HIGH-ENERGY ASTROPHYSICS IN THE MULTI-MESSENGER ERA

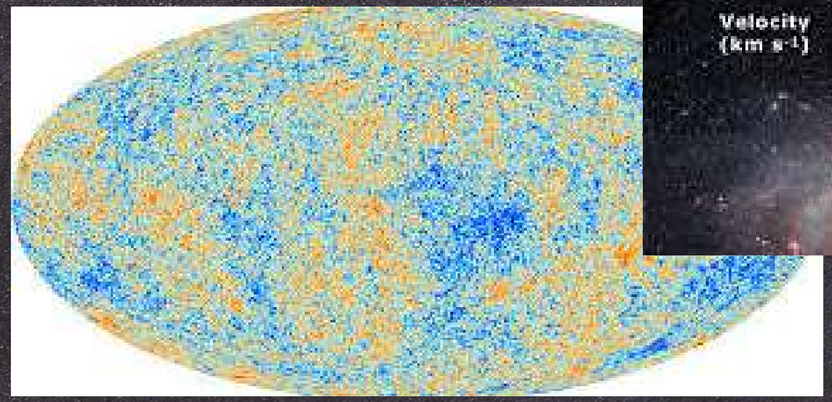
NEW AVENUES FOR DM PARTICLES

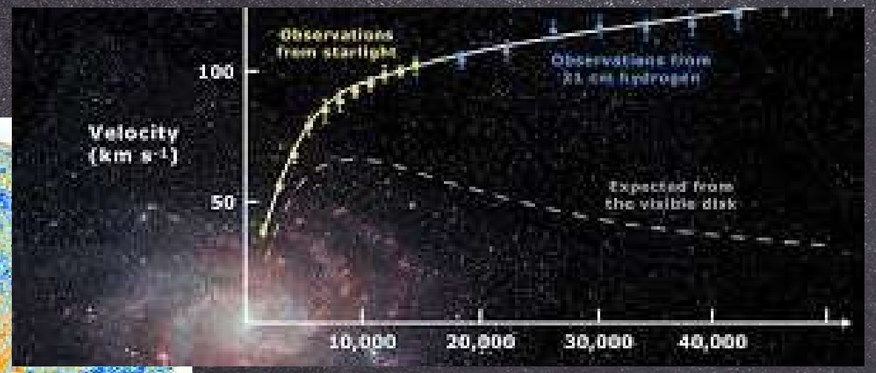
CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

