Global perspectives on dark matter simplified models

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Based on Bagnaschi E. et al [1809.xxxx]

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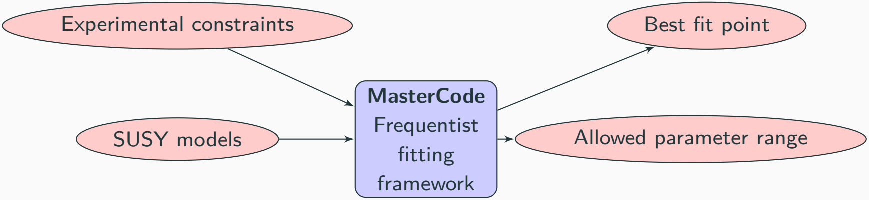
Introduction

Introduction

Global likelihood analyses

- Global-fit frameworks such as `MasterCode`, have been used for years to study BSM extensions of the SM. In our case, up to now we focused our attention to SUSY models (see the other MC talks on SUSY-DM and SUSY @ LHC later today).
- Dark Matter Simplified Models are not complete models, not meaningful to compute p-values. Use the framework with the aim of correlating different sectors and finding still allowed regions.



The models

Dark Matter Simplified Models

The Lagrangians

- We consider DMSMs with a spin-1 (Y_1) s-channel mediator.
- The dark matter candidate is a Dirac fermion (X_D).
- We use the model files provided by the `DMSIMP` package for our implementation.

Spin-1 mediator

- Interaction Lagrangian mediator-DM
  $\mathcal{L}_{X_D}^{Y_1} = \bar{X}_D \gamma_\mu \left(g_{X_D}^V + g_{X_D}^A \gamma_5 \right) X_D Y_1^\mu$.
- Interaction Lagrangian mediator-quarks
  $$\mathcal{L}_{quarks}^{Y_1} = \sum_{i,j} \left[\bar{d}_i \gamma_\mu \left(g_{d_{i,j}}^V + g_{d_{i,j}}^A \gamma_5 \right) d_j + \bar{u}_i \gamma_\mu \left(g_{u_{i,j}}^V + g_{u_{i,j}}^A \gamma_5 \right) u_j \right] Y_1^\mu$$
- Interaction Lagrangian mediator-leptons
  $$\mathcal{L}_{leptons}^{Y_1} = \sum_{i,j} \left[\bar{l}_i \gamma_\mu \left(g_{l_{i,j}}^V + g_{l_{i,j}}^A \gamma_5 \right) l_j \right] Y_1^\mu$$

Scenarios

- Leptophobic, $g_{l_{i,j}}^V = g_{l_{i,j}}^A = 0$ (no constraints from dilepton searches).
- Flavor diagonal, $g_{u/d_{i,j}}^{V/A} = 0$ if $i \neq j$.
- Flavor blind, $g_{u_{i,j}}^{V/A} = g_{d_{i,j}}^{V/A}$.

1. $g_{X_D}^V \equiv g_{DM}$ $\quad g_{X_D}^V = 0$
   $g_{u/d}^V \equiv g_{SM}$ $\quad g_{u/d}^A = 0$,
   pure vector.
2. $g_{X_D}^V = 0$ $\quad g_{X_D}^V \equiv g_{DM}$
   $g_{u/d}^V = 0$ $\quad g_{u/d}^A = g_{SM}$,
   pure axial-vector.

The framework

The framework

- Frequentist fitting framework written in Python/Cython and C++.
- The `Multinest` algorithm is used to sample the parameter space.
- `udocker` used for deployment.

Parameter	Range	Number of segments
M_{Y_1}	(-4 , 4) TeV	6
M_{DM}	(0 , 1.2) TeV	2
g_{SM}	(0 , $\sqrt{4\pi}$)	1
g_{DM}	(1 , $\sqrt{4\pi}$)	1
Total number of boxes		144

Codes

Mediator properties

`Analytic/MadGraph_aMC@NLO`

Collider

`MadGraph_aMC@NLO (DMSIMP models)`

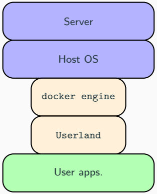
Dark matter

`MicrOMEGAs`

- Sampled a total of xx points.

Docker and udocker

- As suggested by the name, `udocker` uses `docker` containers.
- `Docker`: software framework to automatize the deployment of application inside Linux containers.
- Other options, such as `LXC`, are available to use the Linux container infrastructure.



- Middleware suite developed in the context of the `INDIGO data-cloud` project to run `docker` containers in userspace, without requiring root privileges (both for installation and execution).

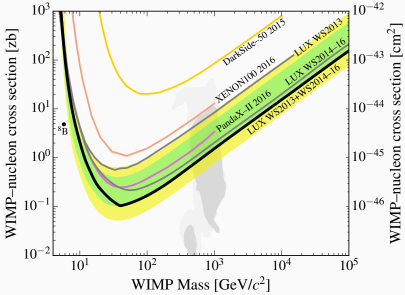
[Gomes at al., 1711.01758, submitted to CPC]

The constraints

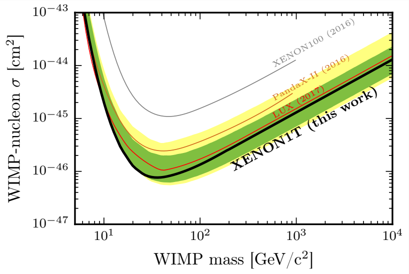
Non-LHC constraints

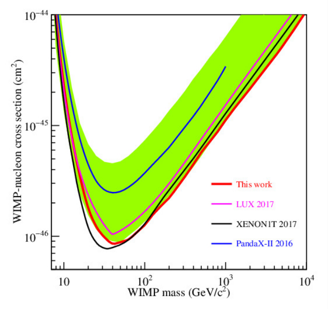
Dark matter

- Relic density constraints from Planck.
- Direct detection constraints on σ_p^{SI} from LUX, XENON1T and PANDAX.
- Direct detection constraints on σ_p^{SD} from PICO60.



[1608.07648, 1705.06655, 1708.06917]





Validation

Collider constraints

Monojet

Validation

Dijet

Validation

Results

Pure vector

Backup slides