t-channel Interpretations at ATLAS

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Introduction(?)

Talk will focus only on interpretations of phenomenological DM models that permit *t*-channel mediator exchange.

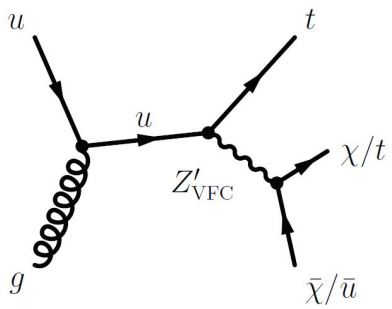
Current ATLAS interpretations of DM models with *t*-channel mediator exchange share a set of commonalities:

- Assume bulk of universe's DM consists of stable WIMPs (Dirac fermions)
- Interpretations done within framework of simplified DM models
- Assume DM-SM interaction mediated by a new particle (or set of particles):
  - Either colour-neutral or colour-charged
  - Spin-1 or spin-0
- Minimal width assumption

Spin-1 *t*-channel Models

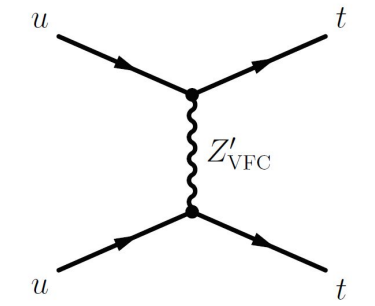
Motivated by "signature-based strategy" targeting final states suppressed in the SM

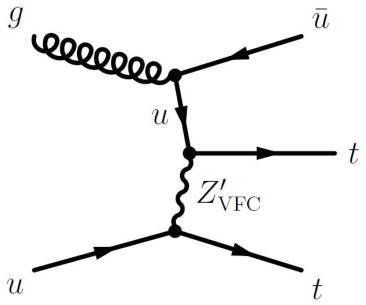
- **Single top + MET**: arises from DM production via *s*-channel exchange of a neutral, colour-singlet vector particle
- **Same-sign tt**: signature of *t*-channel interaction



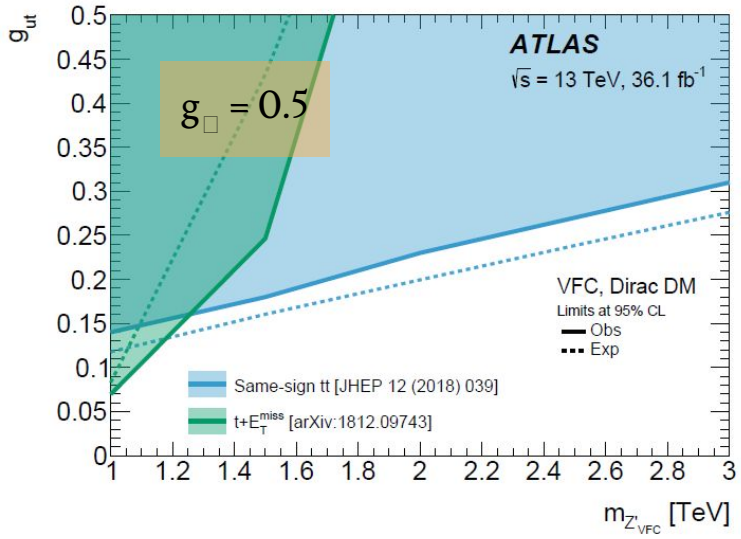
ATLAS limits on **Vector Flavour-Changing (VFC)** models:

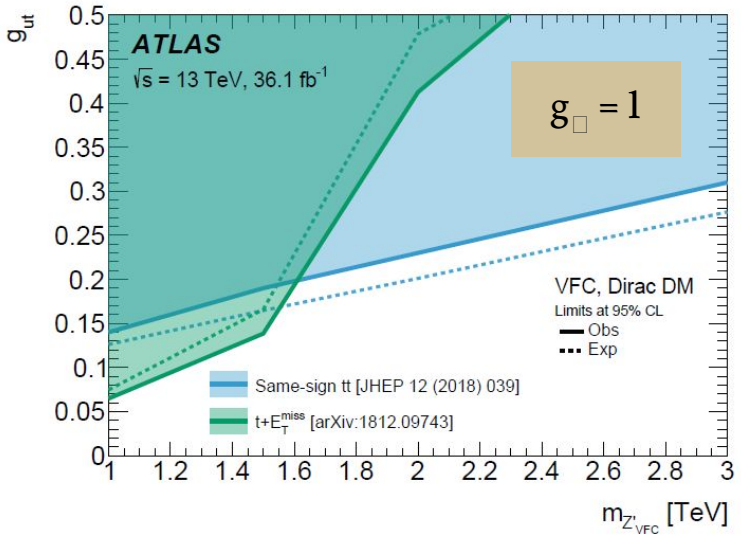
- Adapted from Ref. [JHEP 01 (2015) 017]
- Coupling restricted to *u*- and *t*-quarks
- Described by $m_{Z'VFC}$, $m_{\square}$, $g_{\square}$, and g_{ut}
- Rescaling of results from 13 TeV mono-top [CERN-EP-2018-301] and same-sign tt [JHEP 12 (2018) 039] analyses
- Three interpretation planes:
  - $m_{Z'VFC}$ - g_{ut}
  - Br(□□) - g_{ut}
  - $g_{\square}$ - g_{ut}

