Search for dijet resonances along with an isolated charged lepton at √s=13 TeV pp collision with the ATLAS detector

Wasikul Islam*

*University of Wisconsin-Madison, USA

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Motivation

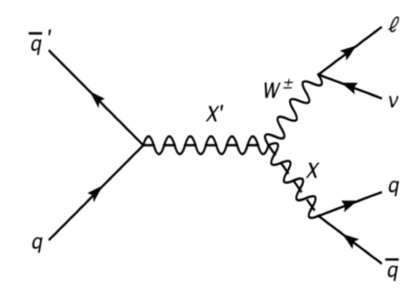
Resonance search in the dijet invariant mass spectrum provides scopes to find BSM Physics

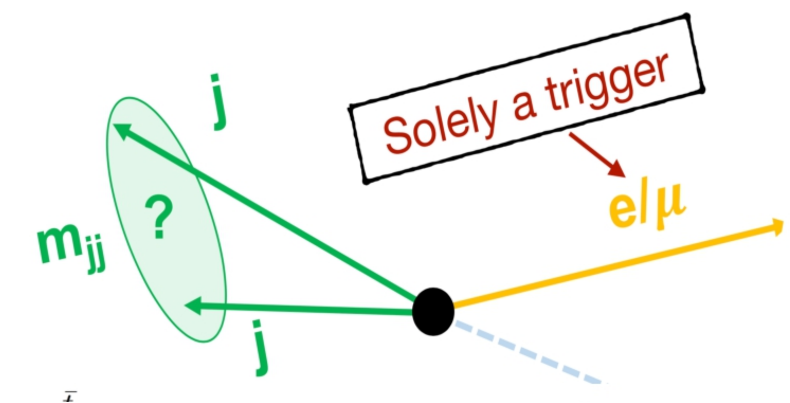
The final state lepton provides many benefits :

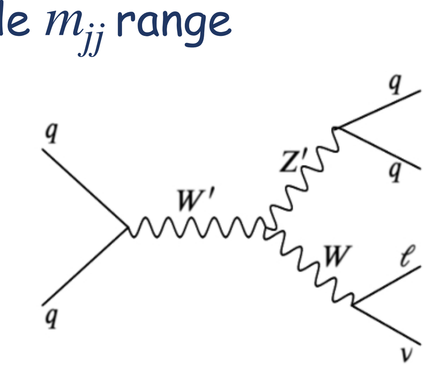
- Sensitive to different physics and final states compared to inclusive searches
- Overcome trigger limitations by using lepton as spectator object & cover a wide m_{jj} range
- Reduces QCD multijet background

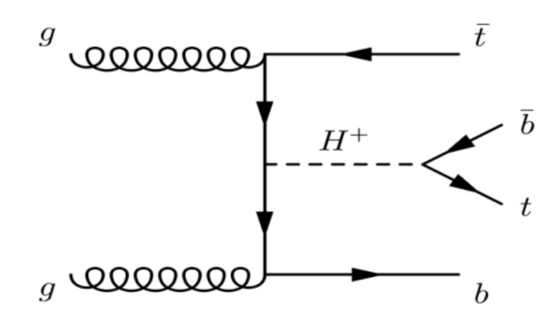
Along with model independent searches, following BSM models were probed:

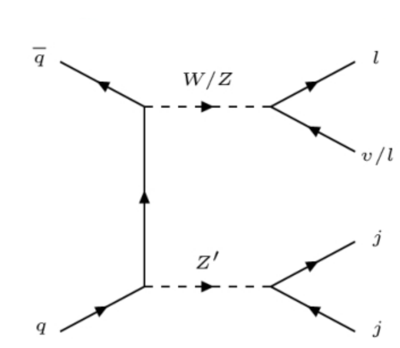
- Sequential Standard Model (SSM)
- Technicolor Model
- Charged Higgs Model
- Simplified Dark Matter Model

