X-rays constraints on sub-GeV dark matter

Based on:

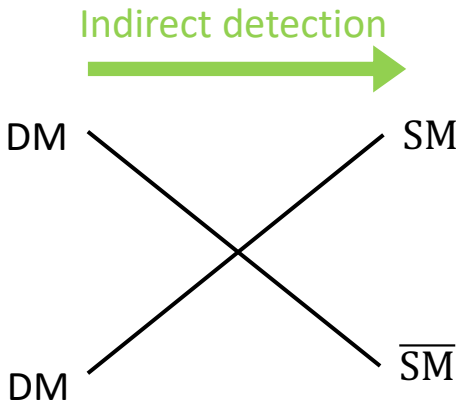
Cirelli, Fornengo, **JK**, Pinetti & Roach, *JCAP* '23 [arXiv:2303.08854]

Balaji, De La Torre Luque , **JK**, '23 [arXiv:2311.04979] (accepted to *ApJ)*

Jordan Koechler

LPTHE, Sorbonne University, Paris

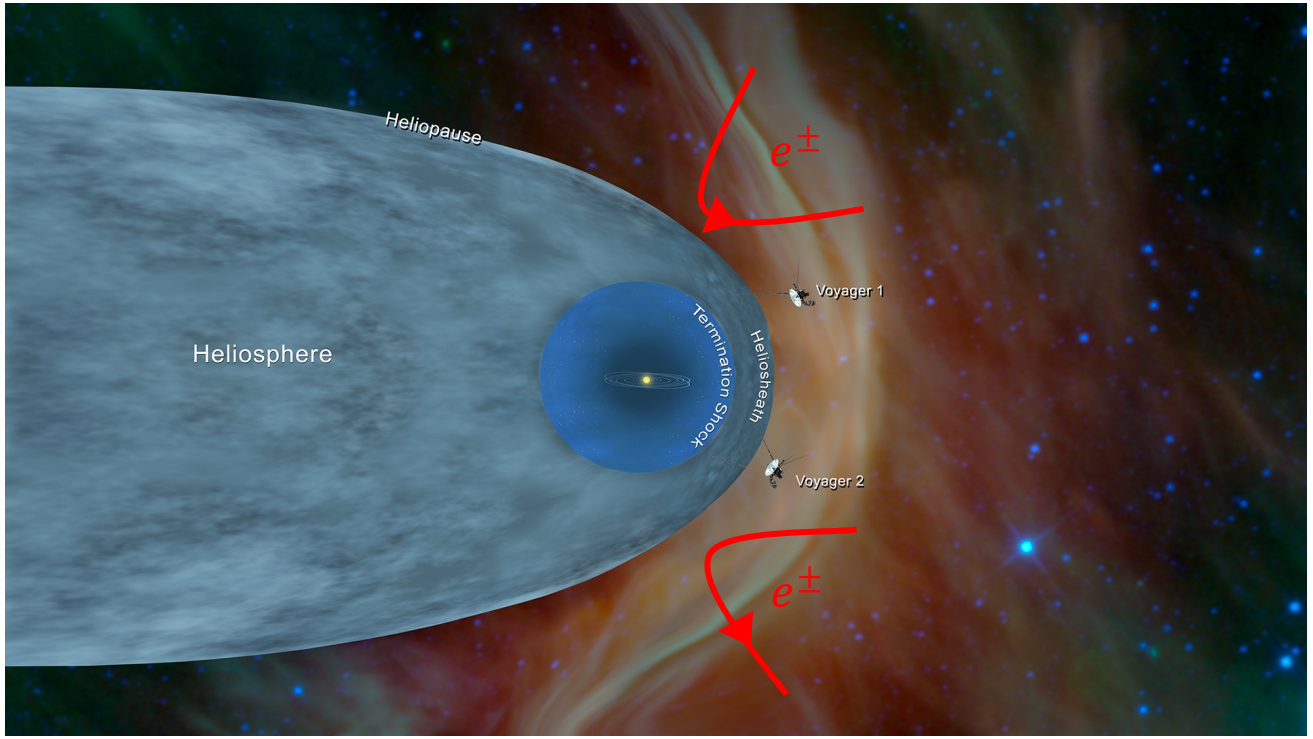