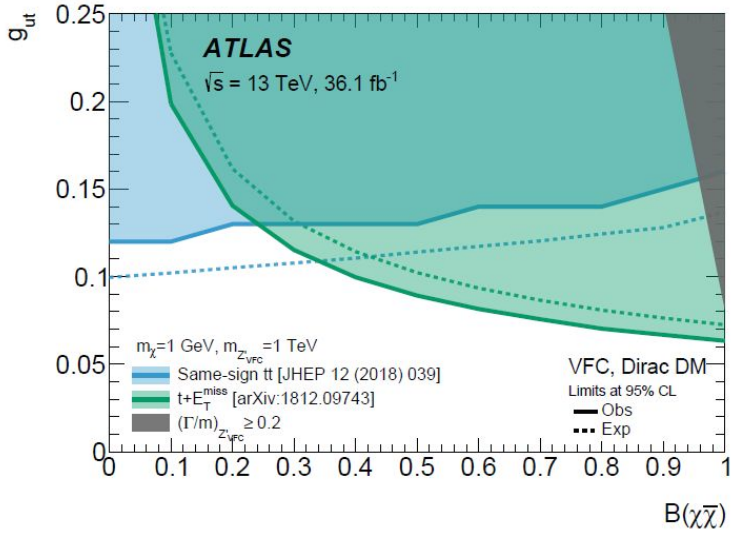


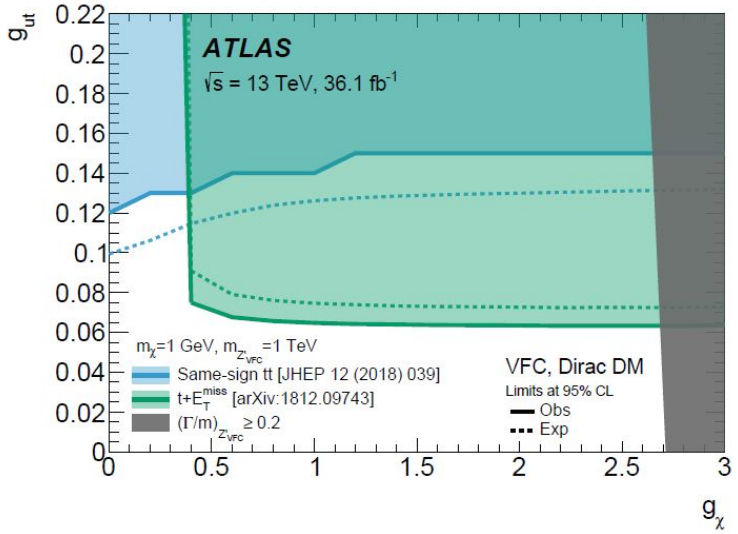


Spin-1 *t*-channel Models





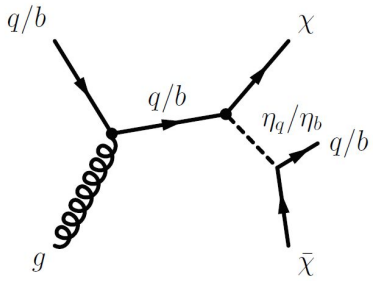


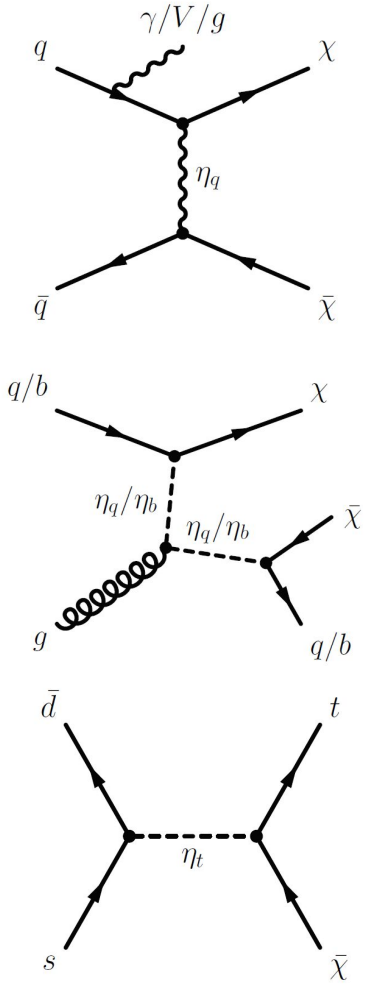


Spin-0 *t*-channel Models

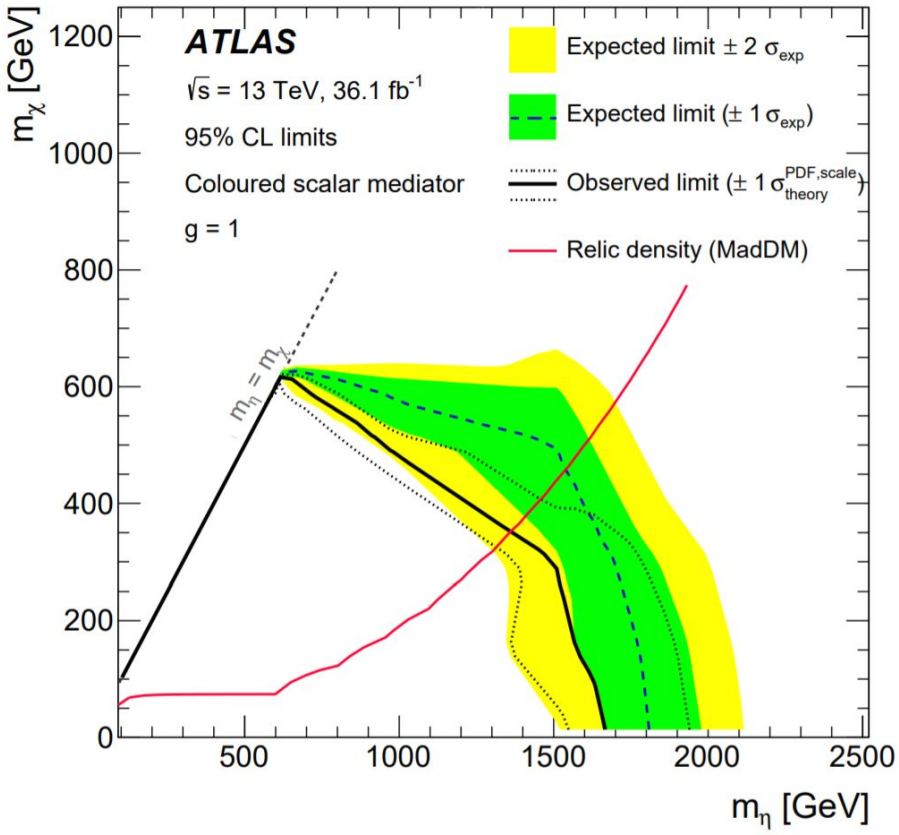
ATLAS studies of **Scalar Colour-Charged mediator (SCC)** models grouped into three sub-categories:

1. **SCC$_q$ Model** [JHEP 11 (2014) 024]
   - SU(2) singlet mediator couples to LH light quarks
   - Described by **m_η**, **$m_\square$**, and **$g_{q\square}$**
   - Limits **j + MET** search [JHEP 01 (2018) 126]
2. **SCC$_b$ Model** [Phys. Rev. D 90 (2014) 063512]
   - Mediator couples to RH bottom quark, decays to *b*-quark + DM pair
   - Described **m_η**, **$m_\square$**, and **λ_b**
   - Limits from **b(b) + MET** search [Eur. Phys. J. C 78 (2018) 18]
3. **SCC$_t$ Model** [JHEP 01 (2015) 017, Phys. Rev. D 86 (2012) 034008]
   - SU(2)L-singlet mediator couples to RH quarks, produced by quark fusion, decays to *t*-quark + DM pair
   - Described **m_η**, **$m_\square$**, and **λ_t**, and **g_{ds}**
   - Limits from **t + MET** search [CERN-EP-2018-301]



