From Lagrangian to Events - FR/MG5aMC tutorial -

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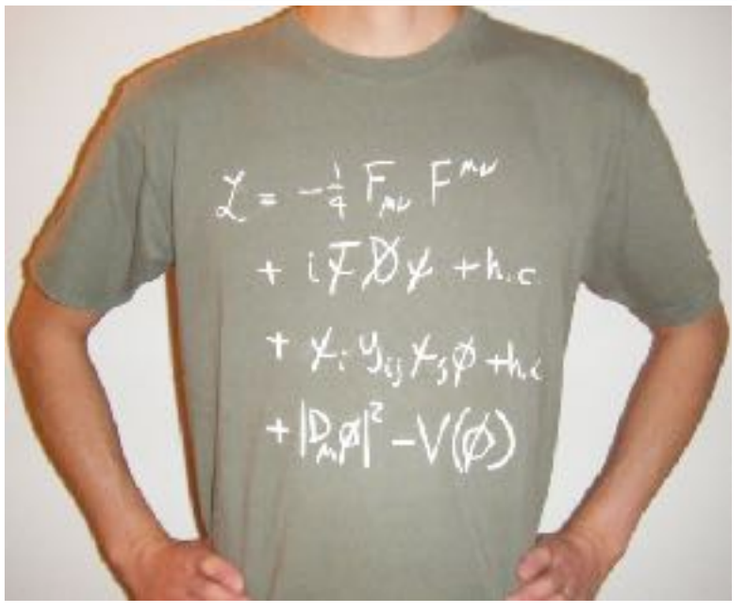
on behalf of the MadGraph5_aMC@NLO (MG5aMC) team

<u>disclaimer (Who am I?)</u>

- I'm a (BSM) pheno person.
- I'm a heavy user of MG5aMC, but not a real developer…

Lagrangian (TH) ⇔ Data (EXP)



simulation tools

BSM phenomenology workflow

- take a BSM model (symmetry, particle contents,…), i.e. Lagrangian
  - derive the Feynman rules Model provider
    - draw Feynman diagrams for our interesting processes
    - compute the amplitude (squared) Matrix-element Generator
    - generate parton-level events
  - parton-shower/hadronisation Shower Monte-Carlo programs
  - detector effect Detector simulation tool
  - analysis Recasting tool

DM physics tool

DM annihilation
(relic density, indirect search)
DM-N cross section

BSM phenomenology workflow

- take a BSM model (symmetry, particle contents,…), i.e. Lagrangian
  - derive the Feynman rules FeynRules

model files (UFO) → MadDM

  - draw Feynman diagrams for our interesting processes
    - compute the amplitude (squared) MadGraph5
      - generate parton-level events

LHE file → parton-shower/hadronisation Pythia, Herwig, Sharpa

HEP file → detector simulation Delphes

LHCO file → analysis MadAnalysis5

BSM phenomenology workflow

at NLO

- take a BSM model (symmetry, particle contents,…), i.e. Lagrangian
  - derive the Feynman rules FeynRules+NLOCT

model files (UFO)→

  - draw Feynman diagrams for our interesting processes
    - compute the amplitude (squared)
      - generate parton-level events

MadGraph5_aMC@NLO

LHE file → parton-shower/hadronisation Pythia, Herwig, Sharpa

HEP file → detector simulation Delphes

LHCO file → analysis MadAnalysis5

Plan of the tutorials

- take a BSM model (symmetry, particle contents,…), i.e. Lagrangian
  - derive the Feynman rules FeynRules T1
  - draw Feynman diagrams for our interesting processes
  - compute the amplitude (squared)
    - generate parton-level events