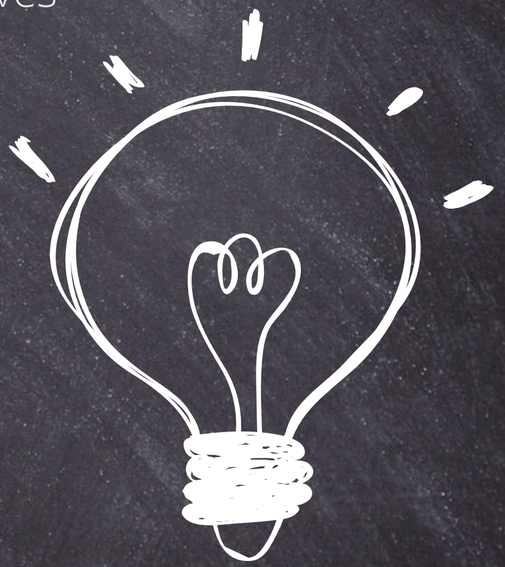
INTRODUCTION

CMB

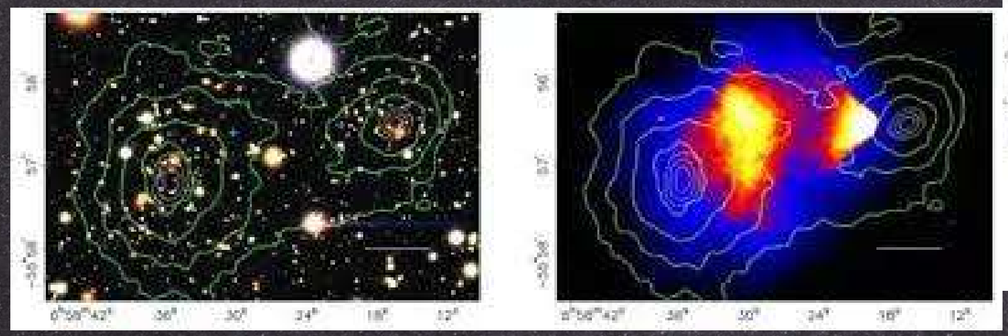


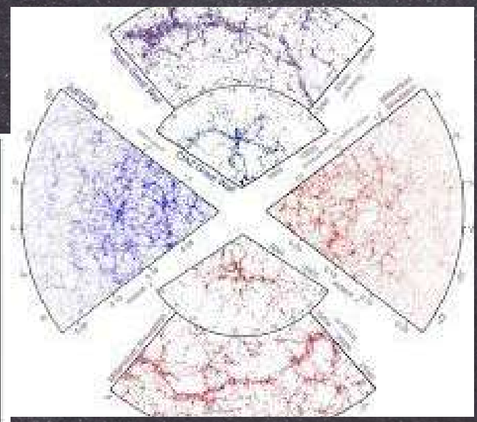


Galaxy rotation curves



Bullet Cluster





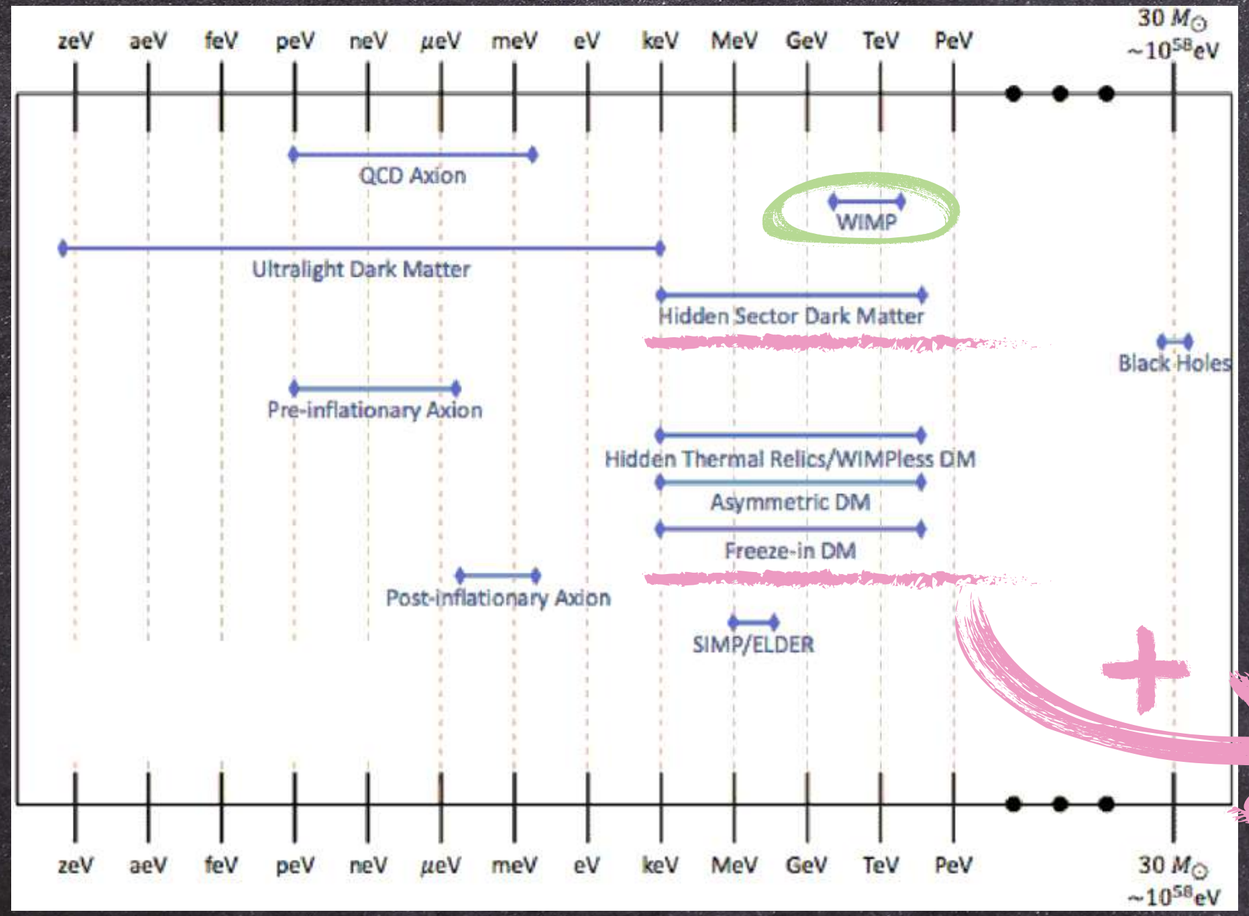
Structure Formation

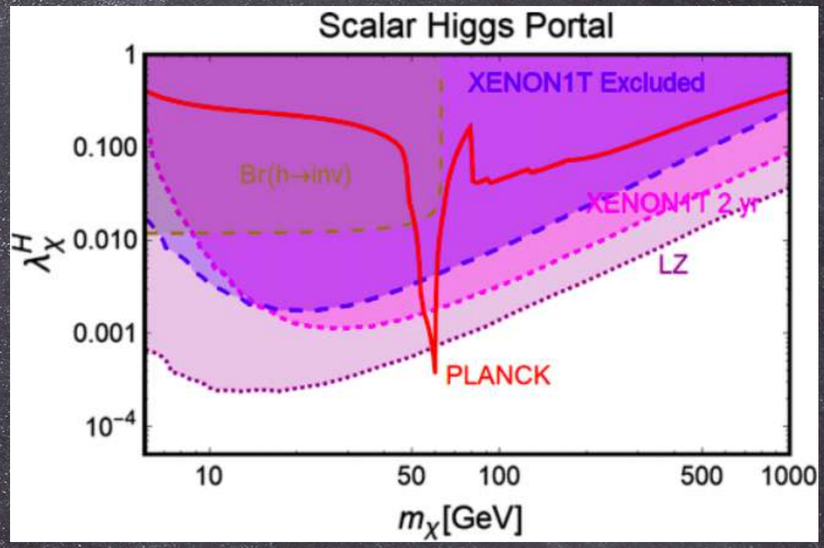
WIMPS: WEAKLY INTERACTING MASSIVE PARTICLES

CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

ALTERNATIVE CANDIDATES



