

# **Tutorial (part II)**

**DM Simplified models in MG5**

Invisibles school

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# BSM Monte Carlo study

## Goals

- Use MG5 to study simplified DM models
- Use a ready-made UFO model which involves a mediator coupling to the SM and to DM
- Obtain the missing PT distribution using MA5 for different types and masses of the mediator and DM
- Reproduce literature results

# Spin-1 mediator with fermionic DM

$$\mathcal{L}_{X_D}^{Y_1} = \bar{X}_D \gamma_\mu (g_{X_D}^V + g_{X_D}^A \gamma_5) X_D Y_1^\mu, \quad \text{mediator-DM coupling}$$

and with quarks by

$$\mathcal{L}_{\text{SM}}^{Y_1} = \sum_{i,j} \left[ \bar{d}_i \gamma_\mu (g_{d_{ij}}^V + g_{d_{ij}}^A \gamma_5) d_j + \bar{u}_i \gamma_\mu (g_{u_{ij}}^V + g_{u_{ij}}^A \gamma_5) u_j \right] Y_1^\mu, \quad \text{mediator-SM coupling}$$

$$\{g_{\text{SM}}, g_X, m_X, m_Y\}.$$

# Dark Matter simplified models

<http://feynrules.irmp.ucl.ac.be/wiki/DMSimp>

Install the DMSimp\_s\_spin1.zip model into your mg5 Models/ directory

Try out the following commands

```
import model DMSimp_s_spin1  
generate p p > xd xd~ j
```

Check the diagrams

Goal: Use madanalysis5 to plot distributions for the missing transverse momentum for different masses of the mediator and DM

# Example Scenarios

## Spin-1 scenarios

$(m_Y, m_X)$  [GeV]

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(10, 1)

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(10, 50)

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(10, 500)

