Two-component scalar Dark Matter

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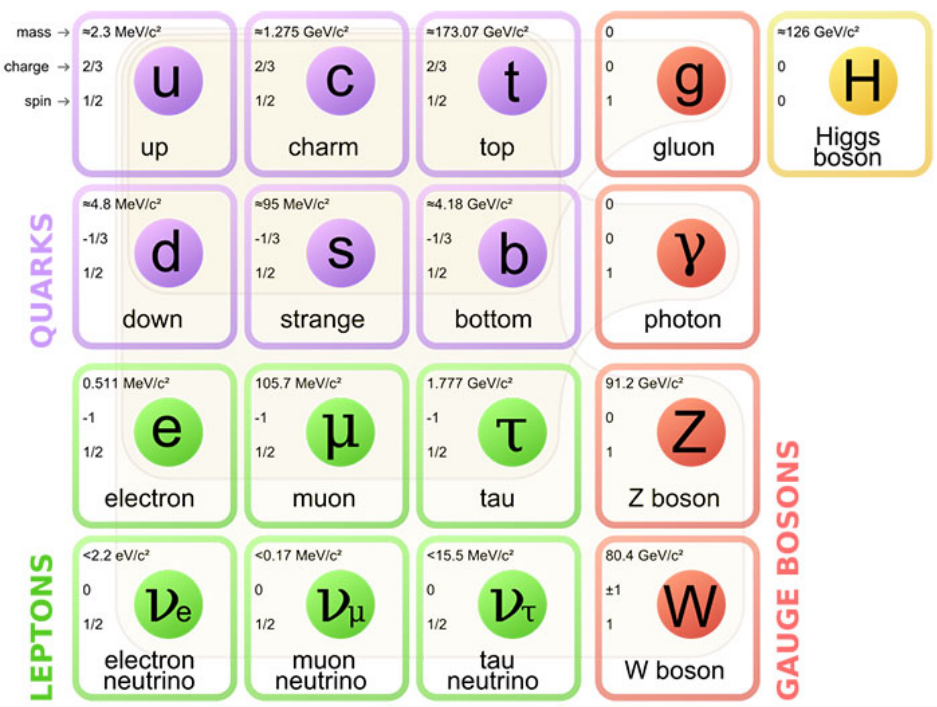
Introduction

The SM does not answer to:

- Why there is more matter than antimatter?
- Why do neutrinos have mass?
- **What is DM?**