4th EuCAPT Symposium

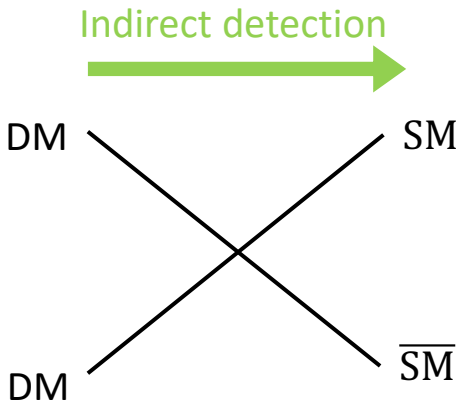


Main challenges for sub-GeV DM ID

- <u>Issue 1:</u> when DM produces $e^{\pm}$

  Solar screening suppresses the flux





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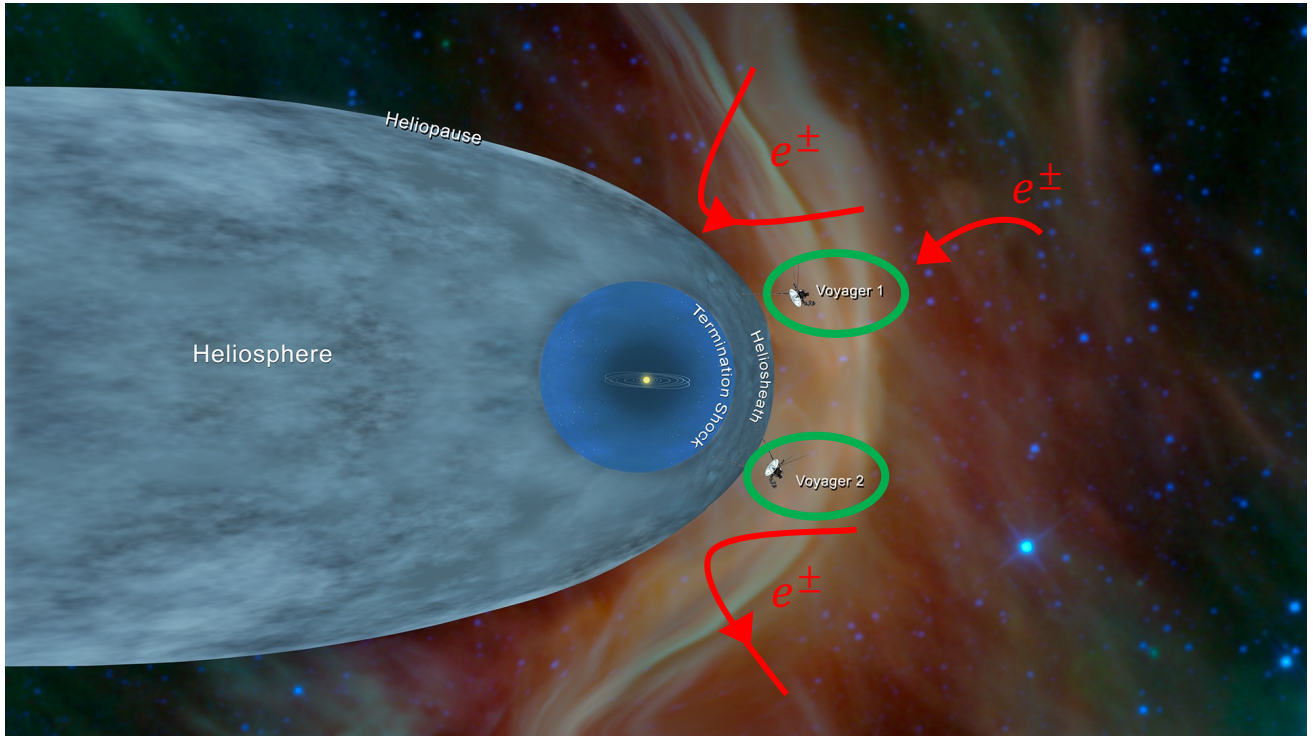
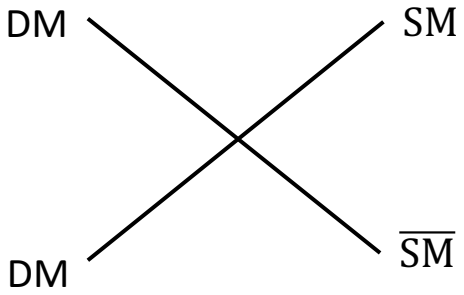


