

tmini Weizmann Workshop

Top LHCb Physics

based on Kagan, J.F.K., Perez & Stone, 1103.3747

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Forward-backward asymmetry in tt production

• Charge (a)symmetric cross-section at the Tevatron



• In bins of Δy :

$$A^{t\bar{t}}(\Delta y_i) = \frac{N(\Delta y_i) - N(-\Delta y_i)}{N(\Delta y_i) + N(-\Delta y_i)} \qquad \Delta y = y_t - y_{\bar{t}}$$



6(stat.) (Pred. : -0.040 ± 0.055).

New Physics Interpretation(s)

- Light to moderate mass t(u)-channel resonances
 - Z', W', scalar color triplets, sextets • Exhibit Rutherford scattering peak $\mathcal{M} \propto \frac{1}{\hat{t}} \propto \frac{1}{1 - \cos\theta} \quad \bar{t}$ See Jures talk \bar{t} \bar{t}
 - enhanced forward x-section $(\cos \theta = \tanh \Delta y)$

 $\beta_t = \sqrt{1 - \frac{4m_t^2}{\hat{s}}}$ $\hat{t} = (p_q - p_t)^2$

 $\hat{t} = m_t^2 - \frac{\hat{s}}{2} [1 - \beta_t \cos \theta]$

New Physics Interpretation(s)

• Light to moderate mass t(u)-channel resonances





Cross-check of Tevatron AFB measurements at LHC?

• initial state valence quarks dominate large x



Cross-check of Tevatron AFB measurements at LHC?

- \bullet t-channel contributions exhibit a forward scattering peak in σ
 - Effects at Tevatron and LHC correlated

expect sizable σ_t excess in the forward region: top quarks at LHCb?

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• Virtues/caveats of LHCb for top physics

- High pseudorapidity coverage η<5 (4.5) for jets (muons)
- Excellent vertexing, b-tagging capabilities
- Low calorimeter saturation energy, high punch-through rate
- Small phase-angle coverage (no E_{miss} constraints)

Somewhat higher than APPENDIX: THE COLOR-OCTET MODELS in the Science and Technology Facilities APPENDIX: THE COLOR-OCTET MODELS the Royal Society, UK; the Institut National with the Royal Society, UK; the Institut National (NLO 1000) is the Royal Society. $i h h g f Q G Q f Q G h m pectation of <math>0.058 \pm 0.009$. even asymptmeest frame we measure fully corrected asym-metries at small and large Δy for energy color-octet model of Ref. [Foundation for Basic Research; the Minister $\mu = \mu c M$ for the formation of the formation of the matrix $cos(4^*)$ term for basic Research; the Minister $A^{tt}(\Delta_{u})$ the production ± 0.518 eross section. The couplings of the Slovak R&D Agency; and the Acad $= 0.15\overline{3}$ $A^{t\bar{t}}$ Δp and the light quarks to the massive gluon have op-).114 posite sign, giving a positive asymmetry as seen in the Eftively 31 0.008 work hand the regualings and Mry. were tuned to reason APPENDIX: THE COLOR-OCTET viations $The vertex of the asymmetry is a fishing function <math>M_{t\bar{t}}$ distribution of etry hef the contrast $M_{tt}^{[26]}$ with parton level as $M_{tt}^{[26]}$, with parton level as $M_{tt}^{[26]}$. of these theo-parate results $g_V = 0, g_A(q) = 3/2, g_A(t) = -3/2$, and mass M_{the} generic color-octet model of Ref. [8] parate results TeV/c^2 , has parton level asymmetries of A^{pocted} investigance produces an asymmetric c in the production cross section. The coup $A^{t\bar{t}} M = (1.153)$ top and the light quarks to the massive glue $A^{t\bar{t}}(M_{t\bar{t}} \ge 450 \text{ GeV}/c^2) = 0.475 \pm 0.114$ posite sign, giving a positive asymmetry as