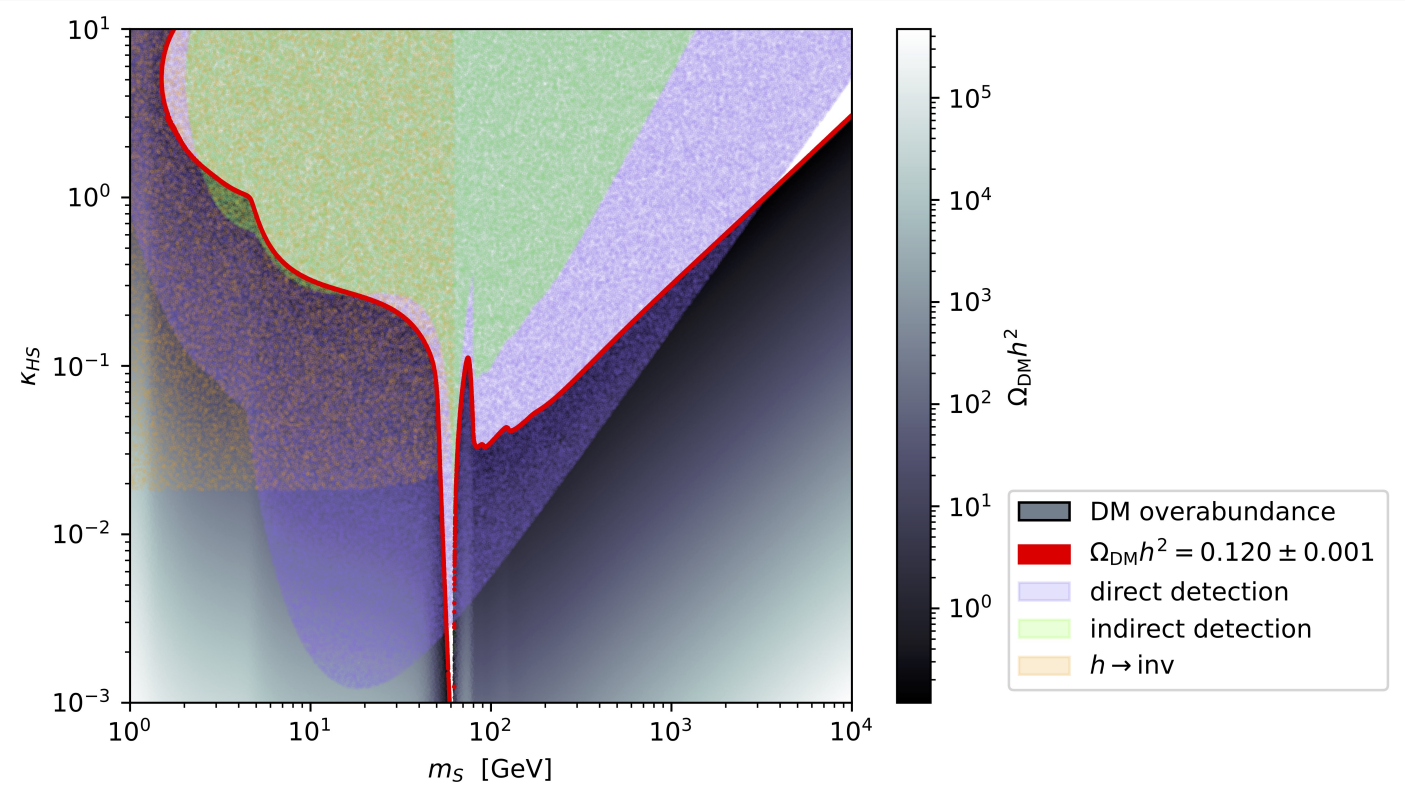


Simplest DM models:

- Higgs Portal models $\rightarrow$ Singlet Scalar model

Singlet Scalar Model

For a freeze-out DM candidate, the Singlet Scalar model (Dark-RxSM) is highly constrained, only allowed for masses starting at ≈ 3500 GeV or at the Higgs resonance region.



Two Singlets Scalar Model

The two singlets scalar model (Dark-TRSM) is an extension of the Standard Model, its lagrangian is given by,

$$\mathcal{L}_{\text{SM+Dark-TRSM}} = \mathcal{L}_{\text{SM}} + \frac{1}{2}(\partial_\mu S_1)\partial^\mu S_1 - \frac{1}{2}\mu_1^2 S_1^2 + \frac{1}{2}(\partial_\mu S_2)\partial^\mu S_2 - \frac{1}{2}\mu_2^2 S_2^2 - \frac{\lambda_1}{4!}S_1^4 - \frac{\lambda_2}{4!}S_2^4 \underbrace{-\frac{\lambda_{12}}{4}S_1^2 S_2^2}_{=\mathcal{L}_{\text{int}(1,2)}} \underbrace{-\frac{\kappa_{H1}}{2}S_1^2\Phi^\dagger\Phi}_{=\mathcal{L}_{\text{portal}(1)}} \underbrace{-\frac{\kappa_{H2}}{2}S_2^2\Phi^\dagger\Phi}_{=\mathcal{L}_{\text{portal}(2)}},$$

