

LEPTON AND HEAVY QUARK ASYMMETRIES

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Implications at the LHC of BSM interpretations of CDF's $t\bar{t}$ forward-backward asymmetry and W_{jj} anomaly

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Edge Charge Asymmetry (arXiv:1101.2507)

- 1. Proposes a new definition of charge asymmetry in top pair production at the LHC--edge charge asymmetry (ECA)
- 2. ECA utilized information of the drifting direction for only a single hadronically decaying top (anti-top) and can be free from the uncertainty arising from the missing neutrino in top pair reconstruction.
- 3. Y of the top (anti-top) is required to be greater than a critical value Y_c in order to suppress symmetric top pair events (mainly due to gluon-gluon fusion)
- 4. ECA is calculated up to NLO in the SM

Edge Charge Asymmetry

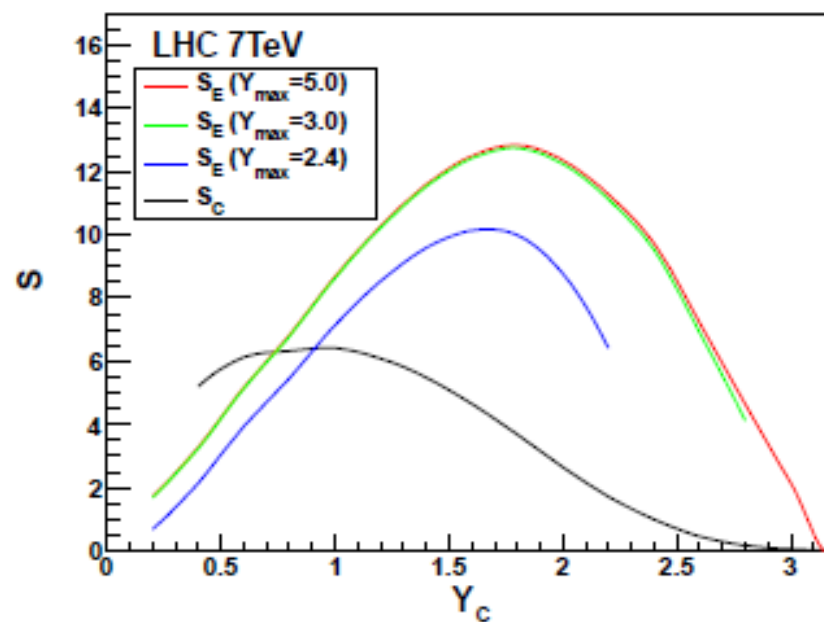
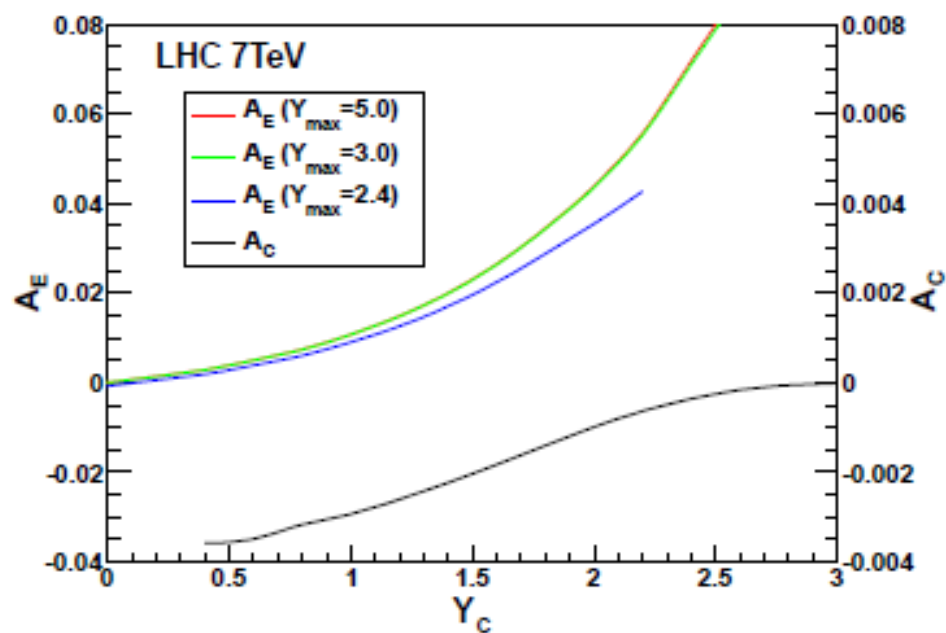
$$A_E(Y_C, Y_{\max}) \equiv \frac{\sigma_t(Y_C < |Y_t| < Y_{\max}) - \sigma_{\bar{t}}(Y_C < |Y_{\bar{t}}| < Y_{\max})}{\sigma_t(Y_C < |Y_t| < Y_{\max}) + \sigma_{\bar{t}}(Y_C < |Y_{\bar{t}}| < Y_{\max})} \equiv \frac{\sigma_E^A(Y_C, Y_{\max})}{\sigma_E(Y_C, Y_{\max})}$$