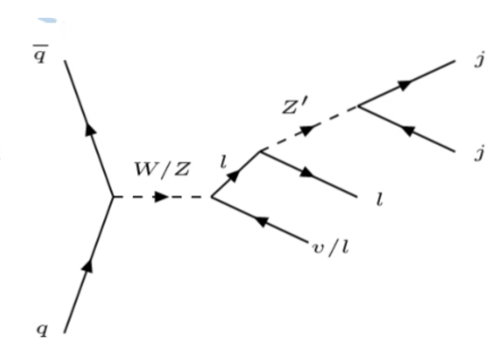












Event and object selection

- Using full 139 fb-1 Run 2 dataset of ATLAS, search was conducted at the range : 0.22 TeV $< m_{\mathrm{jj}} <$ 6.3 TeV
- Various single-electron/muon triggers with different p_{T} (muon), E_{T} (electron), quality, and isolation thresholds were used
  - Lowest unprescaled thresholds were $p_{\mathrm{T}} > 24$ GeV for muon triggers, $E_{\mathrm{T}} > 26$ GeV for electron triggers.
- Dominant sources of background modeled by MC are multijet (≥ 2 jets), $t\bar{t}$ and W+jets processes

Object	Type	pT	Eta (η)	Cleaning/isolation
Electron Selection		pT > 60 GeV	|η| < 1.37, 1.52 < |η| < 2.47	Calo-based isolation
Muon Selection		pT > 60 GeV	|η| < 2.7	Calo-based isolation
Jet Selection	Anti-kT 0.4 EMTopo jets	pT > 20 GeV	|η| < 2.47	Jet cleansing

- Overlap removal techniques applied between leptons & jets

Background modeling studies

2+1 jets control region (MC-CR)

Loose Electron control region (LE-CR) (Electron id requirement loosened)

- The LE-CR contains an order of magnitude more events than MC-CR

5p fit function : $(x \equiv m_{jj}/\sqrt{s})$

$$f(x) = p_1(1-x)^{p_2} x^{p_3 + p_4 \ln x + p_5 \ln^2 x}$$

Alternative 5p fit function :

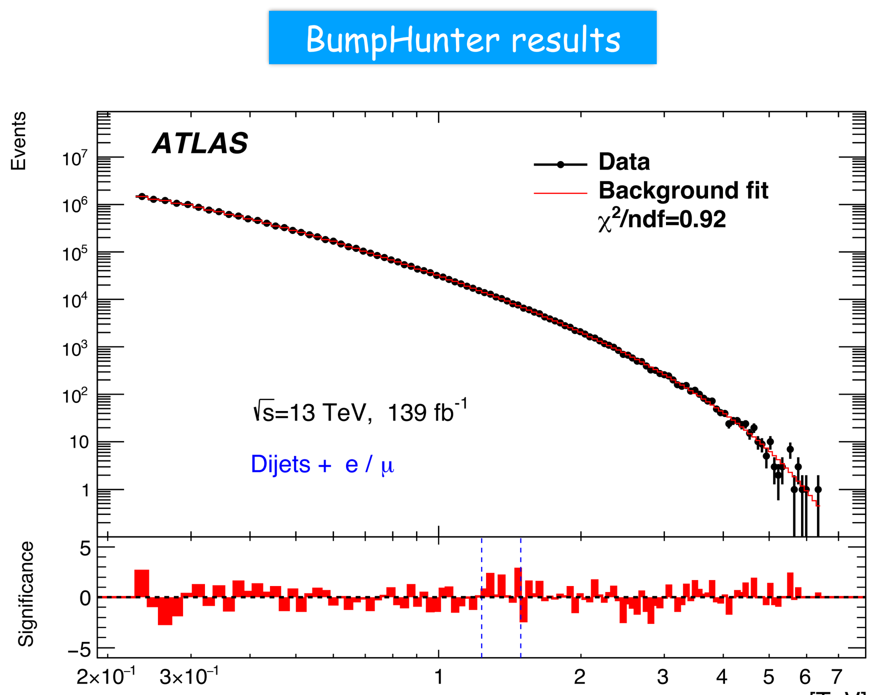
$$f(x)^{alt} = p_1(1-x)^{p_2} x^{p_3 + p_4 \ln x + p_5/\sqrt{x}}$$

- Based on the studies of the control regions, background-only hypothesis for the signal region is constructed over the m_{jj} search range