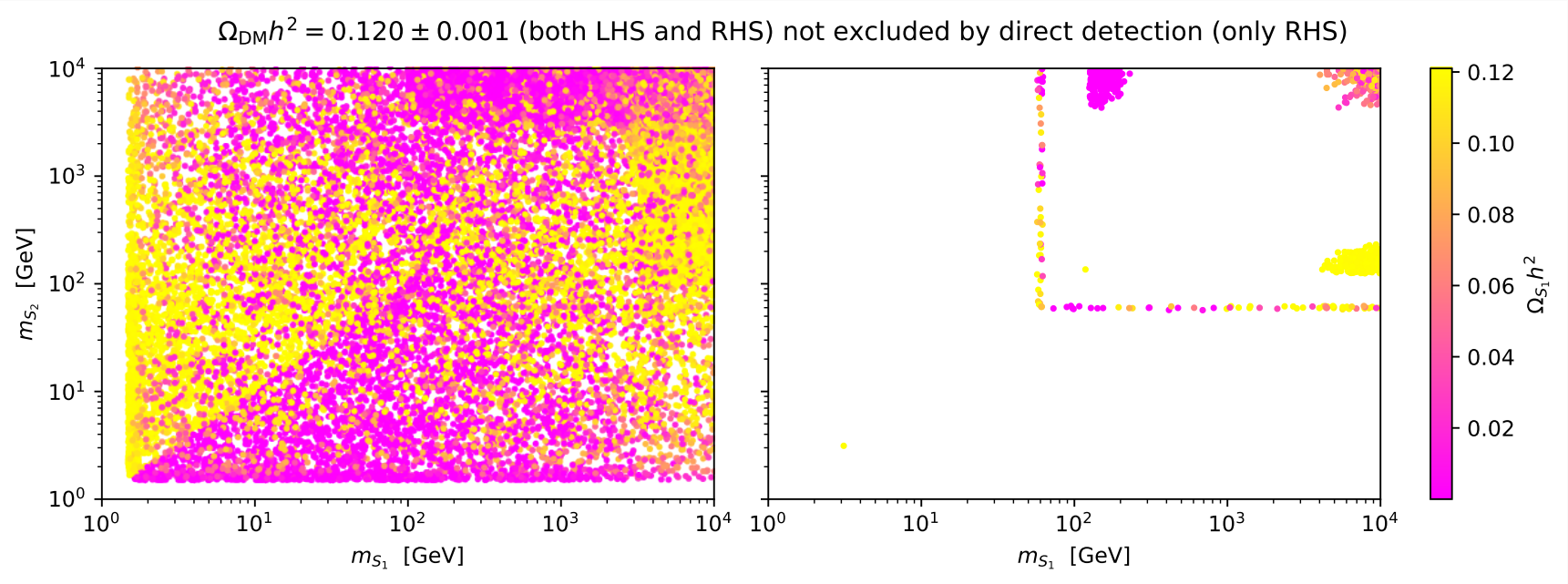
Each DM field has its own $\mathcal{Z}_2$ symmetry:
$\mathcal{Z}_2^{(1)} \times \mathcal{Z}_2^{(2)} : S_r(x) \to -S_r(x)$ ($r = 1$ or $r = 2$).

Both S_1 and S_2 do not acquire VEVs, *i.e.* $\langle 0 | S_{1,2} | 0 \rangle = 0$.

Two Singlets Scalar Model

Constrains:

1. Relic density
2. Direct detection



Two Singlets Scalar Model

Region allowed by DD:

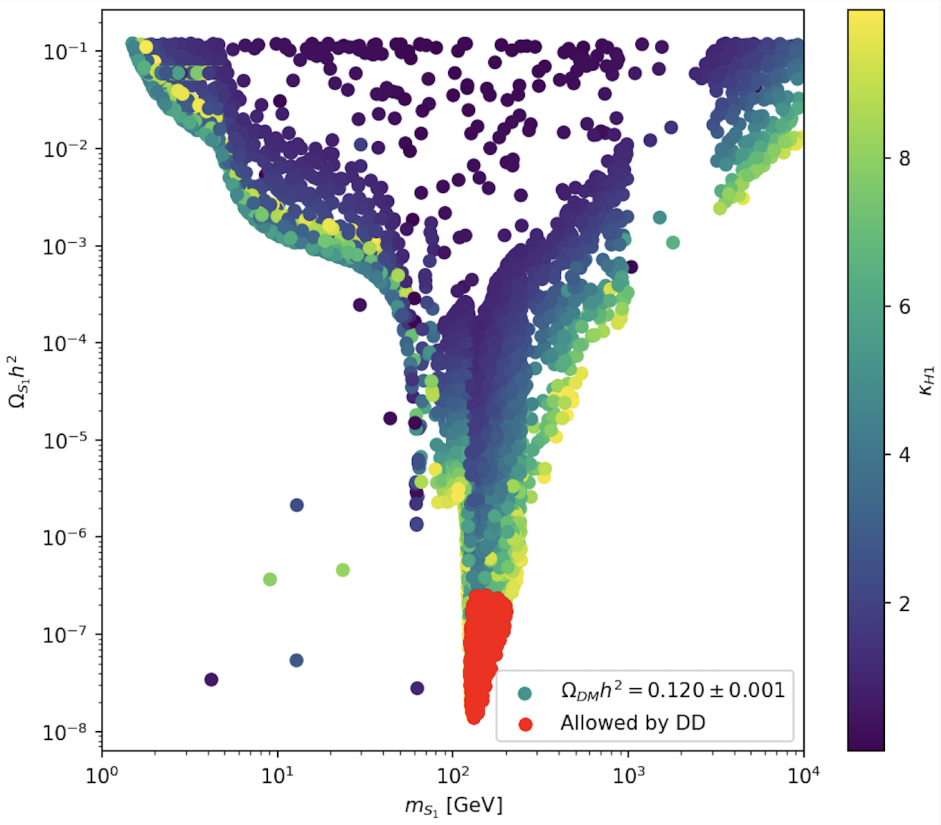
$m_{S_1} \in [124.8, 230.0]$ GeV

$m_{S_2} \in [4321.0, 9977.0]$ GeV

$\kappa_{H1} \in [4.066, 9.986]$

$\kappa_{H2} \in [1.321, 3.074]$

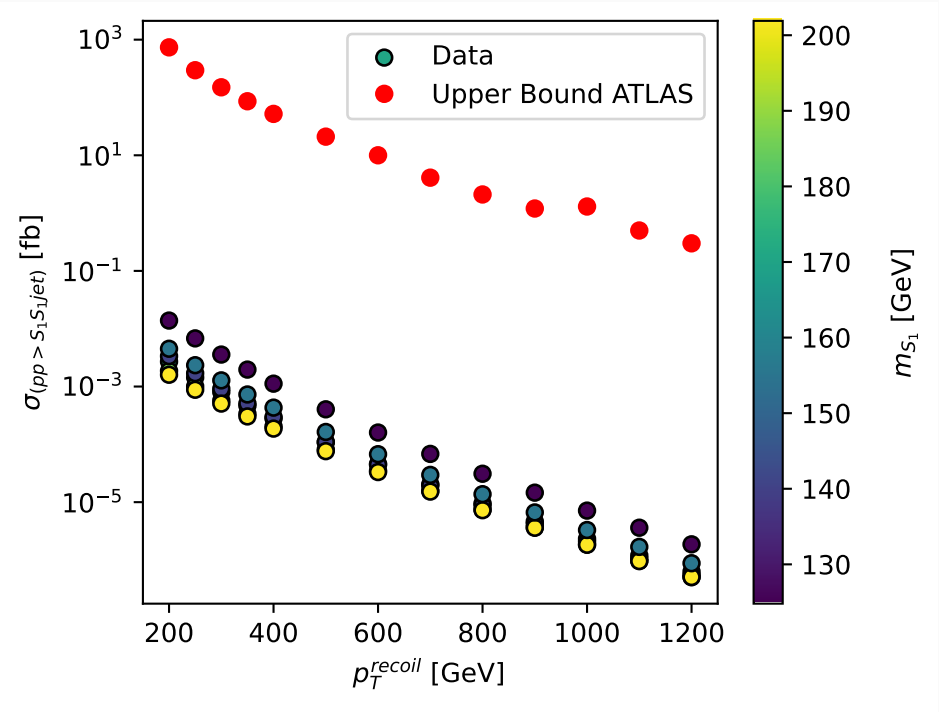
$\lambda_{12} \in [2.940 \times 10^{-6}, 0.7093]$



Two Singlets Scalar Model

Monojet Searches:

- Points are allowed
- S_1 can be detected at colliders
- Detection of a lot of MET



Final Remarks

- Dark-TRSM less constrained than Dark-RxSM
- S_1 difficult to detected by DD or ID
- S_1 visible at colliders
- S_2 cannot be visible at colliders (yet)
- Collider constraints on the Dark-TRSM may be important in the next LHC run

Thank you!