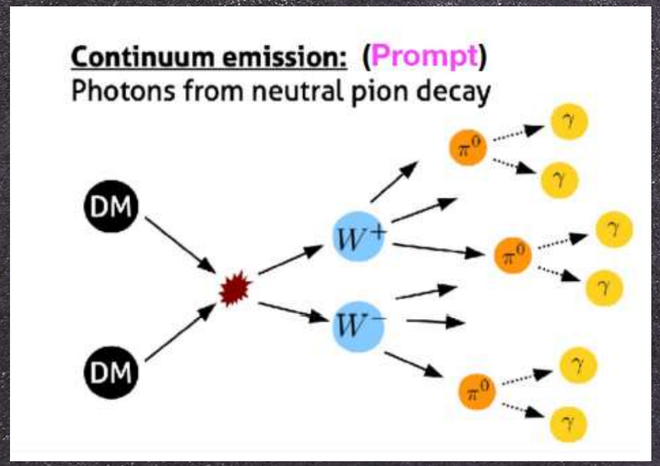


STRINGENT LIMITS ON WIMPS

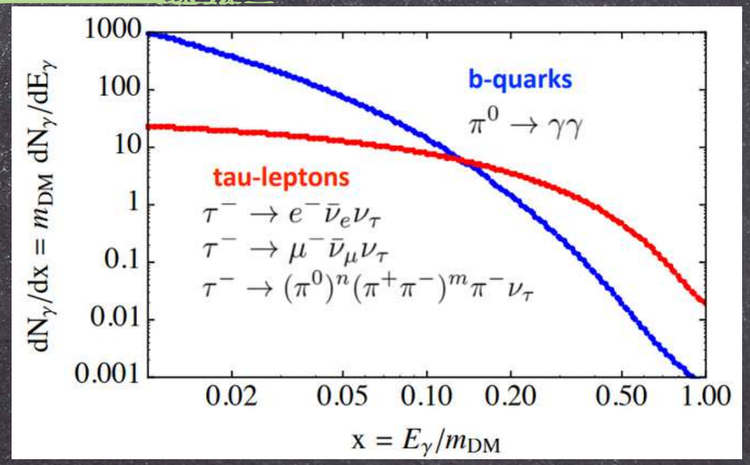
+

NON-STANDARD COSMOLOGY?

BRIEF REVIEW ON INDIRECT DETECTION SEARCHES

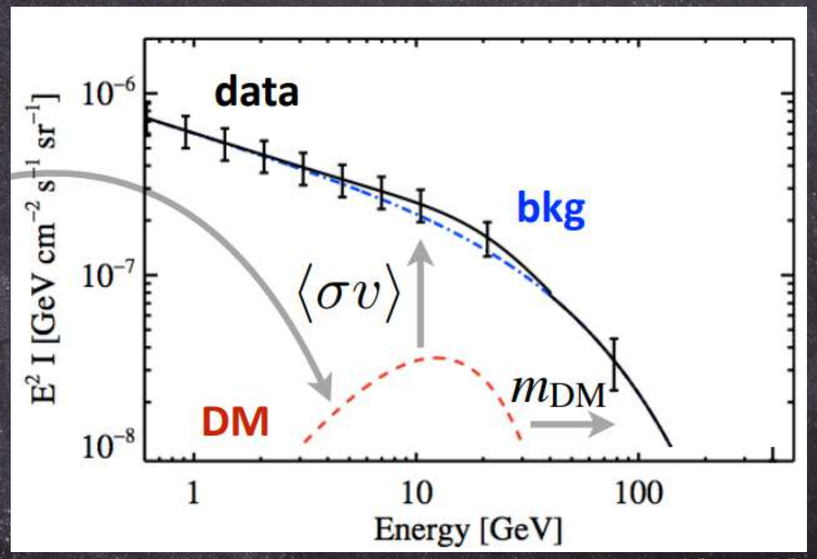


SPECTRUM



Particle Physics | J−Factor

$$\gamma\text{-ray Flux: } \frac{\varphi_\gamma}{dE} = \frac{\langle \sigma v \rangle}{8\pi m_{DM}^2} \frac{dN_\gamma}{dE} \int ds \int d\Omega\, \rho_{DM}^2$$