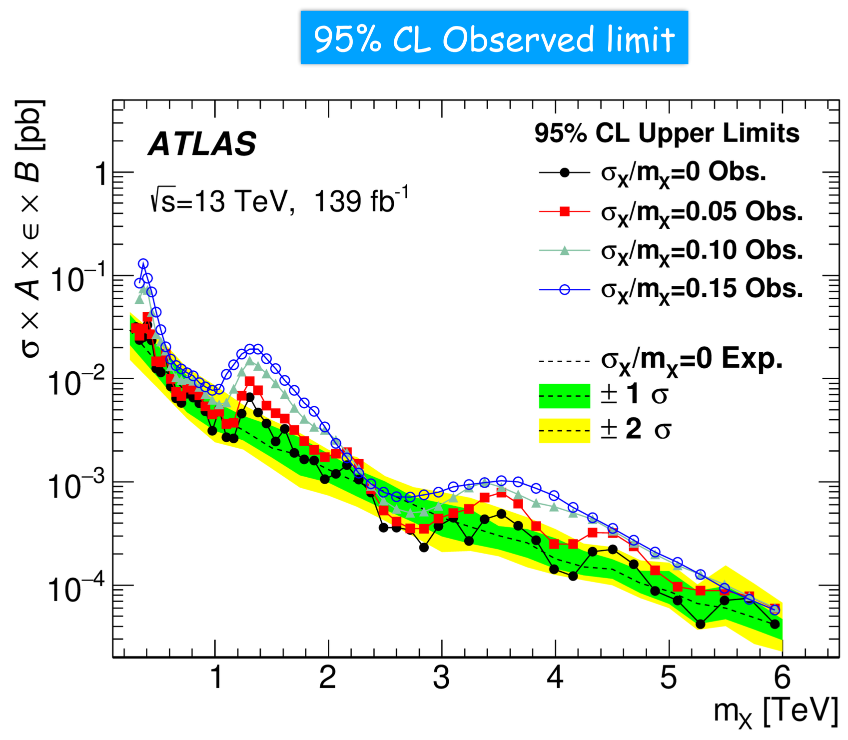
Model independent results

- BumpHunter found no significant excess from null hypothesis
- Largest deviation at m_{jj} = 1.3 TeV, with global p-value = 0.305, corresponding to Z-value = 0.5σ

BumpHunter results



95% CL Observed limit



Conclusions

- Searched for resonance in m_{jj} in events with at least two jets and one isolated lepton using full Run 2 dataset – Found no significant excess
- Set limits on Gaussian-approximated signals – limits range from 50 fb to 0.1 fb in the 0.25 – 6 TeV mass range
- 3 and 4 body invariant mass distributions constructed from jets and leptons on same strategy can also extend and complement the results of some of the shown BSM physics scenarios

Systematic uncertainties

Systematic uncertainties include those associated with the background fit, fit parameters, JES, JER, lepton systematics, PDF, scale, luminosity etc.

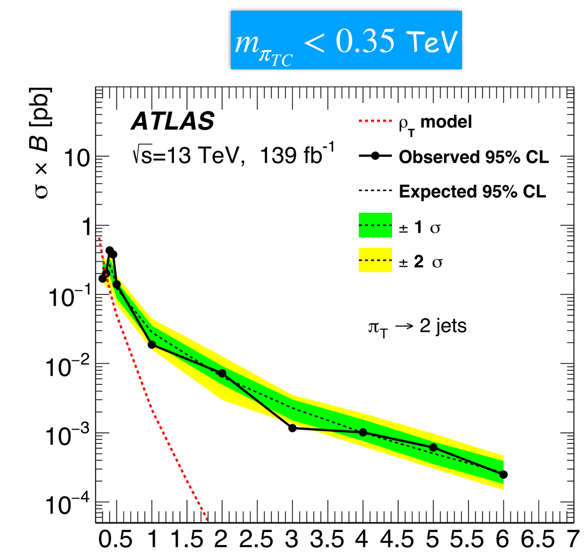
- The fit uncertainty extracted by fitting pseudo-experiments with an alternative 5p fit
- Uncertainties on limits are not dominated by systematic uncertainties
- Systematic uncertainties are also included as nuisance parameters
- The combined effect from all systematic uncertainties leads to a 6% worsening of the limits