Y_C is the border between the edge and central regions. Y_{\max} is the max value

Central
charge
asymmetry

$$A_C(Y_C) \equiv \frac{\sigma_t(|Y_t| < Y_C) - \sigma_{\bar{t}}(|Y_{\bar{t}}| < Y_C)}{\sigma_t(|Y_t| < Y_C) + \sigma_{\bar{t}}(|Y_{\bar{t}}| < Y_C)} \equiv \frac{\sigma_C^A(Y_C)}{\sigma_C(Y_C)}$$

Edge Charge Asymmetry



Tau Lepton Asymmetry (arXiv:1102.0741)

- 1. Tau-lepton charge asymmetry as a tool to probe NP.
- 2. Resonant: Non-universal Z' boson
- 3. Non-resonant: vector lepto-quarks coupling the first generation quark with the third generation leptons.

$$\mathcal{A}(y) = \frac{N_{\ell^+}(y) - N_{\ell^-}(y)}{N_{\ell^+}(y) + N_{\ell^-}(y)}$$

$$\mathcal{A}_c(y_c) = \frac{N_{\ell^+}(-y_c \leq y \leq y_c) - N_{\ell^-}(-y_c \leq y \leq y_c)}{N_{\ell^+}(-y_c \leq y \leq y_c) + N_{\ell^-}(-y_c \leq y \leq y_c)}$$

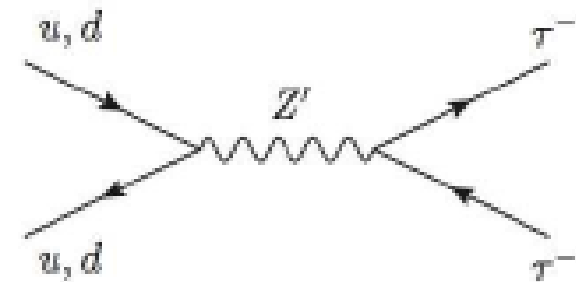
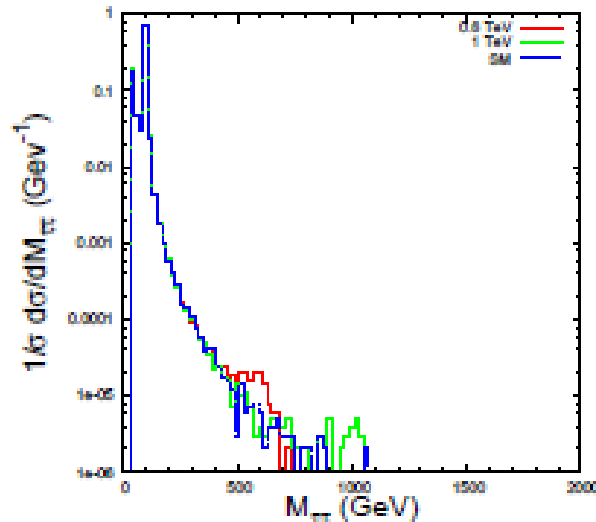
Tau Lepton Asymmetry

Non-universal Z'

$$\mathcal{L}_{Z'} = \frac{g}{2 \cos \theta_W} \left(\bar{f} \gamma^\mu \left(c_L^f P_L + c_R^f P_R \right) f \right) Z'^\mu$$

$$c_L^u = c_L^d = \frac{1}{3} \sin \theta_W \tan \theta_R, \quad c_R^u = 4c_L^u, \quad c_R^d = -2c_L^d,$$

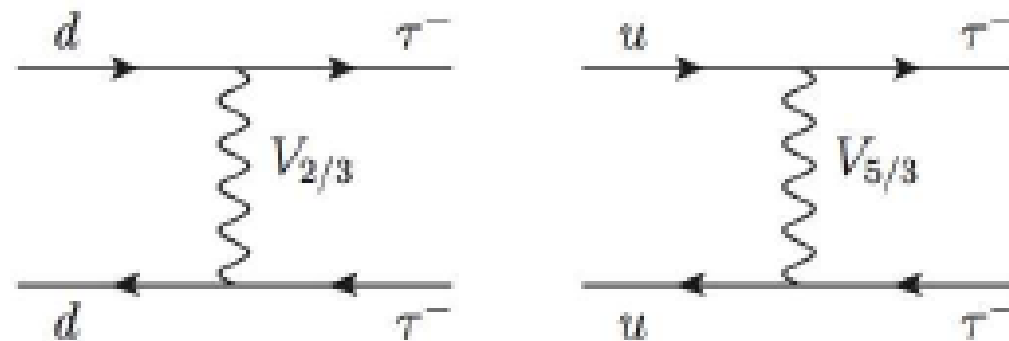
$$c_R^\tau = \sin \theta_W \cot \theta_R.$$