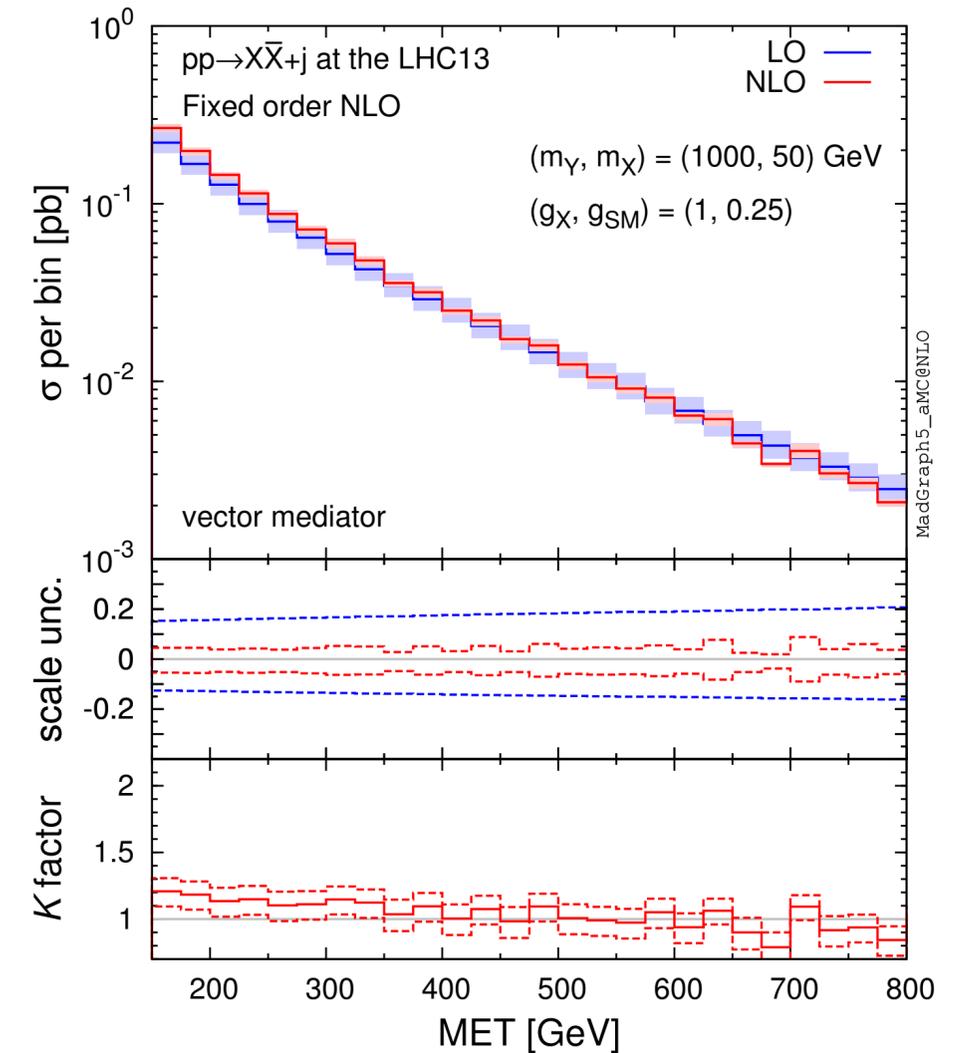
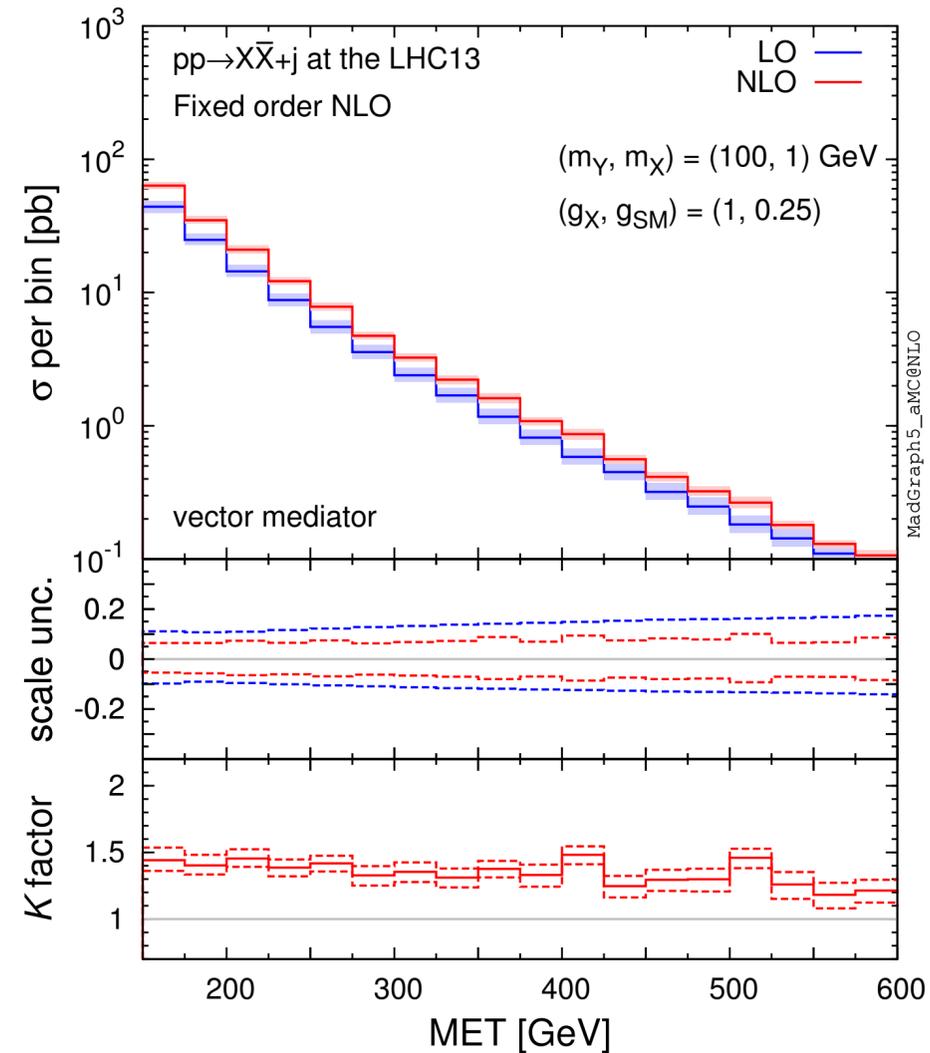
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(100, 1)

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(1000, 50)