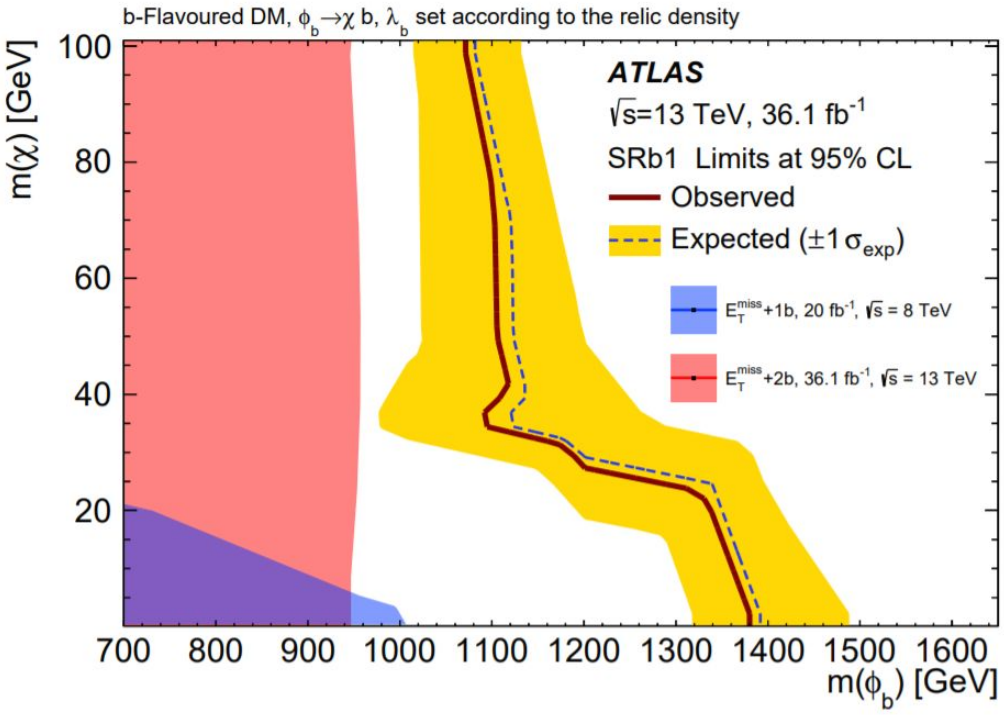


SCC_q Exclusion Limits



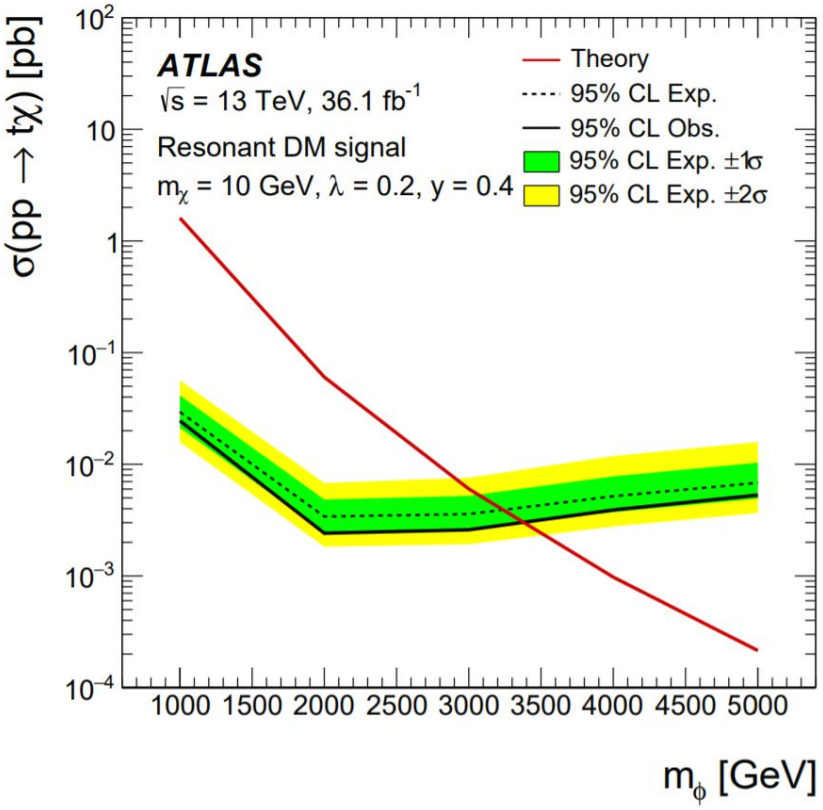
- Mediator masses up to 1.67 TeV excluded for $m_\chi = 50$ GeV.
- In the case of $m_\chi = m_\eta$, masses up to 620 GeV are excluded.

SCC$_b$ Exclusion Limits



- Coupling to *b*-quarks set to value which yields a DM relic density consistent with astrophysical observations for a given choice of m_η and $m_{\square}$
- Masses up to 1.4 TeV excluded for a DM mass of 1 GeV

$SCC_{b/t}$ Exclusion Limits



- Mediator masses up to 3.4 TeV are excluded, assuming a 10 GeV DM particle mass with $\lambda t = 0.4$ and $gds = 0.2$

Conclusions

- ATLAS studies of *t*-channel mediator models include both spin-1 and spin-0 states, colour-neutral and colour-charged
- Limits derived dominantly from heavy flavour ATLAS searches
  - Expect mono-Z(ll) sensitivity to mediator masses <100 GeV for the SCCq model with the full ATLAS dataset
- Models and model parameters not harmonised between channels:
  - Coupling to RH/LH quarks
  - Coupling strength and structure