Extra Dimensions at the LHC

Bogna Kubik
In collaboration with A.Deandrea and G.Cacciapaglia

Theory Division
Institut de Physique Nucléaire de Lyon

Cargèse, August 31, 2012

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
Extra Dimensions at the LHC

RPP model almost (already ... ?) ruled out by the LHC data.

$\Downarrow$

Some interesting (for me) facts about the extra dimensional models.

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
Extra Dimensions at the LHC

Extra Dimensional Models

SPACE-TIME GEOMETRY

- g_{MN} - metric
- n - nb of XDs
- Γ - compactification group
- fields

$\Rightarrow$

MATHEMATICS

- chirality definition
- calculability
- cut off scale Λ
- fixed points
  - localized operators
  - KK symmetry intrinsic

PHYSICS

- particle content
- mass spectrum (splittings)

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
Extra Dimensions at the LHC

Real Projective Plane
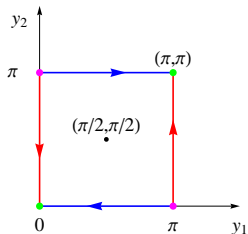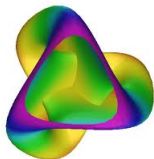
- $n = 2$ - two Universal Extra Dimensions
- $g = diag\{1, -1, -1, -1, -1\}$ - flat metric
- Defining symmetries

$$\mathbb{R}P^2 = \mathbb{R}^2/\Gamma \quad \Gamma = \langle\, r, g \mid r^2 = [g^2 r]^2 = \mathbb{I}\,\rangle$$

$$r : \begin{cases} y_1 \sim -y_1 \\ y_2 \sim -y_2 \end{cases} \quad y : \begin{cases} y_1 \sim y_1 + \pi \\ y_2 \sim -y_2 + \pi \end{cases}$$

- No fixed points
$$(0,0) \xrightarrow{r} (0,0) \xrightarrow{g} (\pi, \pi)$$
$$(0,\pi) \xrightarrow{[r,t_1]} (0,\pi) \xrightarrow{[g,-t_1]} (\pi, 0)$$

- KK symmetry is intrinsic
invariance under $r_\pi \left(\frac{2}{\pi}, \frac{2}{\pi}\right)$

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon

Mass spectrum 1

- at tree level determined by:
  1. parities of the fields (p_r, p_g)
  2. $\xi = \frac{R_4}{R_5}$ $m_{kl}^2 = \frac{k^2}{R_4^2} + \frac{l^2}{R_5^2}$

mass	(0,0) m_{SM}	(1,0) m_{KK}	(2,0) $2m_{KK}$
$A_\mu(y)$	LKP		★
$A_{4/5}(y)$		★	★
$\Phi(y)$	★		★
$\Psi(y)$	★	★ ★	★ ★

Bogna KUBIK In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
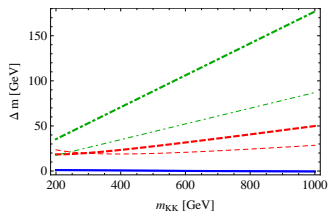EXTRA DIMENSIONS AT THE LHC

Mass spectrum 2

- at loop level determined by:
  1. parities of the fields (p_r, p_g)
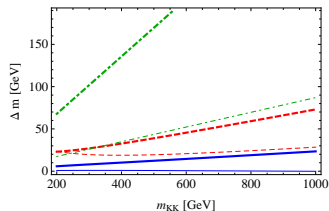
$$\Pi \quad = \quad \underbrace{\Pi_T}_{\sim \frac{1}{\pi} \sum_{(k,l)} \frac{1}{(k^2+l^2)^2} \approx 1.92} \quad + \quad \underbrace{p_g \Pi_G \; + \; p_g p_r \Pi_{G'}}_{\sim \zeta(3)} \quad + \quad \underbrace{p_r \Pi_R}_{\sim \ln \frac{\Lambda^2 R^2 + n^2}{n^2}}$$

  2. $\xi = \frac{R_4}{R_5}$ - mixings and log livergent contributions to the masses coming from rotation projection
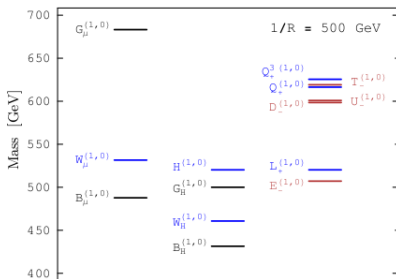 3. Λ - cut-off scale (here $\Lambda R = 10$)

$\xi \to 0$ $\qquad\qquad\qquad\qquad\qquad\qquad$ $\xi \to 1$

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
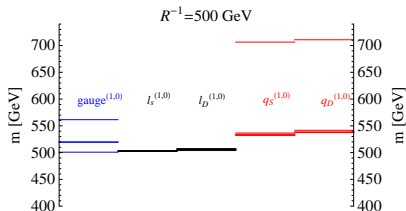Extra Dimensions at the LHC

- Extremenely small mass splittings in our model
- will determine
  1. LHC signatures
  2. DM phenomenology (coannihilatiobans)

Chiral Square,
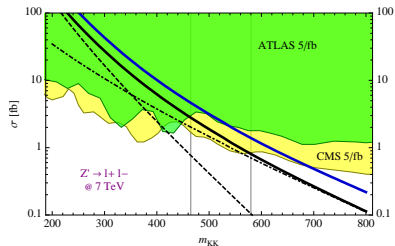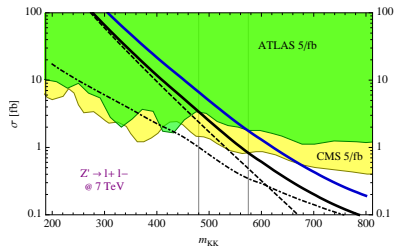*G.Burdman, B.A.Dobrescu, E.Pontón*
[hep-ph/0601186]
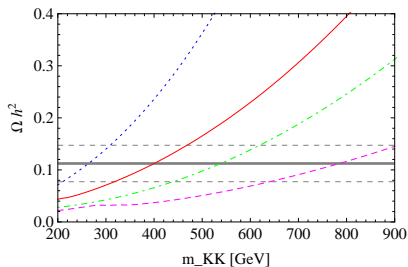

Real Projective Plane
G.Cacciapaglia, A.Deandrea, J.Llodra-Perez
arXiv:0907.4993v1 [hep-ph]

Bogna KUBIK In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
EXTRA DIMENSIONS AT THE LHC

Bounds

- $200\,\mathrm{GeV} \leq m_{KK} \lesssim 900$ GeV (WMAP)
- $m_{KK} \gtrsim 600$ GeV (LHC)

Bogna Kubik In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
EXTRA DIMENSIONS AT THE LHC

My interests

- mathematical structure of the orbifolds and the extra space

- influences of geometry of the space on the physical observables

<p align="center" style="color:red">Thank you for your attention!</p>

Bogna KUBIK In collaboration with A.Deandrea and G.Cacciapaglia
Theory Division Institut de Physique Nucléaire de Lyon
EXTRA DIMENSIONS AT THE LHC