Excited chiral spin-1 bosons

keywords: Z-prime, Z-star
W-prime, W-star

Mihail V. Chizhov

Sofia University and JINR

Motivation for SM extension

The main theoretical motivation for beyond the Standard Model physics around TeV energies (LHC) is provided by the Hierarchy Problem, an inexplicable the UltraViolet stability of the weak interaction scale ($M_{W,Z}$ = 10^2 GeV) versus the Planck mass (M_P = 10^{19} GeV),

WHY IS $M^2_{W,Z}/M^2_P$ = 10^{-34} ?

Introduction of new spin-1 bosons with the internal quantum numbers identical to the Standard Model Higgs doublet can help to solve by the Hierarchy Problem.

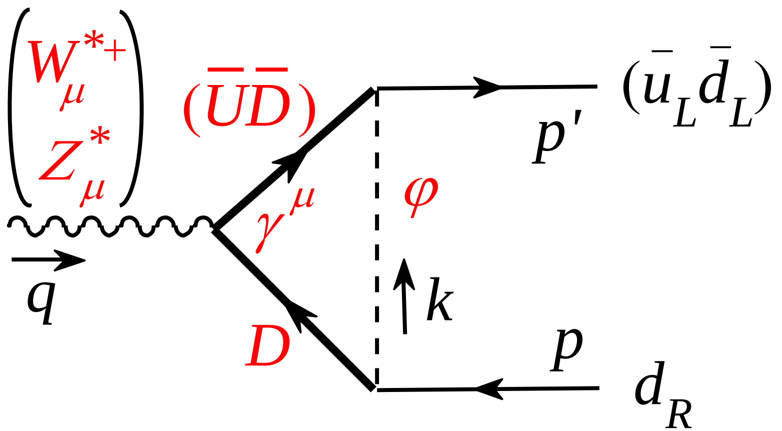
M. Chizhov and G. Dvali "Origin and Phenomenology of Weak-Doublet Spin-1 Bosons", Phys. Lett. B 703 (2011) 593, arXiv:0908.0924

$$\begin{pmatrix} H^+ \\ H^0 \end{pmatrix} \leftrightarrow \begin{pmatrix} W^{*+}_\mu \\ Z^*_\mu \end{pmatrix}$$

Standard Model $SU(2)_L \times U(1)_Y$

$$\frac{g}{\Lambda}\left(\bar{u}_L\,\bar{d}_L\right)\sigma^{\mu\nu}d_R\left[\partial_\mu\begin{pmatrix}W_\nu^{*+}\\ Z_\nu^{*}\end{pmatrix}-\partial_\nu\begin{pmatrix}W_\mu^{*+}\\ Z_\mu^{*}\end{pmatrix}\right]$$

M.V. Chizhov, Mod. Phys. Lett. A**8** (1993) 2753



M.V. Chizhov, G. Dvali, Origin and Phenomenology of Weak-Doublet Spin-1 Bosons, Phys. Lett. B**703** (2011) 593

Excited particles (compositeness)

$$\mathcal{L}_{\psi^*} = \frac{g}{\Lambda}\, \bar{\psi}^* \sigma^{\mu\nu} \psi \cdot \left(\partial_\mu Z_\nu - \partial_\nu Z_\mu \right)$$

Searches for excited fermions ψ^* have been performed at LEP, HERA and the Tevatron, and are also planned for the CMS and ATLAS experiments at the LHC.