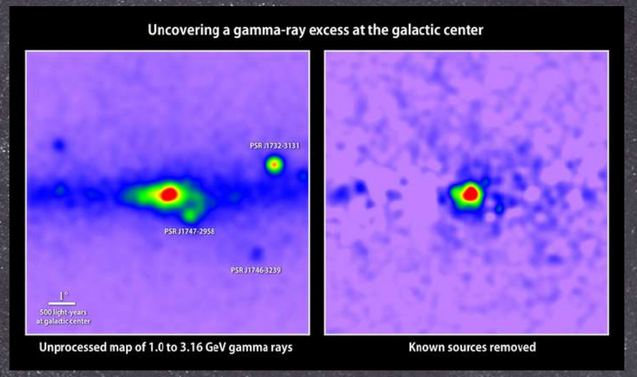


Source: https://www.trlinden.com/talks/mainz2016.pdf

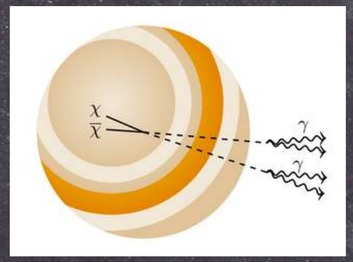
HIDDEN SECTORS

VISIBLE SECTOR — MEDIATOR — DARK SECTOR

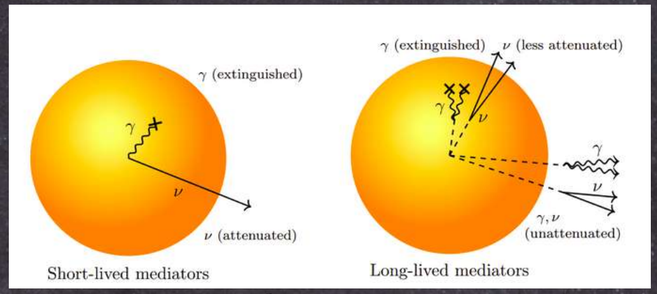
- AVOID CONSTRAINTS FROM DIRECT AND COLLIDER SEARCHES
- PROVIDE INTERESTING INDIRECT SIGNATURES



Picture from: Tim Linden



Picture from: 2104.02068



Picture from: 1703.04629

CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

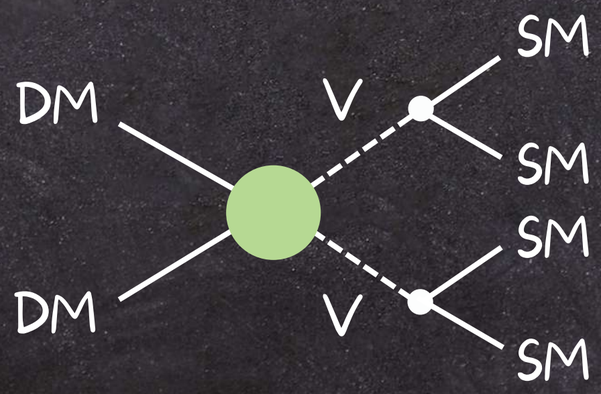
HIDDEN SECTORS

FORTES, VIANA, QUEIROZ, CS. SUBMITTED TO JCAP, 23.

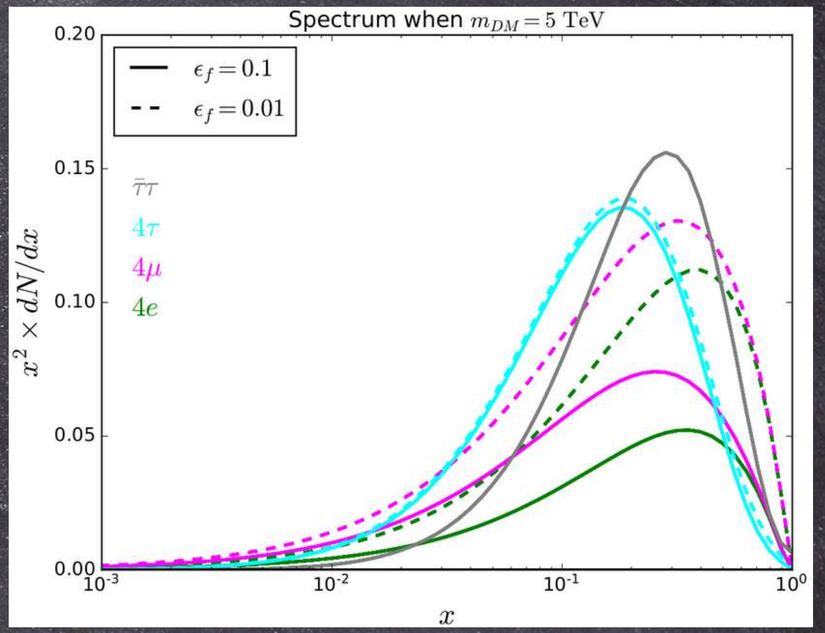
1 TeV Gamma-rays at the Galactic Center (GC):
$r < 1^\circ$ for HESS and CTA;
$r < 10^\circ$ for SWGO (Excluding $|b| < 0.3^\circ$).