Tau Lepton Asymmetry

Lepto-quarks

$$\begin{aligned}
 \mathcal{L}_{LQ} = & \mathcal{L}_{SM} \\
 & + \lambda_{V_0}^{(R)} \cdot \bar{d} \gamma^\mu P_R e \cdot V_{0\mu}^{R\dagger} + \lambda_{\tilde{V}_0}^{(R)} \cdot \bar{u} \gamma^\mu P_R e \cdot \tilde{V}_{0\mu}^\dagger \\
 & + \lambda_{V_{1/2}}^{(R)} \cdot \bar{d}^c \gamma^\mu P_L l \cdot V_{1/2\mu}^{R\dagger} + \lambda_{\tilde{V}_{1/2}}^{(R)} \cdot \bar{u}^c \gamma^\mu P_L l \cdot \tilde{V}_{1/2\mu}^\dagger \\
 & + \lambda_{V_0}^{(L)} \cdot \bar{q} \gamma^\mu P_L l \cdot V_{0\mu}^{L\dagger} + \lambda_{V_{1/2}}^{(L)} \cdot \bar{q}^c \gamma^\mu P_R e \cdot V_{1/2\mu}^{L\dagger} \\
 & + \lambda_{V_1}^{(L)} \cdot \bar{q} \gamma^\mu P_L V_{1\mu}^\dagger l + h.c..
 \end{aligned}$$



Tau Lepton Asymmetry (Z' model)