ψ^* why not Z^* **?**

$$\mathcal{L}_{Z^*} = \frac{g}{\Lambda}\, \bar{\psi} \sigma^{\mu\nu} \psi \cdot \left(\partial_\mu Z^*_\nu - \partial_\nu Z^*_\mu \right)$$

M. C., V. A. Bednyakov, and J. A. Budagov, Proposal for chiral bosons search at LHC via their unique new signature, Phys. Atom. Nucl. **71** (2008) 2096; arXiv:0801.4235

Z* has **different** interactions than **Z′** **!**

$$\mathcal{L}_{Z'} = \bar{\psi} \gamma^\mu \left(g_V + g_A \gamma^5 \right) \psi \cdot Z'_\mu$$

WG3 Summary

Pierre Savard
University of Toronto and TRIUMF
(on behalf of WG3 Group)

Workshop on Implications of LHC Results on TeV-scale Physics

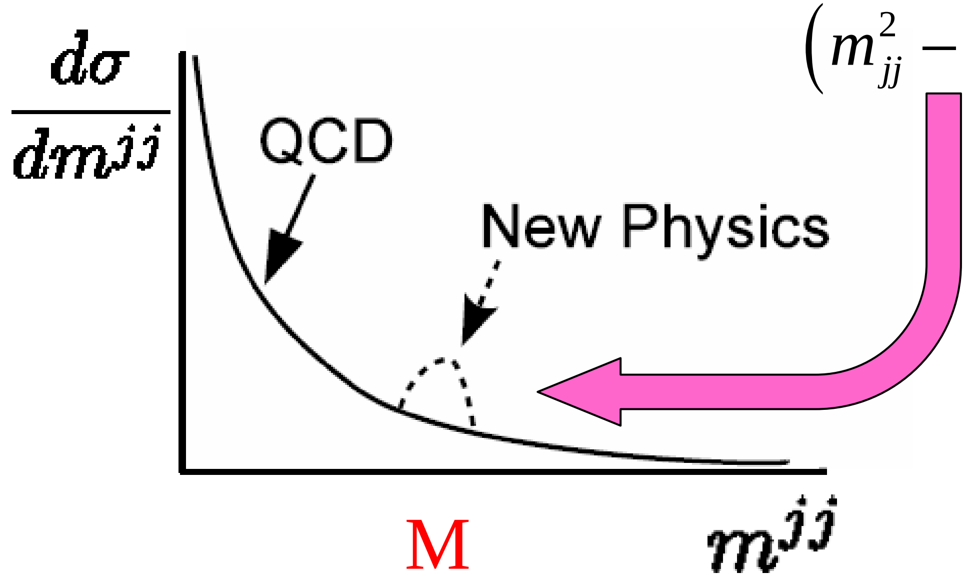
August-September 2011

Questions on New Gauge Interactions:

- New vectors: experiments have made efforts to provide generic limits (what is missing?)
  - Parameterizations: balance between number of independent parameters used/constrained vs generality
- Z', W': mature analyses. Have already doubled Tevatron limits (SSM W'). Limits will improve but no large increase in mass limits at 7 TeV
  - We must not focus only on high mass end. Look for weaker couplings/BR everywhere in the mass spectrum
  - Add decays to more channels (b-bbar, tau-tau, bosons, etc.)
  - Make sure that we look at wide resonances
  - Some models (e.g. W*) have different kinematics: default selections can affect acceptance substantially

Dijet mass resonance search

$$\frac{1}{\left(m_{jj}^2 - M^2\right)^2 + \Gamma^2 M^2}$$



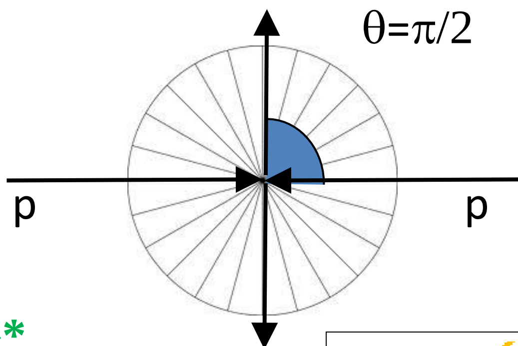
$$|\eta_1 - \eta_1| < 1.3 \quad ?$$

- Is there a bump in m^{jj}?
- If not, set limits on excited quark production.

