

New types of Universal Extra Dimensional Models at Tevatron and LHC

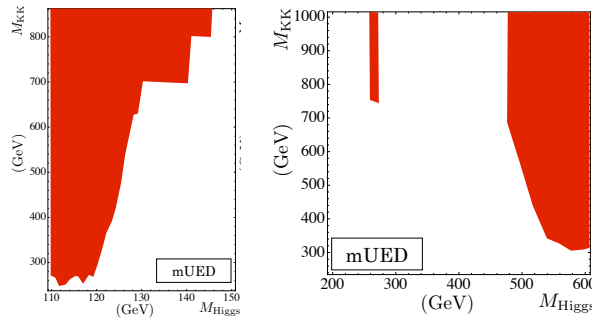
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The ATLAS and CMS experiments at the CERN Large Hadron Collider (LHC) have presented their latest results for the $\simeq 1 \text{ fb}^{-1}$ of data at the center of mass energy 7 TeV at the International Europhysics Conference on High Energy Physics, Grenoble, France, 21–27 July 2011. One of the most remarkable among them is the bound on the Higgs mass in the Standard Model (SM). A combined analysis of the ATLAS experiment excludes the existence of the SM Higgs in mass ranges $155 \text{ GeV} < M_H < 190 \text{ GeV}$ and $295 \text{ GeV} < M_H < 450 \text{ GeV}$ within the 95% Confidence Level (CL) based on $1.0\text{--}1.2 \text{ fb}^{-1}$ data [1] and that of the CMS experiment excludes $149 \text{ GeV} < M_H < 206 \text{ GeV}$ and $300 \text{ GeV} < M_H < 440 \text{ GeV}$ within the 95% CL based on 1.1 fb^{-1} data [2]. Further the total production cross section of a Higgs-like particle, a particle that decays the same way as the SM Higgs, is severely constrained by these data in the still-allowed regions: $115 \text{ GeV} < M_H < 149 \text{ GeV}$, $206 \text{ GeV} < M_H < 295 \text{ GeV}$, and $M_H > 440 \text{ GeV}$. We translate the above constraint on the production cross section into that on the Kaluza-Klein (KK) scale of various 5-Dimensional (5D) and 6D Universal Extra Dimension (UED) models. Due to limitations of space, we only show the allowed region of the Higgs mass and the Kaluza-Klein mass in minimal UED model on S^1/Z_2 , which is indicated by the red area, and it is noteworthy that both the ATLAS and CMS groups have observed 2σ excess of events in the combined analyses in the region $130 \text{ GeV} \lesssim M_H \lesssim 140 \text{ GeV}$ [1, 2]. For this region, we get a constraint on the 5D mUED model on S^1/Z_2 :

$$M_{\text{KK}} > 700 \text{ GeV} \quad (\text{at } 95\% \text{ CL for } 130 \text{ GeV} < M_H < 140 \text{ GeV}),$$

which is by far the severest collider bound ever obtained.



We also obtain our numerical results showing that the UED models may account for the 2σ excess of the $ZZ \rightarrow 4\ell$ events around 250 GeV observed at ATLAS [1], which is consistent to the CMS data [2]. For larger Higgs mass $M_H = 500 \text{ GeV}$, we can see a few (virtually background free) $H \rightarrow ZZ \rightarrow 4\ell$ events in 5D UED models with 10 fb^{-1} of integrated luminosity. The 6D UED models can further exhibit the shape of the resonance if the KK scale is relatively low. When Higgs mass is as large as $M_H = 700 \text{ GeV}$, we found no parameter region that can be seen within the integrated luminosity of $\mathcal{O}(10) \text{ fb}^{-1}$ at $\sqrt{s} = 7 \text{ TeV}$.

References

- [1] K. Cranmer, *Combined ATLAS Standard Model Higgs Search with 1 fb^{-1} of Data at 7 TeV*, talk given at the 2011 Europhysics Conference on High-Energy Physics, Grenoble, France, see also <http://eps-hep2011.eu/>.
- [2] A. Korytov, *Combined results on SM Higgs Search with the CMS Detector*, talk given at the 2011 Europhysics Conference on High-Energy Physics, Grenoble, France, see also <http://eps-hep2011.eu/>.
- [3] K. Nishiwaki, K.-y. Oda, N. Okuda, and R. Watanabe, *A bound on Universal Extra Dimension Models from the 1 fb^{-1} of LHC Data at 7 TeV*, (2011), 1108.1764.
- [4] K. Nishiwaki, K.-y. Oda, N. Okuda, and R. Watanabe, *Heavy Higgs at Tevatron and LHC in Universal Extra Dimension Models*, (2011), 1108.1765.