Open questions/Prospects for collider DM searches

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Future of collider searches for Dark Matter at the LPC

FNAL

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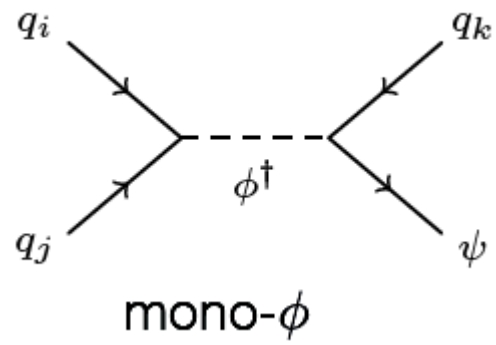
New Signatures/Topologies/Models

Which we did not study yet and should be ready for

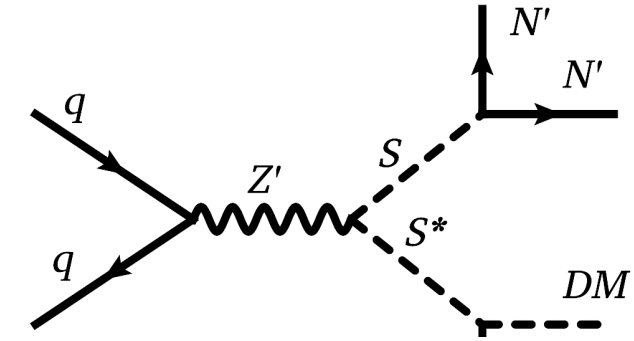
Just a few examples

- Monojet from scalar resonance (see talk by Matt Buckley)

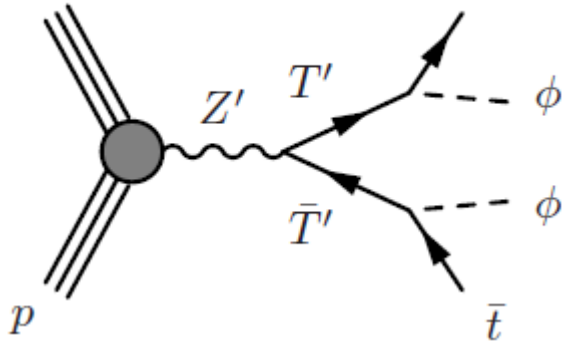


mono-ϕ

- MET recoiling Displaced vertices and/or heavy boosted objects from Z'→ S S*→ (N',N') + (DM,DM) chain (AB, Eung Jin Chun, Dan Locke, Priyotosh Bandyopadhyay, Rusa Mandal)



- tt+MET from Z'→ T'T'→ tt+DMDM **1707.07000** (AB, Patrick Schaefers, Thomas Flacke, Bithika Jain)



Do we need new tools/improvement of the existing ones?

- Better BG prediction/simulation?
  - NLO QCD+ NLO EW SM BG simulation can be done with Sherpa
- Common repository for BSM model implementaiton?
  - FeynRules website, HEPMDB
- Improvements on DM relic density and DM DD and ID signal predictions?
  - Freeze-in scenario will be in micrOMEGAs in ~ two weeks
- ……
- ……..

Common framework/agreement on the recasting of the experimental limits:

- (Re)interpreting the results of new physics searches at the LHC Workshop (CERN)
- Supplemental Material – section – would be very useful, see e.g. arXiv:1508.04094 (LHCb)

Search for hidden-sector bosons in $B^0 \to K^{*0}\mu^+\mu^-$ decays

Supplemental Material

The limits reported in the Letter assume a spin-zero hidden-sector boson. To convert these into limits for a spin-one boson, the ratio of efficiencies for the spin-one to spin-zero cases must be accounted for. Determining this ratio involves integrals of the form

$$\frac{\int f_j(\vec{\Omega})\epsilon(\vec{\Omega}, m^2(\mu^+\mu^-))\mathrm{d}\vec{\Omega}}{\int f_{1c}(\vec{\Omega})\epsilon(\vec{\Omega}, m^2(\mu^+\mu^-))\mathrm{d}\vec{\Omega}},$$

Combining collider searches, relic density and DM detection (DD and ID) limits

- Should experimental papers do this?
- How generic the statement is
  - Non-applicable for non-standard cosmology with low reheating temperature

- Importance of the **running of the operator**
  - In case of axial operators, e.g

$$c_A^{(q)} c_\chi \overline{\chi}\gamma^\mu \chi \overline{q}\gamma_\mu\gamma_5 q \qquad (D7) \qquad \text{or} \qquad c_A^{(q)} c_\phi \phi^\dagger \overleftrightarrow{\partial}_\mu \phi \overline{q}\gamma^\mu\gamma_5 q \qquad (C4)$$

couplings $\mathbf{c_V^{(q)}}$ arise due to the running of the wilson coeffcient $\mathbf{c_A^{(q)}}$ leading to sizable constraints on the DM DD constraints