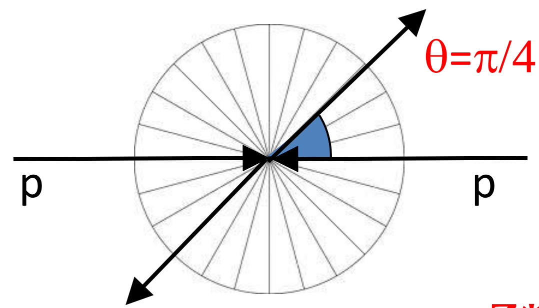
[Representative example of a narrow resonance.]

$\Delta\eta \equiv |\eta_1 - \eta_2|$ distribution

M.Chizhov, V. Bednyakov, J.Budagov, Phys. Atom. Nuclei **75** (2012) 90;
arXiv: 1106.4161 [hep-ph]



The excited bosons have a unique model independent $\Delta\eta$ distribution.



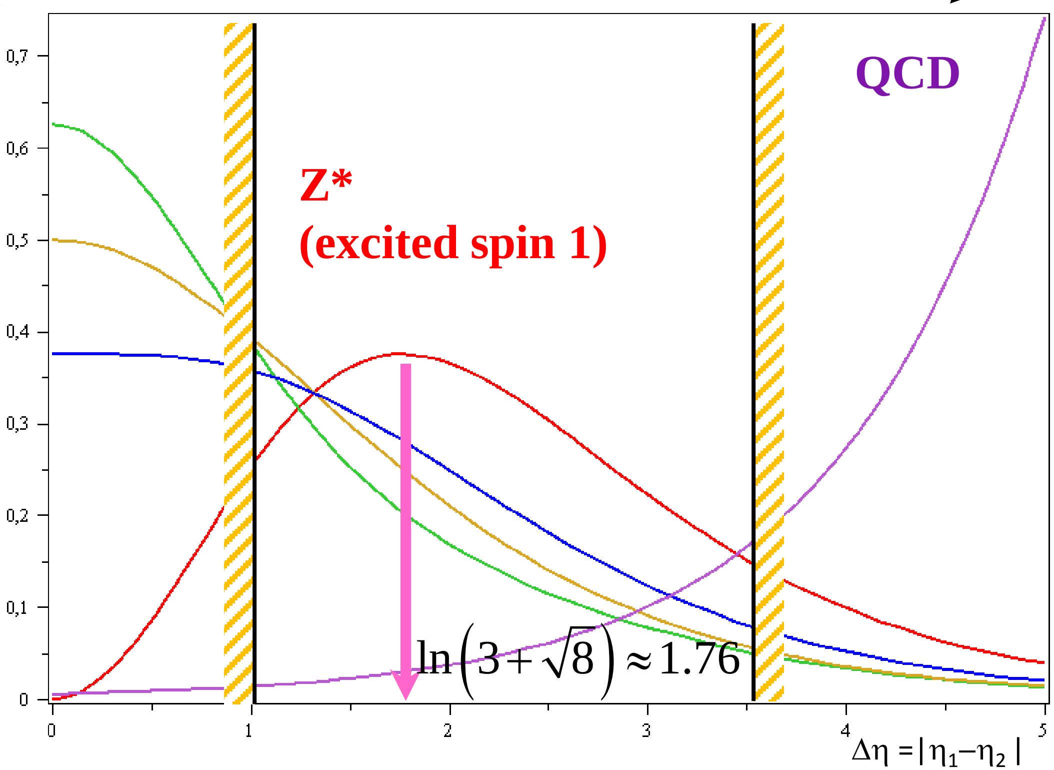
h , **Z’** , **G*** , …

Z*

Spin 2

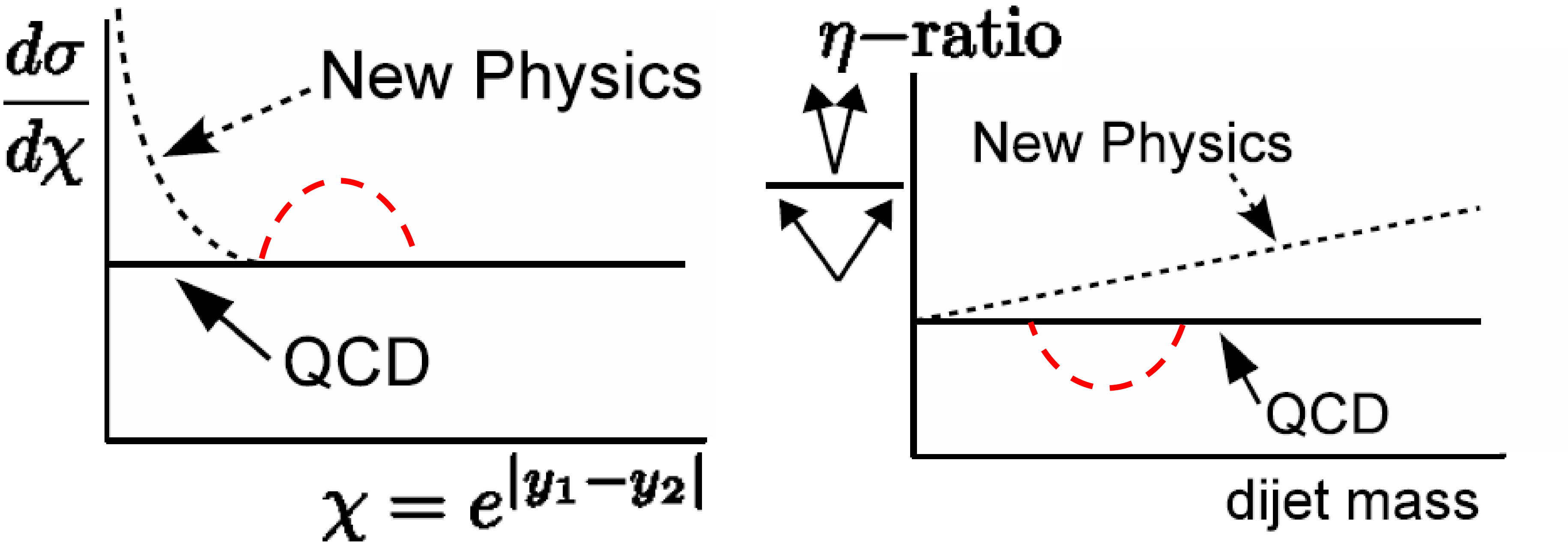
Spin 0

Spin 1



Dijet angular distribution

Observables:

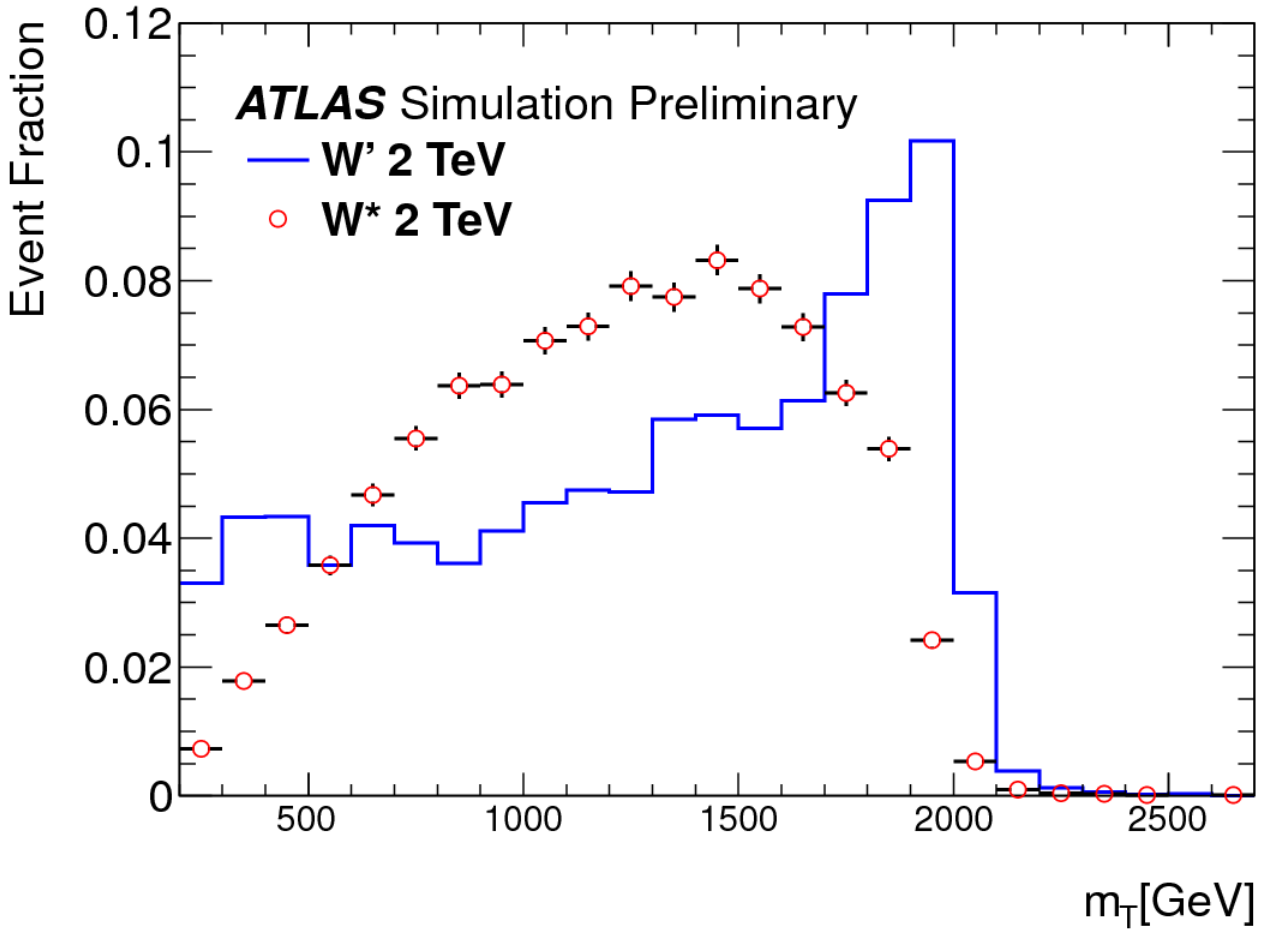


Target:

- Non-resonant production of new physics at high m^{jj}:
  - Quark compositeness at high scale Λ