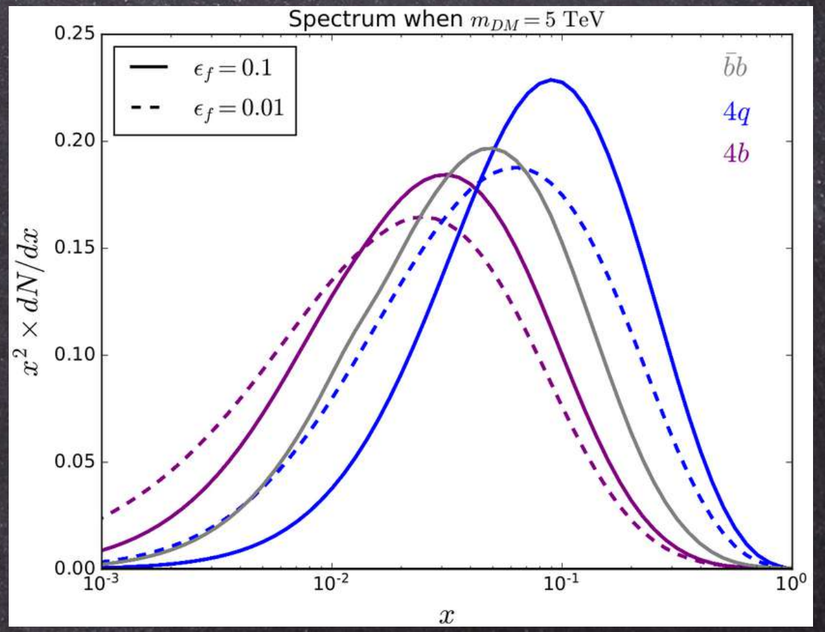
$$\varepsilon_f = \frac{2m_f}{m_V}$$

2 Model-independent analysis:
Channels: $V \to 4e$, $V \to 4\mu$, $V \to 4\tau$, $V \to 4q$, and $V \to 4b$.



3 We built the spectrum for all channels.



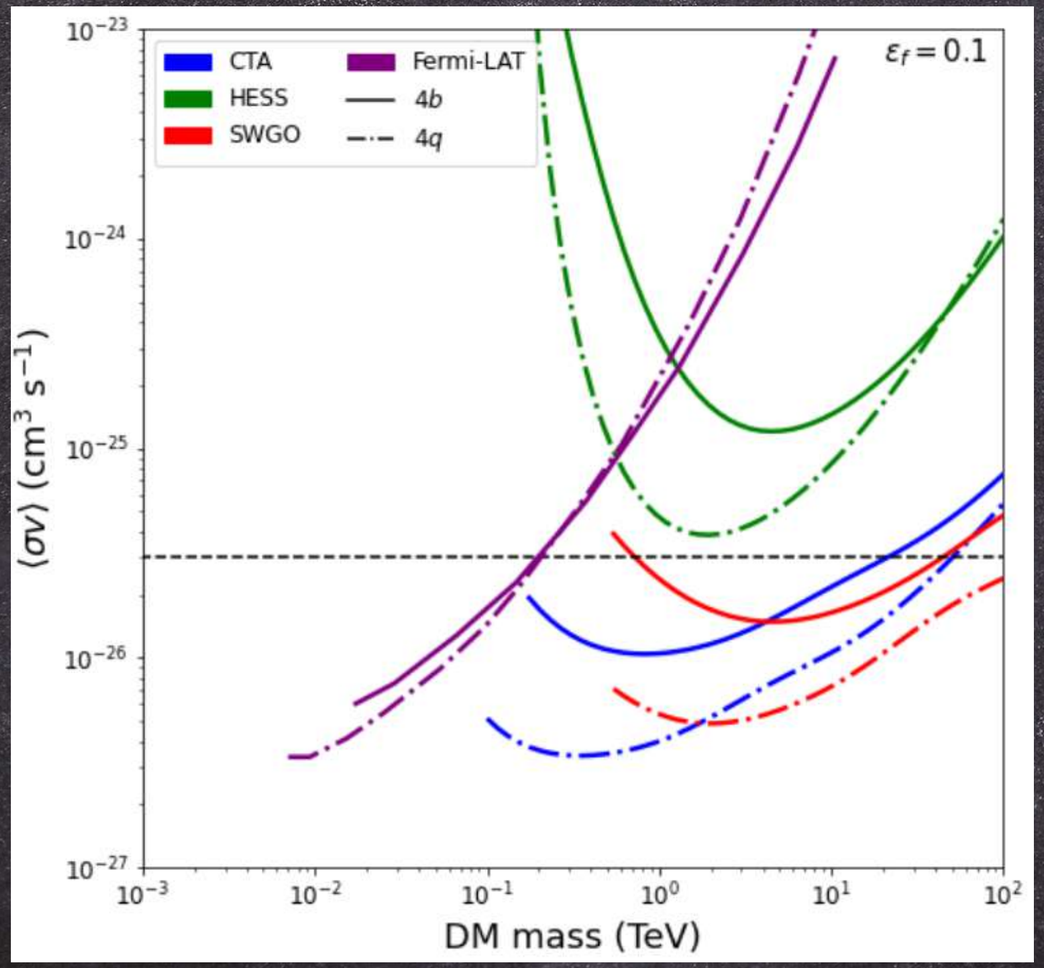


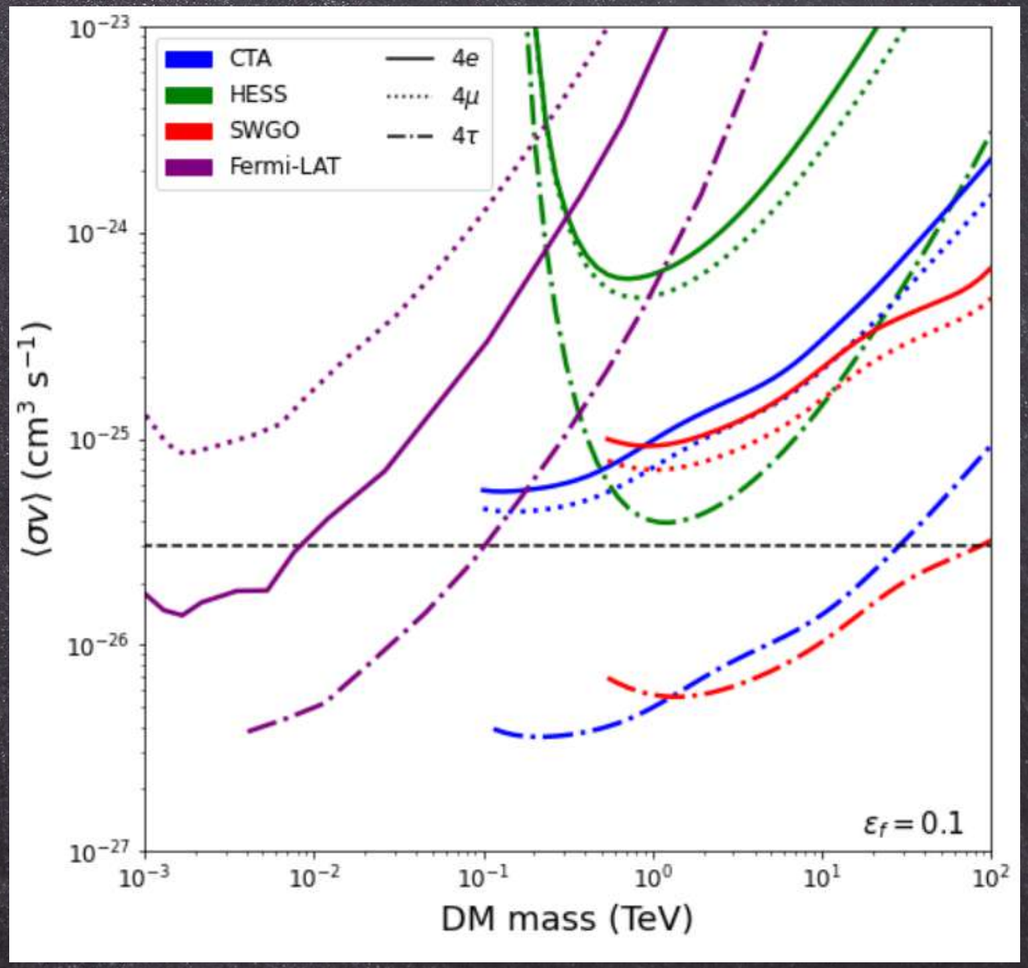
CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

RESULTS

- Binned 2D joint-likelihood analysis;
- H.E.S.S. (current, 254h) and SWGO and CTA (prospects, 10 years and 500h, respectively).





SOME IDEAS AND SKILLS

I AM A PARTICLE PHYSICIST WORKING ON ASTROPHYSICAL THINGS, SO:

SOME POSSIBLE WORKS

- Looking for realizations of the secluded models from the particle physics point of view;
- Working on some alternatives to the DM production like Freeze-in;
- Explore non-standard cosmology combined with Freeze-in...

SKILLS

- Sarah/Spheno;
- Micromegas;
- Pythia/PPPC4DMID;
- GamLike package;
- Gammapy (starting)

LET'S PLAY!

CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

CONCLUSION

- We saw that although highly studied and well-motivated, we didn't get any signals from WIMPs until now;
- At this time, looking for alternative scenarios is mandatory;
- Hidden sectors provide an exciting way to escape from the current stringent limits;
- We built the sensitivity of HESS, CTA, and SWGO for these models, showing that they will cover a sizeable fraction of the parameter space.

HIGH-ENERGY ASTROPHYSICS IN THE MULTI-MESSENGER ERA

THANK YOU!!

CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

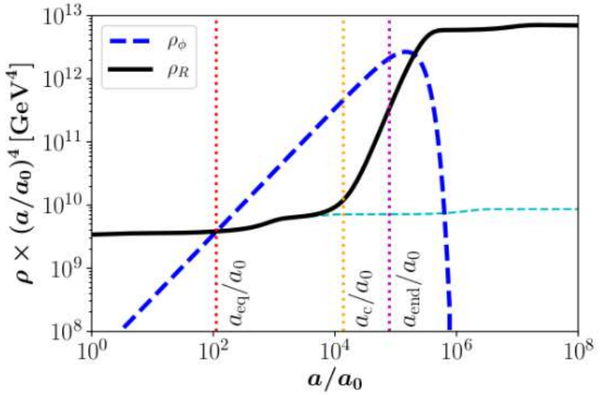
HIGH-ENERGY ASTROPHYSICS IN THE MULTI-MESSENGER ERA

BACKUP SLIDES

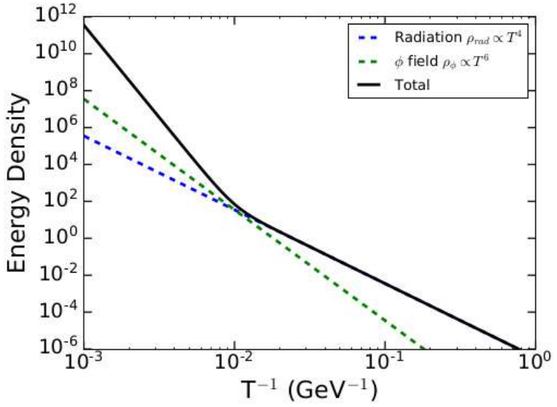
CLARISSA SIQUEIRA - IFSC/USP

MAY 2023

Matter Domination



Fast Expanding



The new relic density:

$$Y_{obs} = \frac{Y_0}{D}$$

with,

$$D = \frac{S(T_{end})}{S(T_{eq})}$$

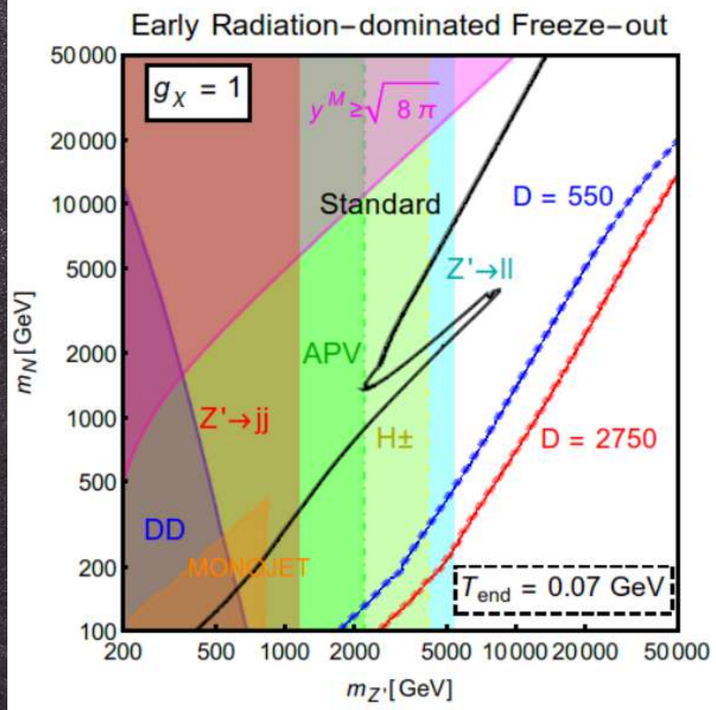
Relic density altered:

$$\uparrow H \rightarrow \uparrow \Gamma \rightarrow \uparrow \langle \sigma v \rangle$$