to be compared with MGFM predictions of 0.000 in the MADGR and 0.088 ± 0.013 for these $M_{t^{\bar{\tau}}}$ regions respectively. The work, and the couplings and M_G were tuned

asymmetry at high mass is 3.4 the NLO prediction for the cl however we are aware that th retical predictions are under s¹

e the asymmetries and $M_{t\bar{t}}$ dis MadGraph/MadEvent ${}^{4}A{}^{57}$ The sample, called OctetA, with $= 3/2_{tt, t}g_{VA}(t) = -3/2$, and mass arton level asymmetries of $A^{p\bar{p}}$ somewhat higher than APPENDIX: THE COLOR-OCTET MODELS $i h h g f Q G Q f Q G h m pectation of <math>0.058 \pm 0.009$. the Royal Society, UK; the Institut National even at small and large Δy octet interference produces an asymmetric $\cos(\theta^*)$ term on, and Programa Consolider-Ir $A^{tt}(\Delta_{u})$ the production ± 0.518 eross section. The couplings of the Slovak R&D Agency; and the Acad $= 0.15\overline{3}$ $A^{t\bar{t}}$ Δp and the light quarks to the massive gluon have op-).114 posite sign, giving a positive asymmetry as seen in the Eftively 3 the constant the regions feespect Mery. were tuned to reason APPENDIX: THE COLOR-OCTET Viations $M_{t\bar{t}}$ $M_{t\bar$ etry heft QCD ariant mass $M_{tt}^{[26]}$, with parton level asymmetric of these theo- $g_V = 0, \ g_A(q) = 3/2, \ g_A(t) = -3/2, \ a$ $\sqrt{s} = 7 \text{ TeV}$ 100.0 ef. [8] $x 10^{-8}$ 50.0 $b x 10^{-5}$ tric c parate **readtsgroTeV/s²f bas p**arton level asymmetries (Wj x 0.01 coup $A_{-}^{\rm tt}(M_{t\bar{t}} < 450 \ {\rm GeV}/c^2) = -0.116 \pm 0.153$ Wb 10.0 e glu $A^{t\bar{t}}(M_{t\bar{t}} \ge 450 \text{ GeV}/c^2) = 0.475 \pm 0.114$ • Real muons, jets: W+bb, W+jets 5.0 cy as to be compared with MCFM predictions of 0.040 ± 0.000 and 0.088 ± 0.013 for steep $M_{t\bar{t}}$ regions respectively. The ADGR tune 1.0 asymmetry at high mass is 3.4 standard deviations above the NLO prediction for the charge asymmetry of QCD CMS-PAS-BPH-08-004 $f_{t\bar{t}}$ dis 0.5 A, wit50 100 150 200 however we are aware that the accuracy TOTS to see the op d mas $m_{b\mu}[GeV]$ $A^{\mathrm{p}\bar{\mathrm{p}}}$ retical predictions are under study. The separate result: Fake muons, jets: bb, jj Estimate O(100) reconstructed events with 1 fb⁻¹ (in SM) • Cal. punch-through & decay in flight

• $i(b) \rightarrow$ isolated μ probability at 10⁻⁶⁽⁵⁾

J.S. Anderson, CERN-THESIS-2009-020.

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- Prospects for top charge asymmetry measurement
 - Study charged conjugated rate differences
 - Main background from Wj
 - could be measured directly (knowing mistag rate)
 - use central region data for MC calibrations

CMS-PAS-EWK-10-005 ATLAS, 1012.5382 CMS, 1103.3470 ATLAS, 1103.2929

Conclusions

- At LHC, A_{FB} manifestation as rapidity dependent charge asymmetry
 - In light t-channel models, forward region particularly enhanced
 - Opportunities for top physics program at LHCb
- High-pt muon reconstruction demonstrated, b-tagging feasible
 - use additional information (jets, etc.) in the detector to suppress backgrounds?
- Possibilities to measure charge asymmetry in t and \overline{t} rates
 - even access to top polarization observables?

Jung et al., 1011.5976 Cao et al. 1011.5564 Choudhury et al., 1012.4750