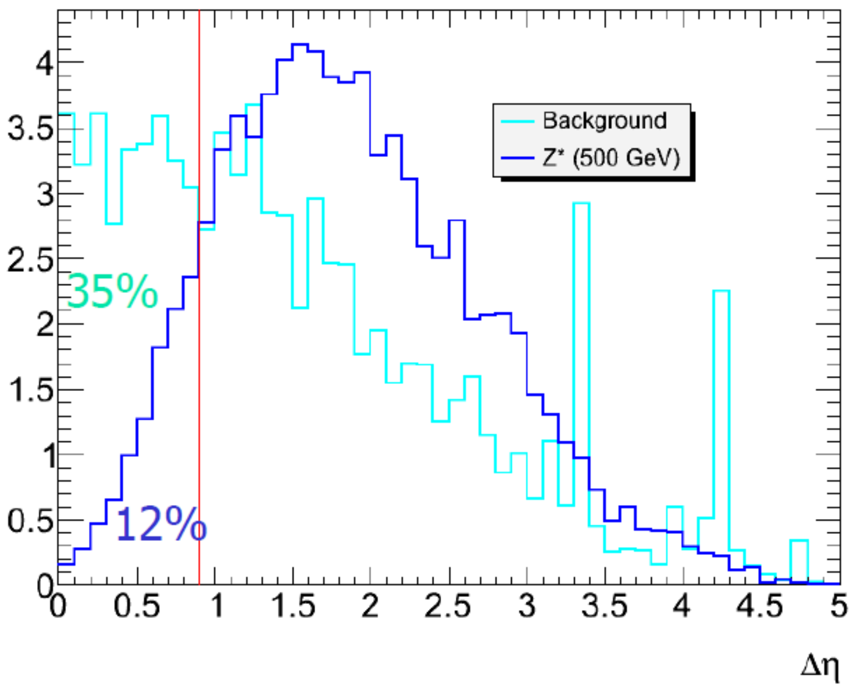
$$\mathcal{L}_{qqqq}(\Lambda) = \frac{\eta g^2}{2\Lambda^2}\bar{\Psi}^L_q\gamma^\mu\Psi^L_q\bar{\Psi}^L_q\gamma^\mu\Psi^L_q, \text{ where } g/4\pi = 1 \text{ and } \eta = +1.$$

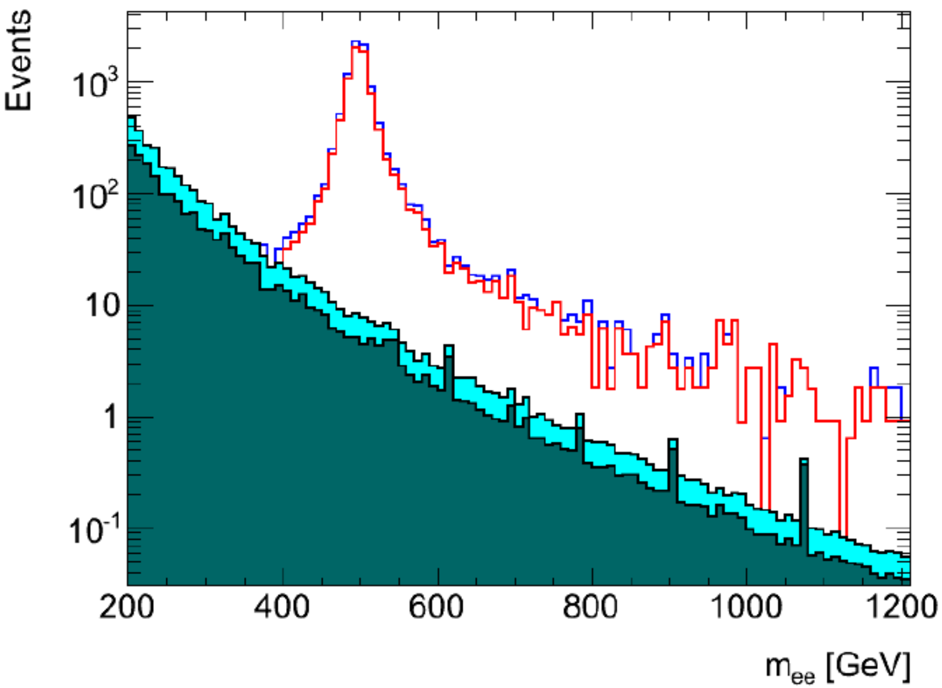
ATLAS search for a heavy gauge boson decaying to a charged lepton and a neutrino in 4.7 fb-1 of pp collisions at sqrt(s)= 7 TeV ATLAS-CONF-2012-086



Δη < 1 cut for DY

M.Chizhov, V. Bednyakov, J.Budagov, arXiv:1109.6876v1 [hep-ph]





Effectively leads to 20 – 30% of increase of statistics