T2 MadGraph5_aMC@NLO

T3,4

model files (UFO) → MadDM T6

LHE file → parton-shower/hadronisation Pythia, Herwig, Sharpa

HEP file → detector simulation Delphes

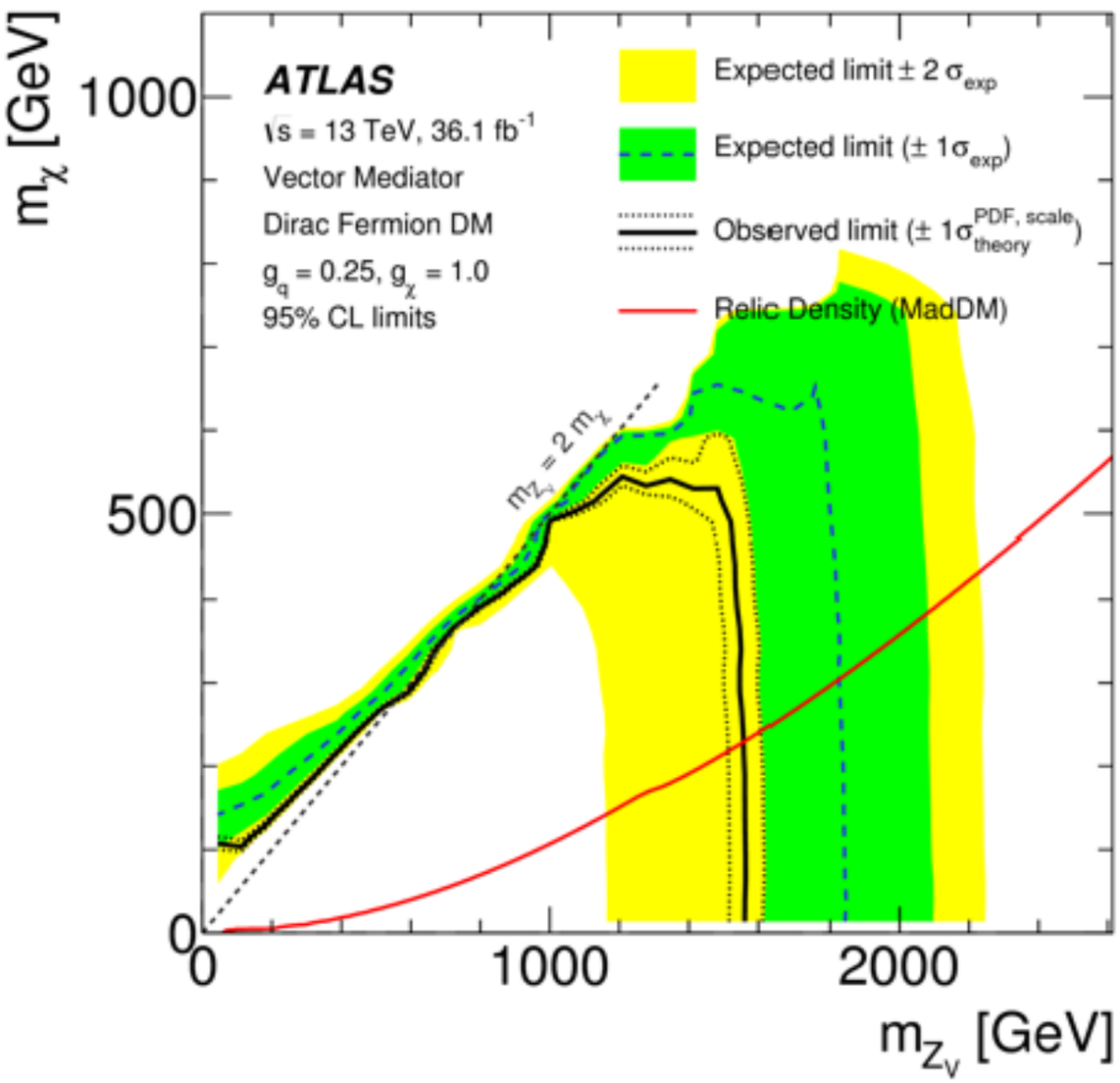
LHCO file → analysis MadAnalysis5 T5

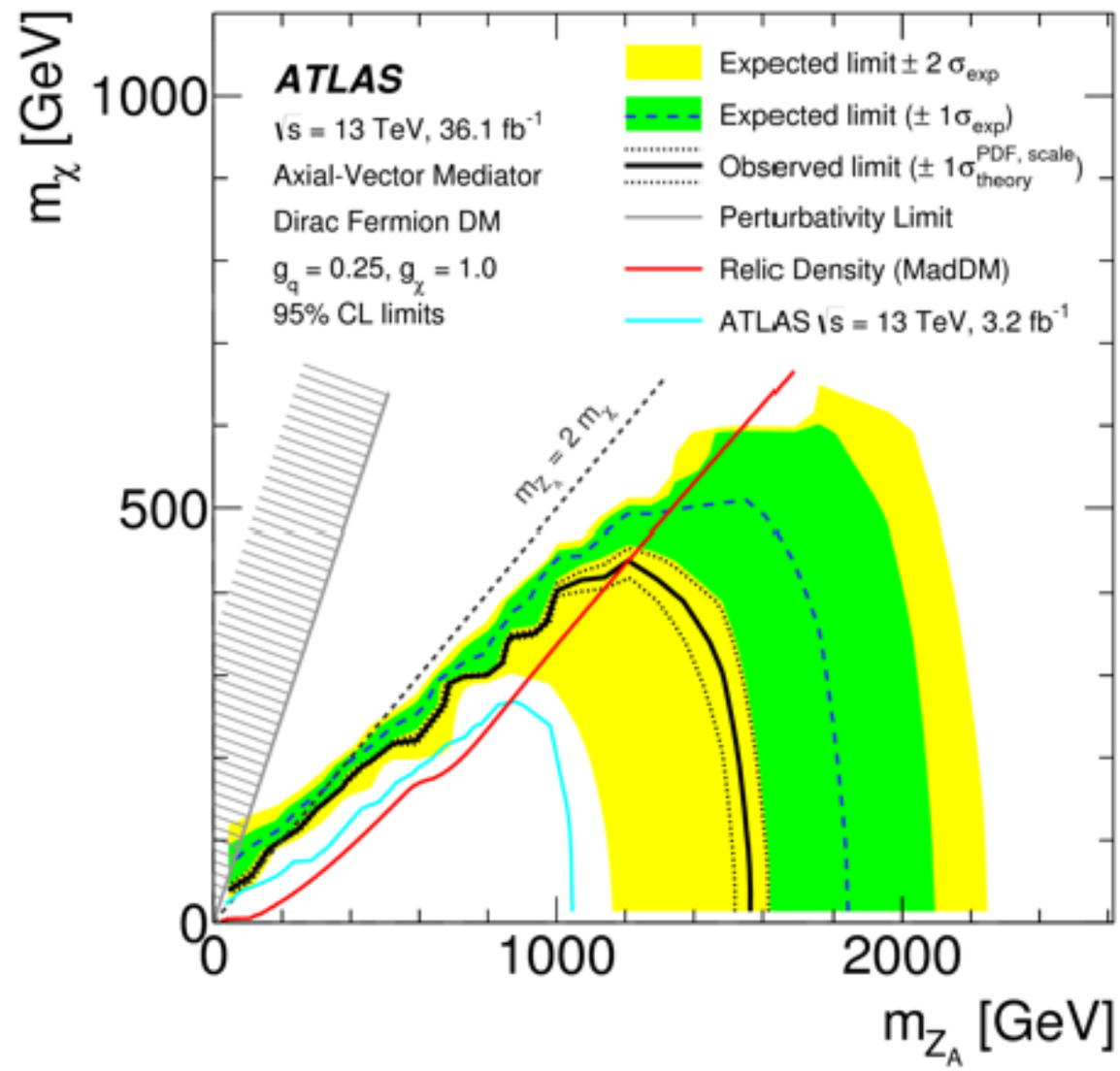
T7

Ultimate goal by the end of the school

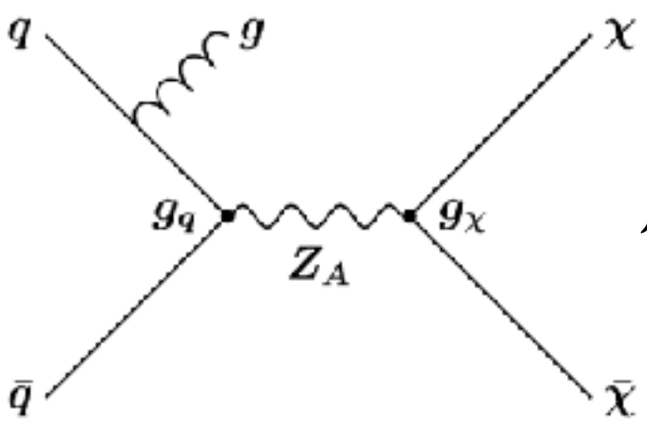
Search for dark matter and other new phenomena in events with an energetic jet and large missing transverse momentum using the ATLAS detector

arXiv: 1711.03301





Today's goal: make your own DM UFO model



$$\mathcal{L} = \bar{\chi}\gamma_\mu(g_\chi^V + g_\chi^A\gamma_5)\chi Z_A^\mu + \bar{q}\gamma_\mu(g_q^V + g_q^A\gamma_5)qZ_A^\mu$$

FeynRules

1. Warm up: follow SM.nb, and generate the SM UFO.
2. cp -r SM YourModel
3. create yourmodel.fr, and LoadModel together with SM.fr.
4. check your model, and generate the UFO.

MG5aMC

1. cp -r YourUFO ~/MG5aMC/models/YourUFO
2. ./bin/mg5_aMC
   - import model YourUFO
   - generate p p > …
   - output
   - launch