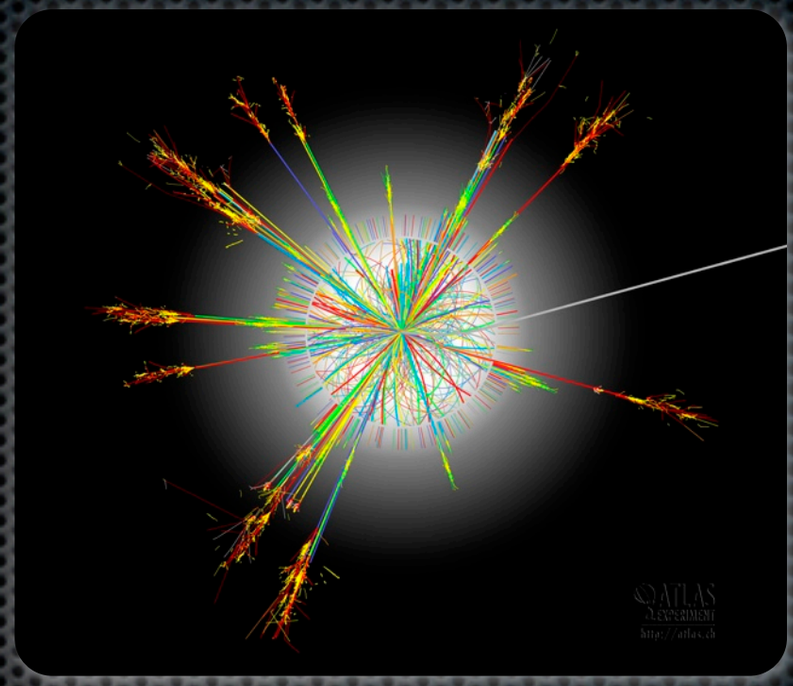
Search for New Physics in Dijet Mass and Angular Distribution in pp Collisions at $\sqrt{s} = 7$ TeV Measured with the ATLAS Detector

read, cursed but approved by Group C

The Idea



- QCD dijet production well understood, expect:
  - rapidly falling dijet invariant mass
  - angular distribution peaks at $|\cos \vartheta| \sim 1$

    (ϑ being the polar angle in the two-parton CM frame)

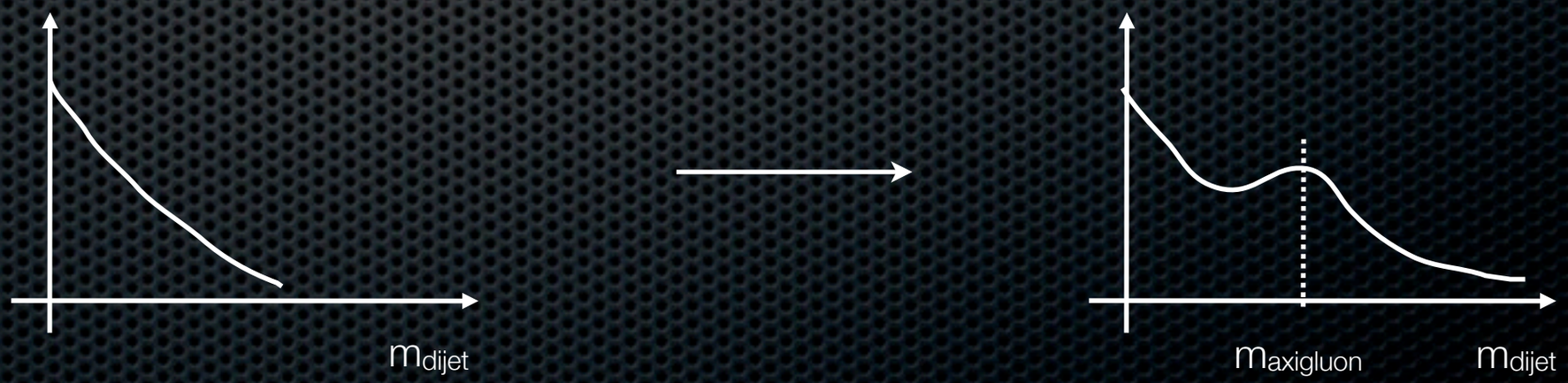
➡ Dijets excellent search field for new physics

1.