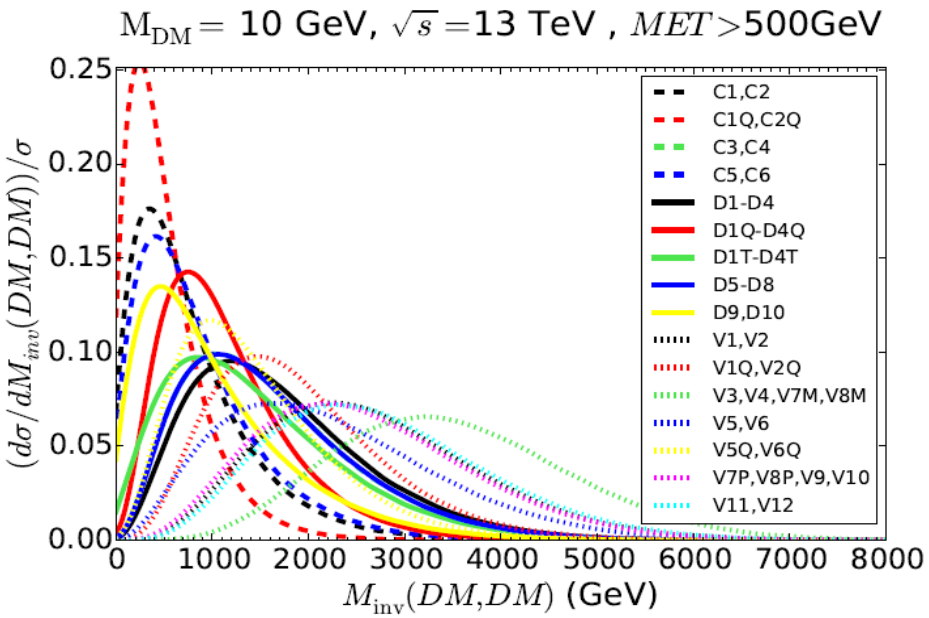
- One can use **runDM** program (**github.com/bradkav/runDM**) by **F. D'Eramo, B. J. Kavanagh & P. Panci**

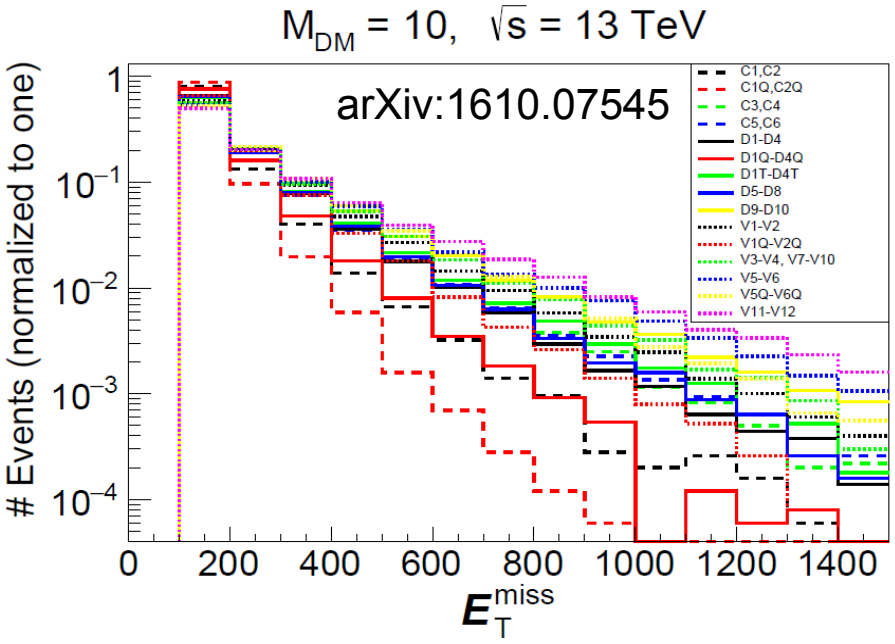
$\mathbf{c_A^{(u)}, c_A^{(d)}, c_V^{(u)}, c_V^{(d)}}$**=(1,1,0,0)**[5TeV] → (**1.1, 1.1, 0.04, -0.07**)[1GeV]

AB, Bertuzzo, Caniu, Eboli, di Cortona

Distinguishing DM operators/theories

M(DM,DM) distributions ⟷ are correlated with Different MET shapes





- energy dependence of the DM operator → M_{DMDM} distributions → slopes of MET
- projection for 300 fb^{-1}: some operators C1-C2,C5-C6,D9-D10,V1-V2,V3-V4,V5-V6 and V11-12 can be distinguished from each other
- Application beyond EFT: when the DM mediator is not produced on-the-mass-shell and M_{DMDM} is not fixed: t-channel mediator or mediators with mass below $2M_{DM}$