Indirect detection



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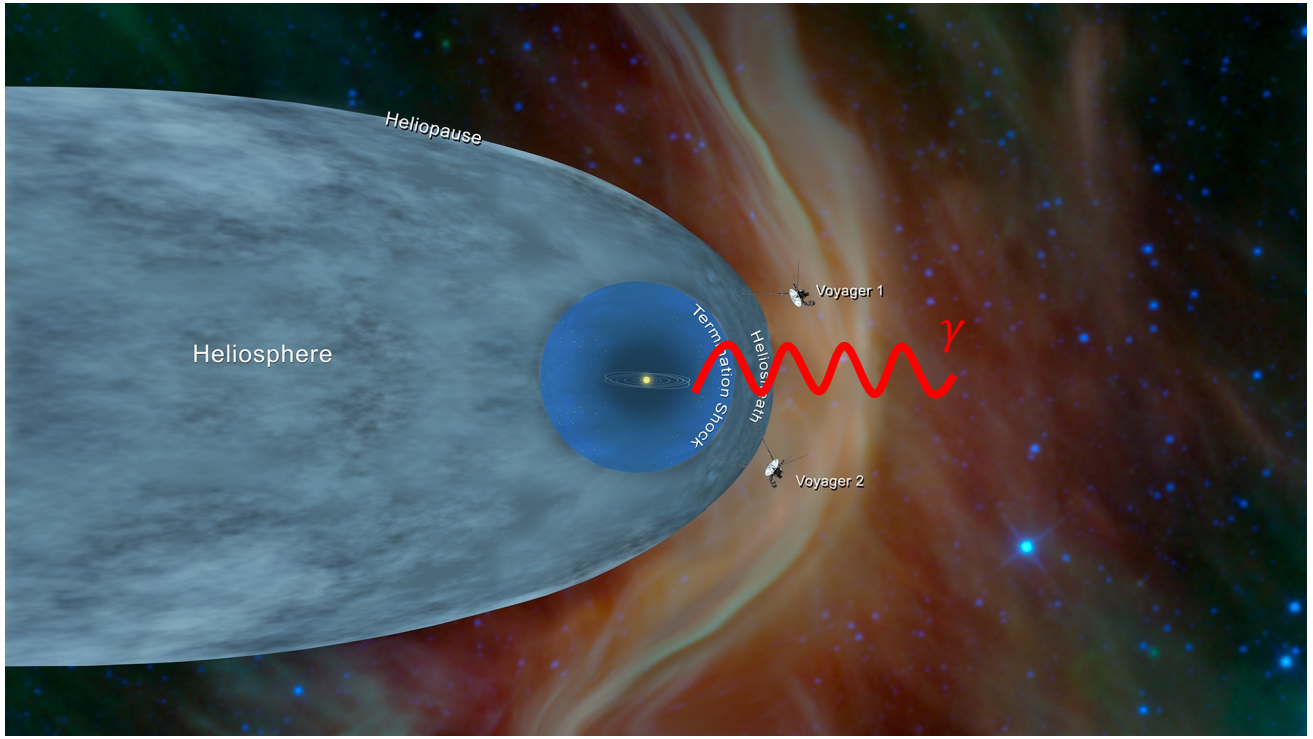
  - Look for DM-produced γ-rays