Model specific limits

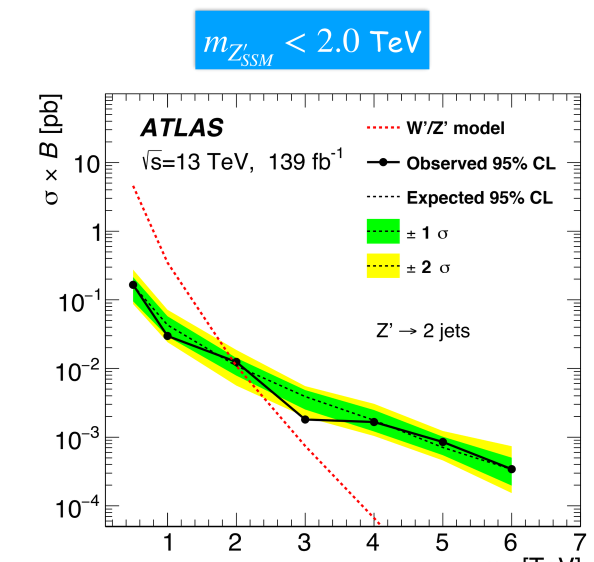
Limits set on BSM models :

- Z′ in SSM excluded at 2 TeV
- πT in Technicolor excluded below 350 GeV
- Charged Higgs excluded at 1.12 TeV (for tanβ = 0.5)
- Z′ in Simplified DM model excluded at 1.2 TeV (for leptophobic couplings g_q = 0.25, g_l = 0 and g_{DM} = 1)

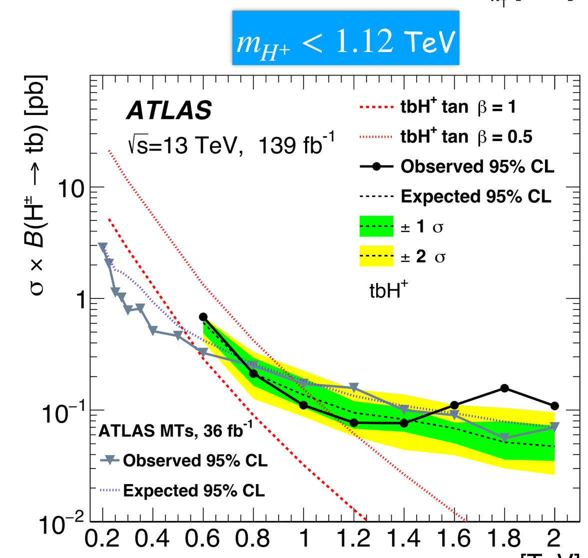
$m_{\pi_{TC}} < 0.35$ TeV



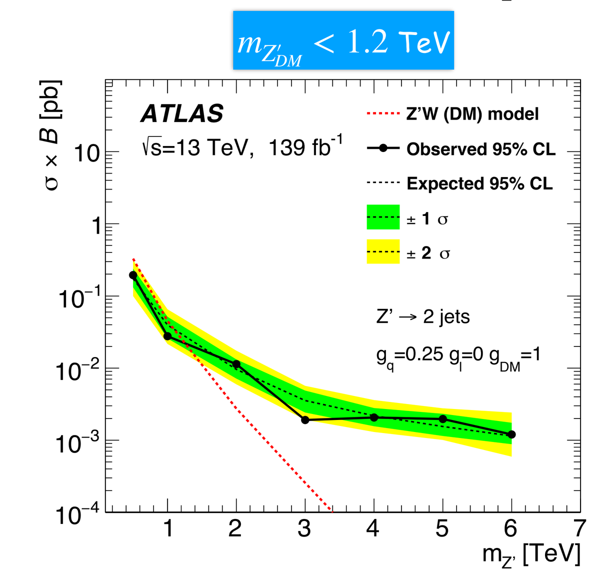
$m_{Z_{SSM}} < 2.0$ TeV



$m_{H^+} < 1.12$ TeV



$m_{Z'_{DM}} < 1.2$ TeV



Reference : https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2018-32/

Univ. of Manchester, UK