Axigluons

- QCD is a SU(3) gauge theory
- Idea: QCD could originate from a spontaneous symmetry breaking of a theory comprised of $SU(3)_L$ x $SU(3)_R$

➡ Existence of an octet of massive spin-1 colored axigluons that couple to quarks and decay into 2 jets



2.

Micro Black Holes

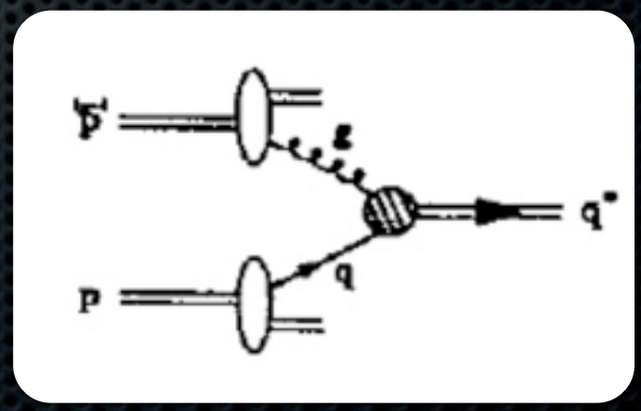
- Introduction of spatial extra-dimension leads to production of MBHs at TeV scale
- Theory neglects inelasticity during formation and MBH entropy ➟ high multiplicity finale states very unlikely
- However, significant increase of 2 particle final states expected when approaching Planck Scale, providing insights into strong gravity

3.

Excited Quarks

Discovery of excited quarks (q*) would be evidence for quark substructure. Properties are:

- Expected mass > 1 TeV
- Coupling like SM
- Leading production: qg→q*
- Leading decay channel: dijet



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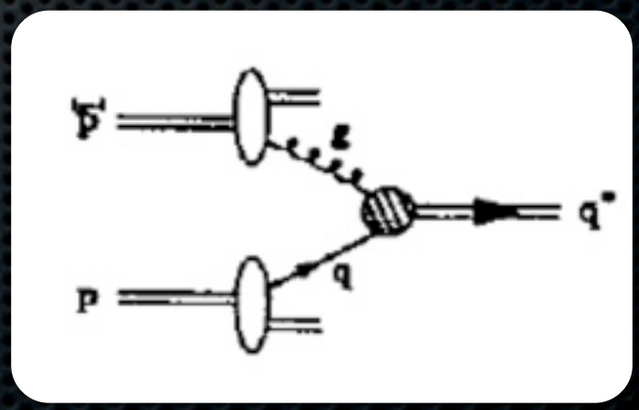


4.

Quark Contact Interactions

- Assume quarks have internal structure made up of *preons*
- Quarks can exchange very heavy bound states of these preons
- Added effective Lagrangian term:

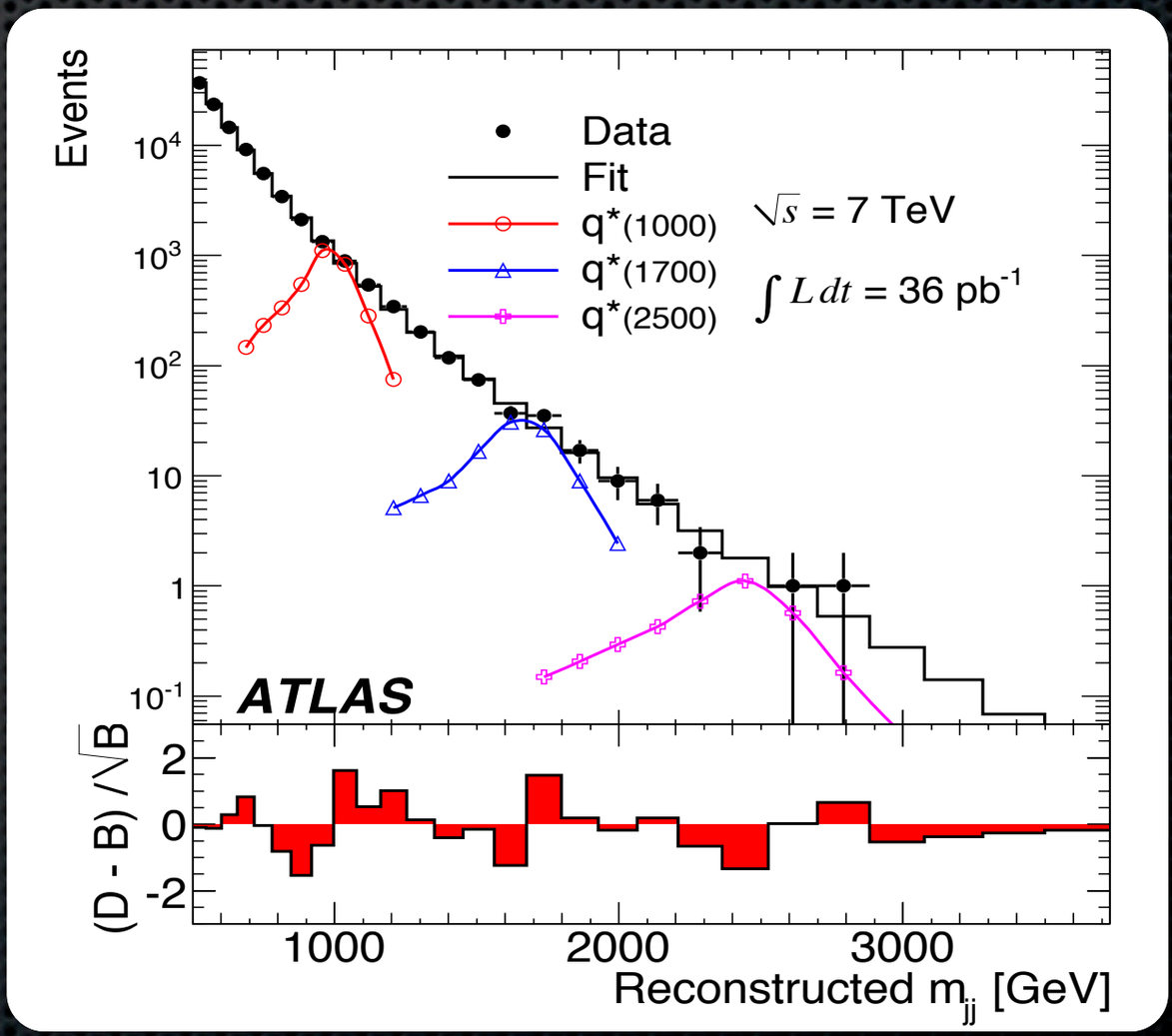
$$\mathcal{L}^{(0)}_{qq} = \eta_0 \frac{g^2}{2\Lambda^{*2}} \bar{q}_L \gamma^\mu q_L \bar{q}_L \gamma_\mu q_L$$

- Leads to enhanced s-channel x-section

Measurement & Results

Mass Distribution

- Bump-finding algorithm finds nothing
- Set limits on axigluons, excited quarks and MBHs