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arXiv:1508.05327

Reproduce the LO plots shown here

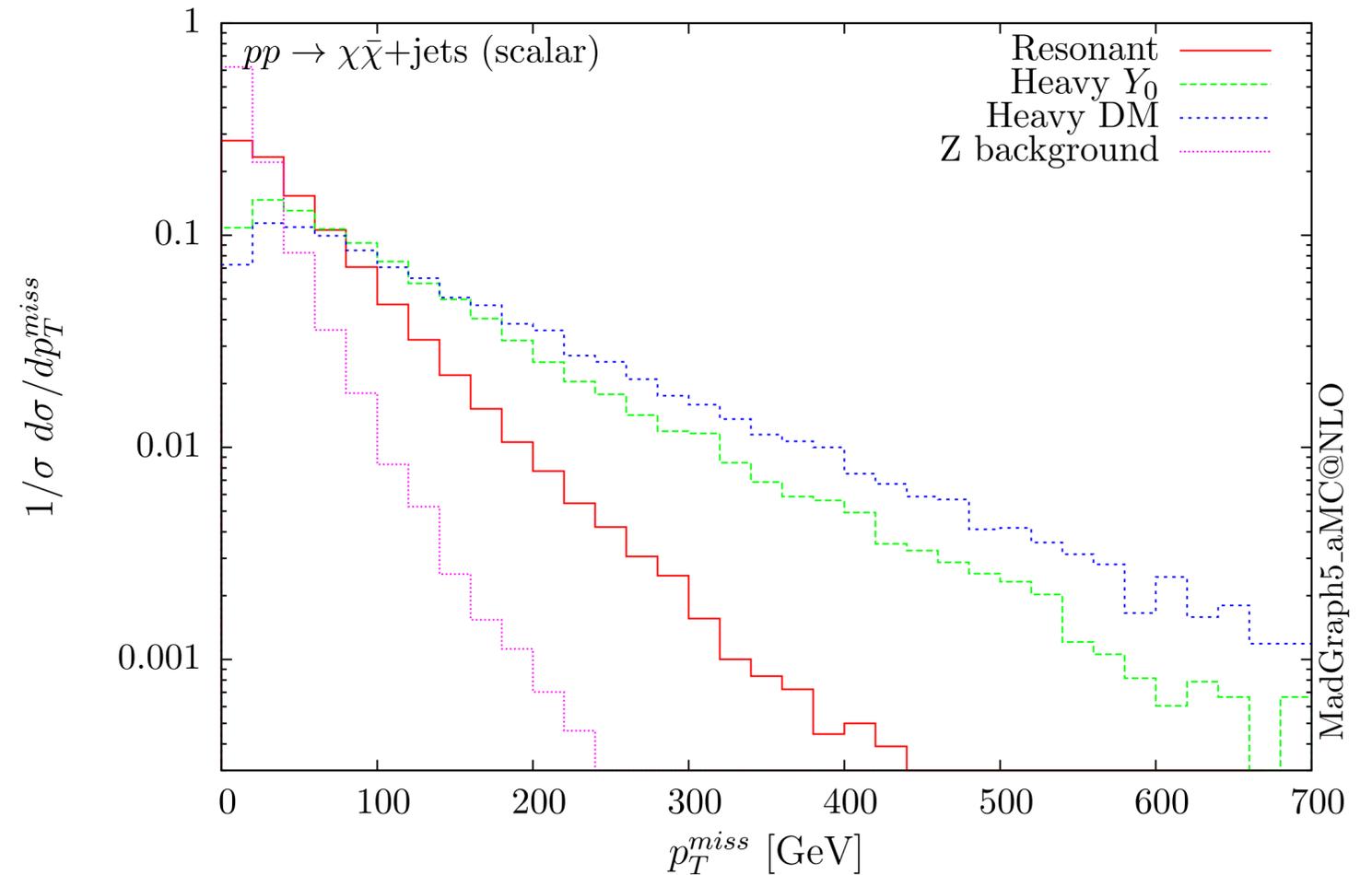
# Spin-0 scenarios

$$\mathcal{L}_{DM}^{Y_0} = \bar{\chi}(g_{DM}^S + ig_{DM}^P \gamma^5)\chi Y_0,$$

$$\mathcal{L}_{SM}^{Y_0} = \bar{t} \frac{y^t}{\sqrt{2}} (g_t^S + ig_t^P \gamma^5) t Y_0.$$

Benchmark	Resonant	Heavy mediator	Heavy DM
Mediator mass	200	1000	400
Dark matter mass	50	1	500

Table 1. Mass benchmarks in GeV.



arXiv:1508.00564

# Try this out

<http://feynrules.irmp.ucl.ac.be/wiki/DMSimp>

Install the DMSimp\_s\_spin0.zip model into your mg5 Models/ directory

Try out the following commands

```
import model DMSimp_s_spin0
generate p p > xd xd~ j DMS=2 QCD=3 QED=1 [QCD]
```

How is this different from the previous example?

Check the diagrams and plot the missing pT distribution for the benchmarks on the previous slide