neglect light fermion's contribution (because small yukawa)

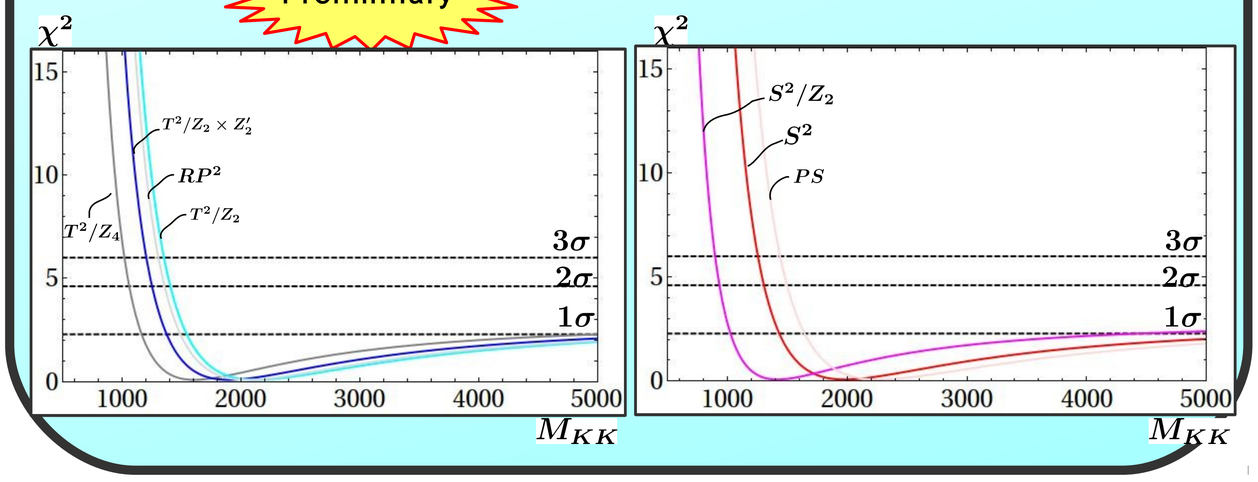
Totaly, KK loops increase S,T



(Latest S,T data : 2012,Sep. PDG)

χ^2 fit

Preliminary



Work in progress

- We will take higher dimensional operators into account our analysis
- We will regard UV cutoff Λ as parameter in the range : 1st KK< Λ < Λ_{max}

Now we are summarizing our result, please wait our paper...