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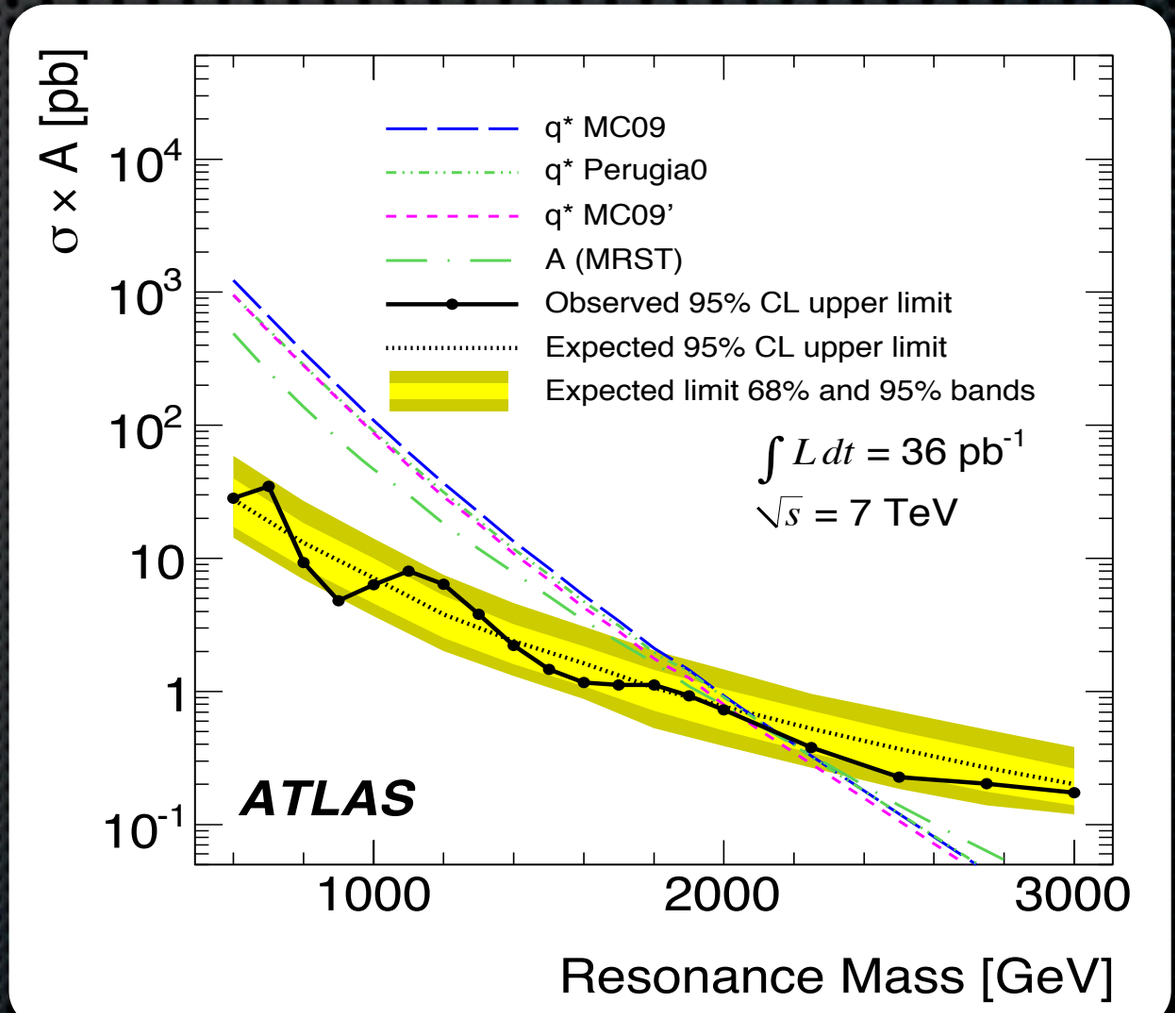
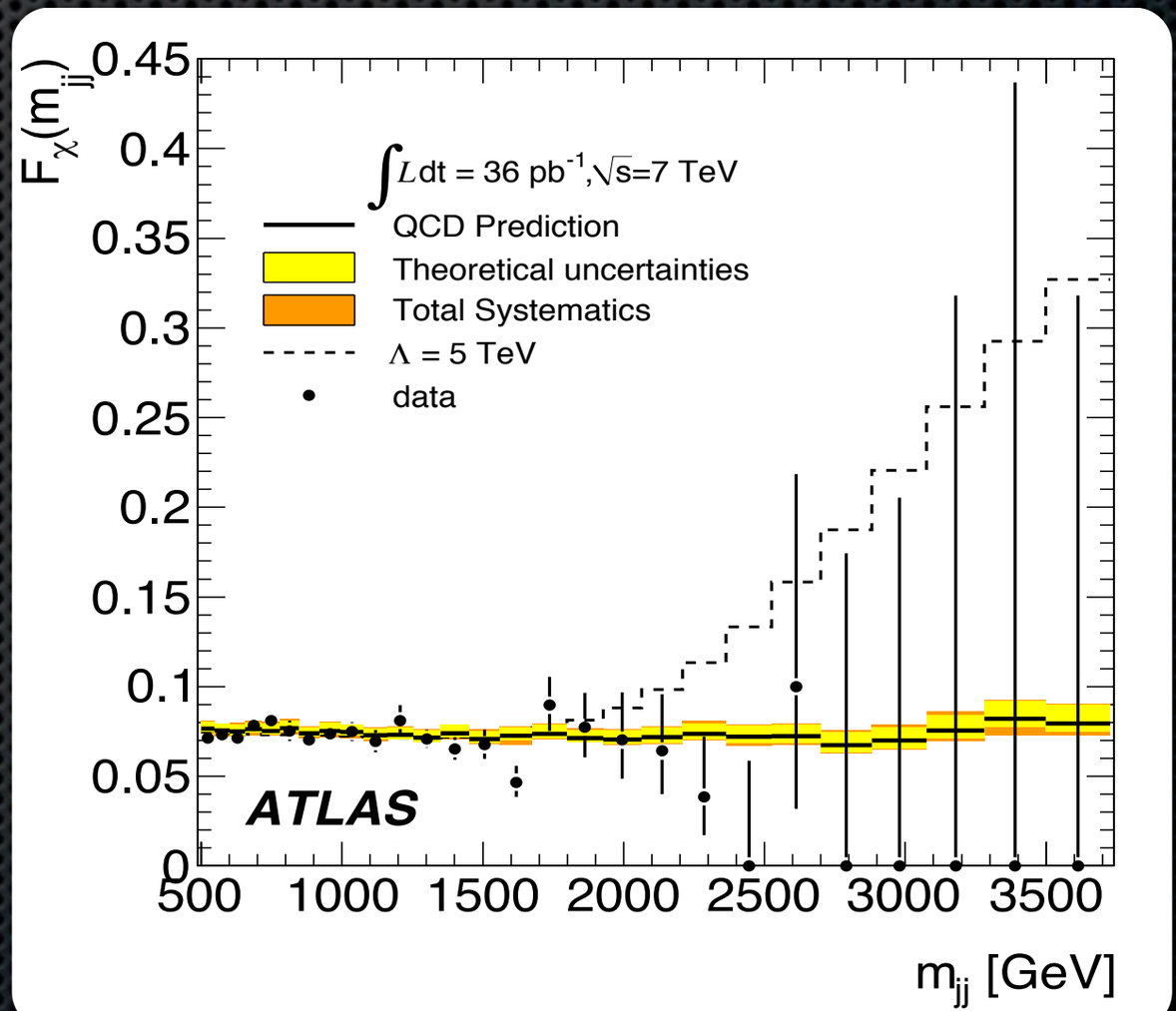