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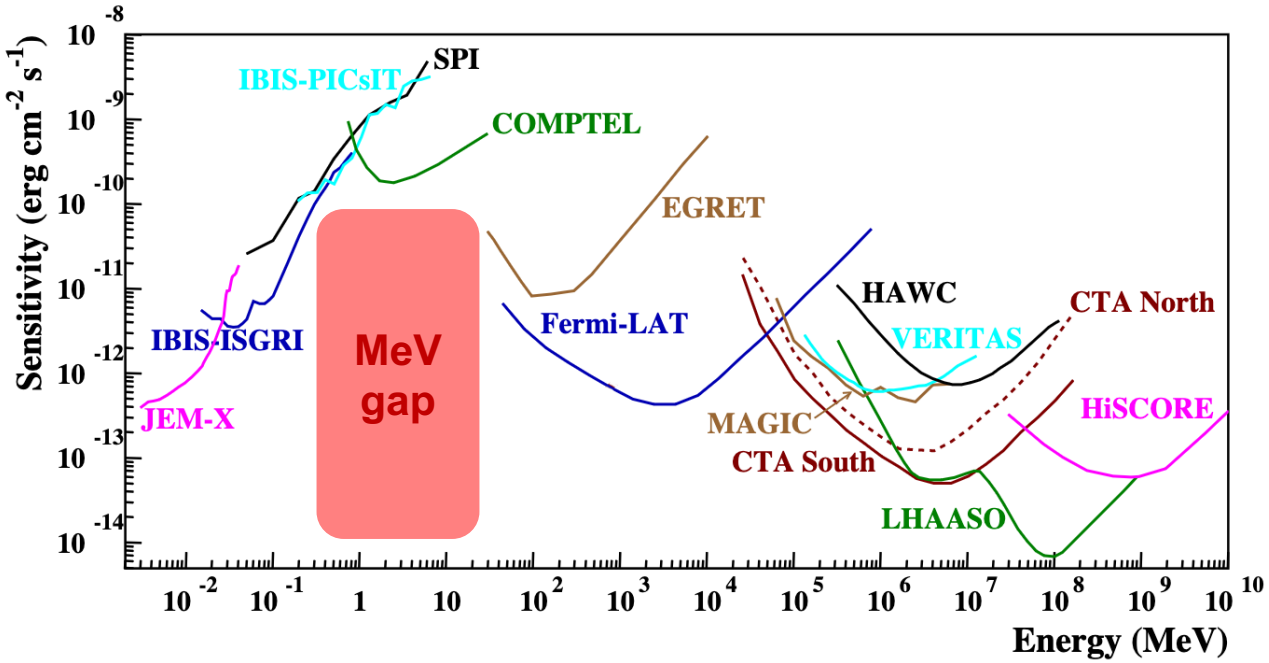

Adapted from eASTROGAM coll., *Exper.Astron.* '17 [arXiv:1611.02232]

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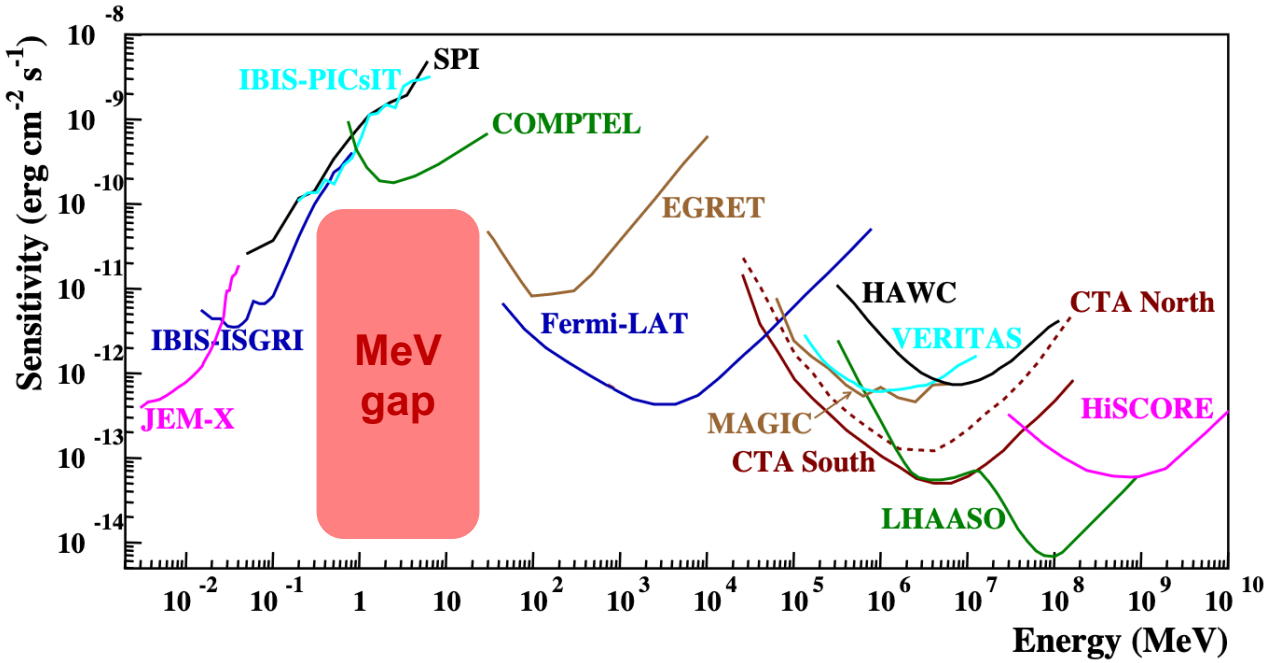
Cirelli et al., *Phys.Rev.D.* '21 [arXiv:2007.11493]



