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Summary of DM WG Meeting, 22 June 2016

C. Doglioni (DMWG organizers) - Introduction to meeting

Goal of this meeting: collect ideas towards next focused effort of DM Working Group. Each effort would leave to a report on the timeline of next Fall
Plan for today: have brief talks from brainstorming google doc, start discussion that should continue on lhc-dmwg-contributors mailing list, continue to develop the google doc, decide on the next topic

Google doc: https://docs.google.com/document/d/1sYGDweKIOHoomvJH9knqEwfoudk3b46PUJcCOYMvrak/edit

1. Refinement of Models

A. Natale - t-channel models

Additional considerations for colored t-channel spin-0 mediators, based on arXiv:1605.07058. Intend to strike a balance between a simplified model and broader set of models. The model in this paper has more free parameters with respect to the previous Dark Matter Forum model (Bell et al., Papucci et al.). They consider the constraints from the Higgs branching ratios. The model has direct detection constraints but viable parameter space for collider signatures.

G. Busoni - Gauge invariant simplified models, s-channel scalar

The DMF S-channel scalar Lagrangian is not gauge invariant. Fixing this requires the new scalar S has to mix with the 125 GeV Higgs. This mixing induces a Higgs coupling to Dark Matter. In the specific gauge invariant model considered, the Higgs coupling to DM brings strong DD constraints. When mDM<mH/2, Higgs to invisible searches are important bounds; when mDM>mH/2, the LHC signal is weak but ATLAS and CMS searches should study whether or not they are sensitive with the upcoming data.

G. Cacciapaglia - Monotop models

A summary of mono-top models as presented at the December DMWG meeting is proposed as a future idea. ATLAS/CMS should harmonize their models, now that the dataset is offering sensitivity to these signatures. CMS has recently completed a search with the 2015 data (PAS EXO-16-017).

2. Presentation of results

T. Jacques - Presenting constraints on simplified models

The models in the ATLAS/CMS Dark Matter Forum report have chosen the minimal set of free parameters (masses, couplings) to capture the range of possible kinematic distributions of their signals. Nevertheless, for practical reasons, results on these models have reduced the set of parameters further, fixing the coupling constants to benchmark values. This is insufficient to convey the full picture. Thomas proposed an alternative to the current "mass-mass" plot with fixed coupling values, scanning mDM, mMed, and gDM*gSM while fixing gDM/gSM. He showed some examples. Alternate versions scanning over the width were discussed afterward. The talk also quantifies the validity of the approximation of cross-section rescaling.

F. D'Eramo - Renormalization Group Evolution (RGE) of simplified models

So far, the LHC results have neglected RGE of the simplified model parameters from the collider scale to the scales of direct detection or indirect detection searches. Francesco showed that RGE must be taken into account because it can have large effects. Code is available to implement these effects: https://github.com/bradkav/runDM/. Example results with some simplified models were given. For example, for the simplified model with axial-vector couplings to quarks and dark matter, the effect of RGE on LHC bounds can be up to a factor of 2 on the direct detection cross section.

S. Meehan - Mono-Higgs / Exotic Higgs complementarity

The talk consists of a series of questions on the relationship between the scalar models proposed in the DMF report for mono-Higgs searches and the models used for mono-jet searches, as well as other general searches for additional scalars (e.g. those unrelated to dark matter done in the Higgs groups of each collaboration). The DMF scalar models ought to be refined to clear up these issues.

N. Whallon - EFT truncation for mono-V models

As reported in the December DM WG meeting, the current truncation procedures are not optimally defined for shape analyses and for models where there is no UV completion, such as the dimension 7 mono-V models. A proposal for the future could be to cover this in more detail.

3. Improving current searches

A. Boveia & al - EW uncertainties

At low MET, the sensitivity of mono-jet-like analyses, including some H->invisible searches, will be limited by the uncertainties on the prediction of Z->invisible+jets. With the help of precision QCD experts, the DM WG could review and compare the techniques currently used by ATLAS And CMS to predict this background, along with the uncertainties, and recommend improvements.

3. Tools

F. Maltoni - DM Tools and questions

The talk presents a summary of state of the art MC calculations and tools, which evolved since the list of DM models in DMF. s-channel (spin 0, 1 and 2) and t-channel are shown. The talk also outlined many of the open questions that the working group could tackle in its mandate, e.g. what else is needed, sensitivity to kinematics of DM spin structure. A list of MC needs would be useful, so that the community can help the LHC address these needs.

Final Q&A

The ideas discussed will be added to the google doc. Further discussion should happen in the next week. More ideas are still welcome. So far, two new topics seem to be favored from the discussion:

- refinements of the DMF simplified models, where needed to capture important physics. How should the t-channel models be implemented? How to make the scalar models gauge invariant, how to reconcile them with measurements of the 125 GeV Higgs, and how are the models related to the search benchmarks evolving in the Higgs groups (e.g. 2HDM)? How to present the results while capturing the additional dependence on coupling?
- review of and improvements to the SM backgrounds to mono-jet-like searches