# **Projections for Elusive Dark Sector:**

Or how to save tax-payers' money by looking for new physics in a model independent way

#### **Work in Progress**

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Artwork by Sandbox Studio, Chicago with Ana Kova

# Sometimes we feel stuff we don't see...

#### Galaxy Rotational Curves



#### **Gravitational Lensing**







- Contains dark matter
- Neutral under Standard Model : DARK





**Singlet** operator

- Contains dark matter
- Neutral under Standard Model : DARK

 $\text{Dim}[O_{\text{SM}} O_{\text{DS}}] > 4$ 

**Irrelevant Portals** 

#### **ELUSIVE Dark Sector**

Contino, Max, Mishra 2012.08537





 $-\Lambda_{\rm IR} \rightarrow$ 



Lightest state





Lightest state

 $-\Lambda_{\rm IR} \rightarrow$ 









5D Randall Sundrum Models etc.



\*lightest dark sector particle 9

$$\sigma_{pp\to DS} \sim \left(\frac{1}{\Lambda_{UV}^2}\right)^{D-4}$$

#### production cross section



\*lightest dark sectors particle 10



\*lightest dark sectors particle 11















### **Collider Bounds**





#### Contino, Max, Mishra 2012.08537

Production Portal  $\mathcal{O}_{\mathcal{DS}}H^{\dagger}H$ Decay of LDSP back to SM via:  $O_{DS} H^{\dagger}H (dim 6)$  $J_{DS}^{\mu\nu}J_{\mu\nu}^{SM}$  (generic  $\dim 6$  $T_{DS}^{\mu\nu} T_{\mu\nu}^{SM} (dim 8)$ 

### **Collider Bounds**



ATLAS search for Displaced Vertex in muon spectrometer and Inner detector : ATLAS PRD 99 (2019) 052005 ATLAS PRD 101 (2020) 052013



#### Contino, Max, Mishra 2012.08537

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Can we improve reach on lower  $\Lambda_{\mathrm{IR}}$  ?

## **A zoo of Future Proposed Experiments**











# What did we find?



# What did we find?



### Conclusions

- Dark Sectors interacting with SM via irrelevant portals are very elusive.
- Current Experiments leave a lot of parameter space untouched for these elusive dark sectors.
- Future experiments dedicated for long lived particle searches will probe these dark sectors.



### Outlook

# How well do these model independent bounds do when imposed on particular motivated models?

### Outlook

How well do these model independent bounds do when imposed on particular motivated models?

- You have a model in mind and you want to see how our bounds do for you?
  - You have a future experiment for detecting Long Lived Particles up your sleeve and want us to include that?

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