Angular Distribution

- Angular distribution found to be consistent with QCD
- set limits on quark contact interactions using log-likelihood ratio

$$F_\chi\left(\left[m_{jj}^{min}+m_{jj}^{max}\right]/2\right) \equiv \frac{N_{events}(|y^*|<0.6, m_{jj}^{min}, m_{jj}^{max})}{N_{events}(|y^*|<1.7, m_{jj}^{min}, m_{jj}^{max})}$$



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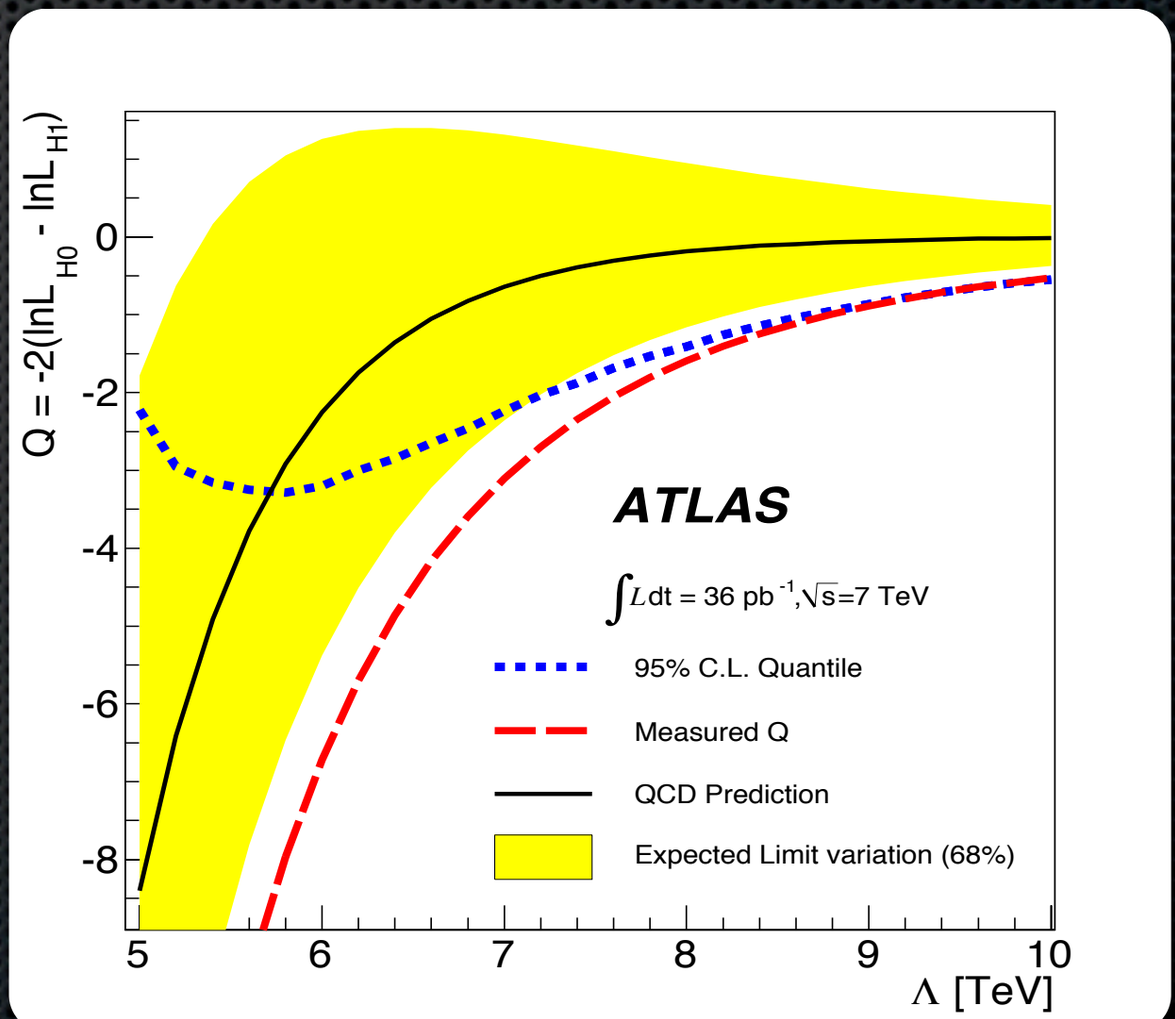

Conclusion

- extensive dijet studies find no deviation from SM, limits have been set on BSM physics:
  - axigluons: mass > 2.1 TeV
  - MBH (n=6): M_{PL} > 3.67 TeV
  - excited quarks: mass > 2.64 TeV
  - quark contact interaction: Λ > 9.5 TeV


Searches for New Physics using
Dijet Angular Distributions at ATLAS
Ryan M Buckingham for the ATLAS Collaboration
CERN Latin American School of High Energy Physics, 2011

Thank you!