and,

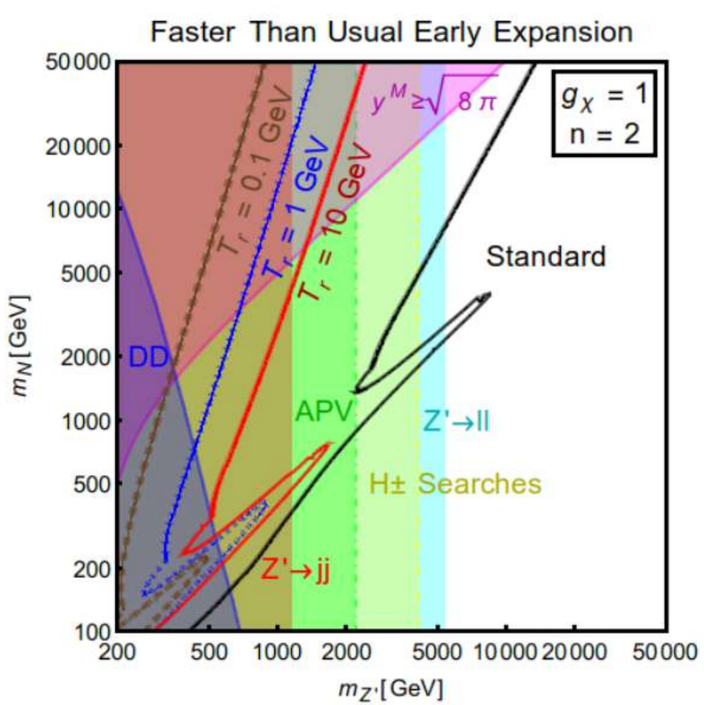
$$Y_\chi(x) \simeq \frac{x_r}{m_\chi M_{Pl} \langle \sigma v \rangle} \left[\frac{2}{x_f} + \log(x/x_f) \right]^{-1}$$

Matter Domination

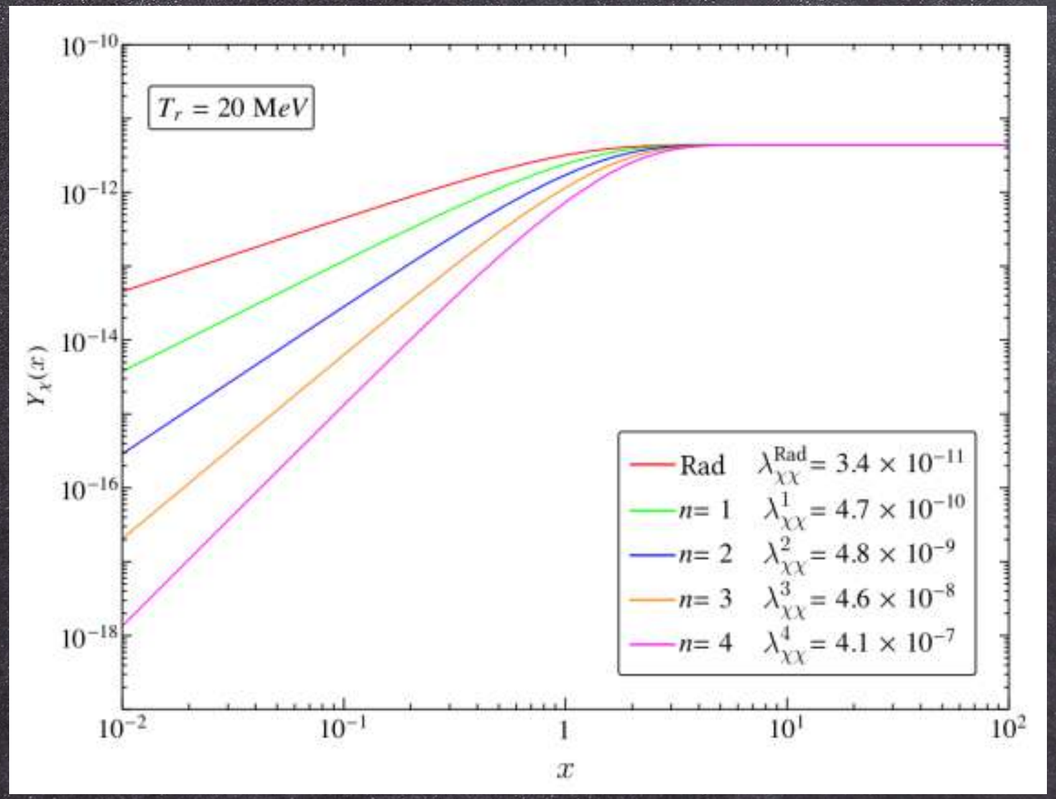


Arcadi, Profumo, Queiroz, CS. JCAP, 20.

Fast Expanding



Arcadi, Queiroz, Silva, CS. PRD, 22.


T_r = 20 MeV
$Y_\chi(x)$
x
10^{-10}
10^{-12}
10^{-14}
10^{-16}
10^{-18}
10^{-2}
10^{-1}
1
10^{1}
10^{2}
Rad $\lambda_{\chi\chi}^{\mathrm{Rad}} = 3.4 \times 10^{-11}$
n= 1 $\lambda_{\chi\chi}^{1} = 4.7 \times 10^{-10}$
n= 2 $\lambda_{\chi\chi}^{2} = 4.8 \times 10^{-9}$
n= 3 $\lambda_{\chi\chi}^{3} = 4.6 \times 10^{-8}$
n= 4 $\lambda_{\chi\chi}^{4} = 4.1 \times 10^{-7}$