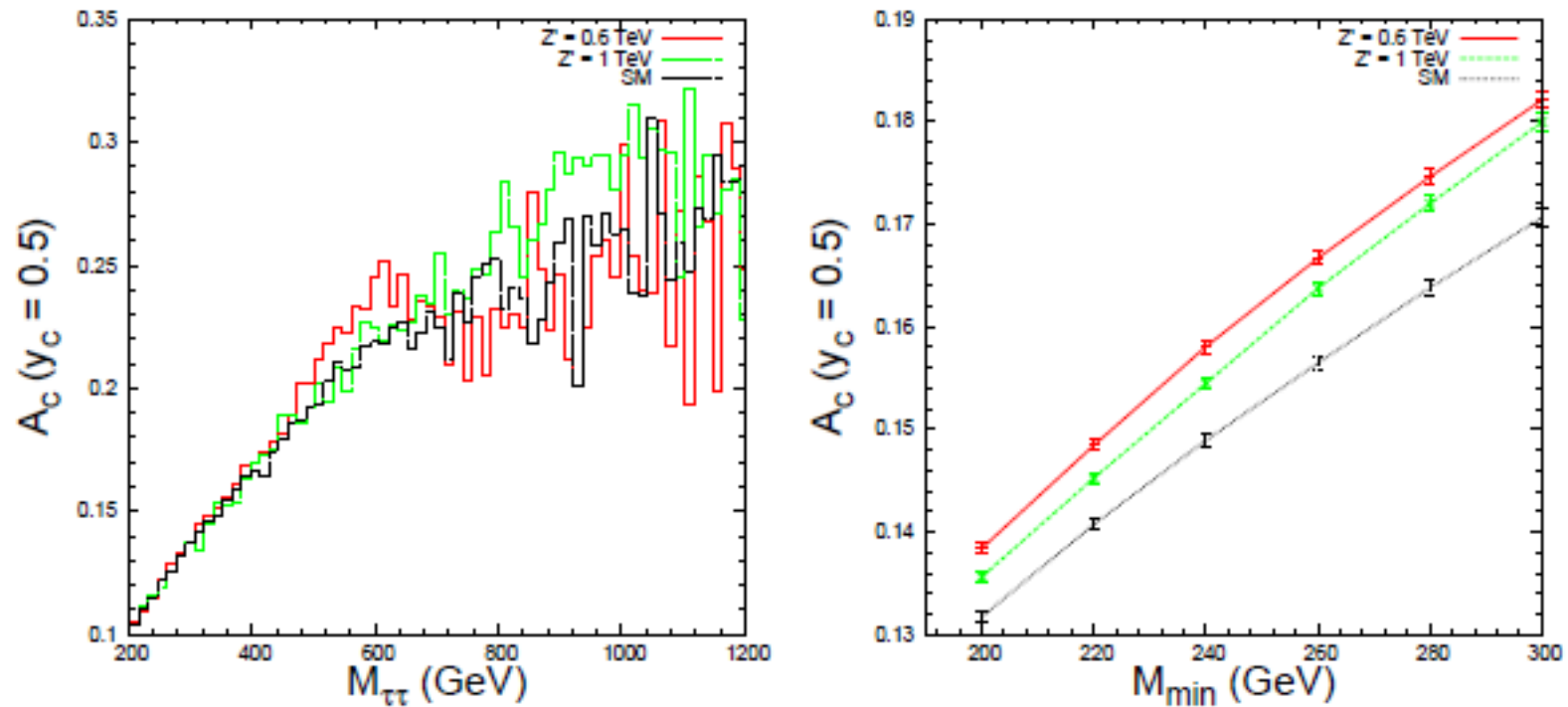


FIG. 5: Lepton charge asymmetry in the Z' model for $M_{\tau\tau} > 200$ GeV, $y_c = 0.5$ and $M_{Z'} = 0.6$ and 1 TeV vs (a) $M_{\tau\tau}$ and (b) integrated over $M_{\tau\tau} \geq M_{\min}$.

Tau Lepton Asymmetry (Lepto-quarks)

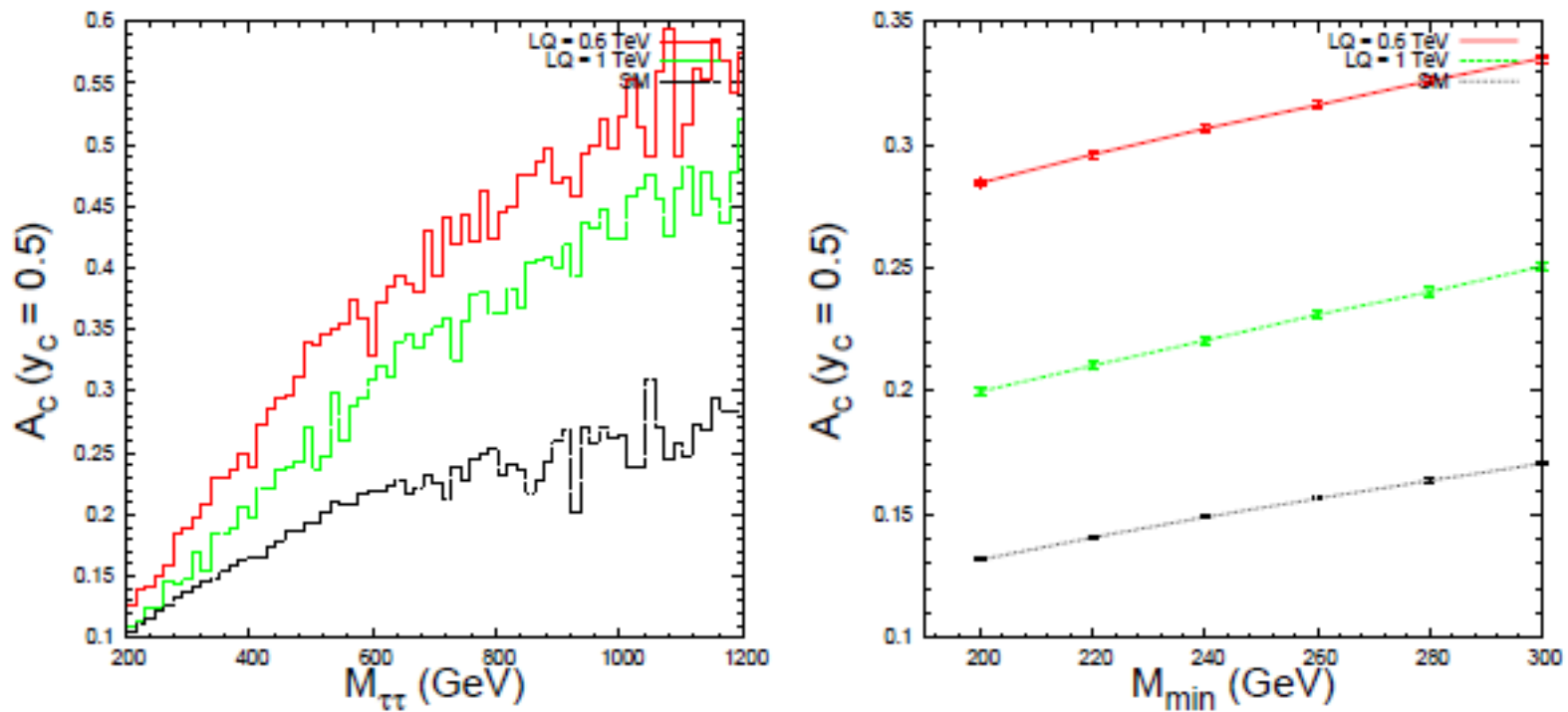


FIG. 9: Integrated charge asymmetry for the lepto-quark model 2 (LQ-2) for $M_{LQ} = 0.6, 1$ TeV vs (a) $M_{\tau\tau}$ and (b) integrated over $M_{\tau\tau} \geq M_{\min}$.