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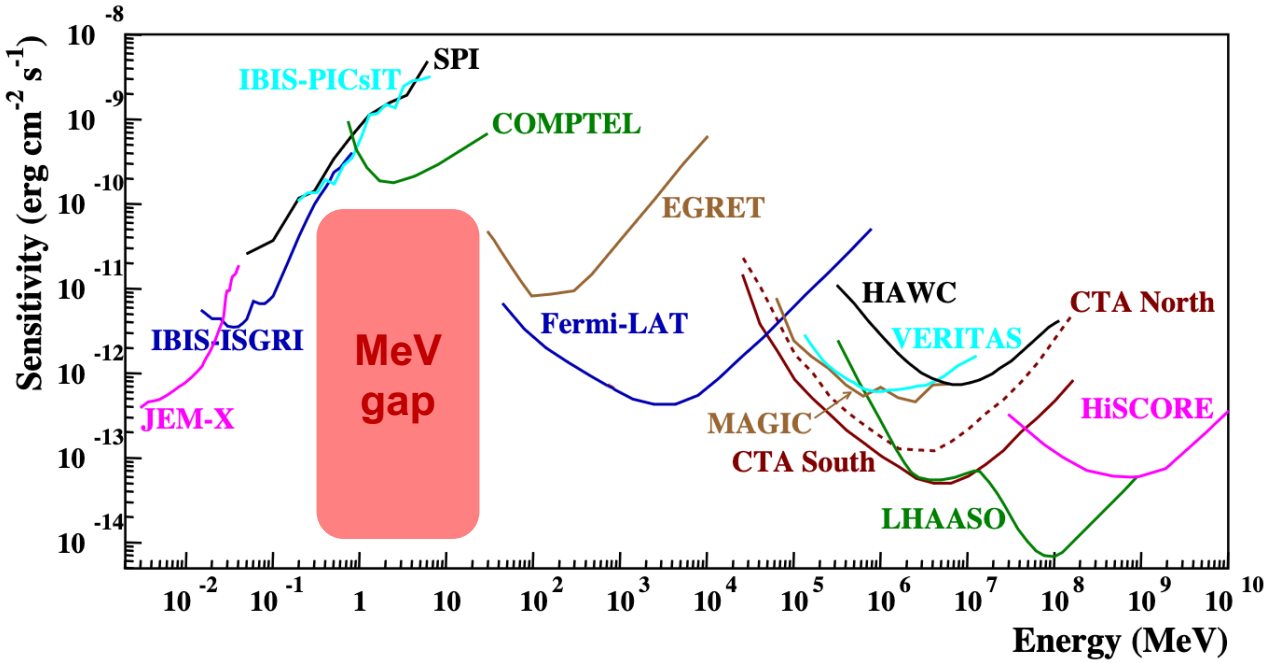
Inverse-Compton scattering!



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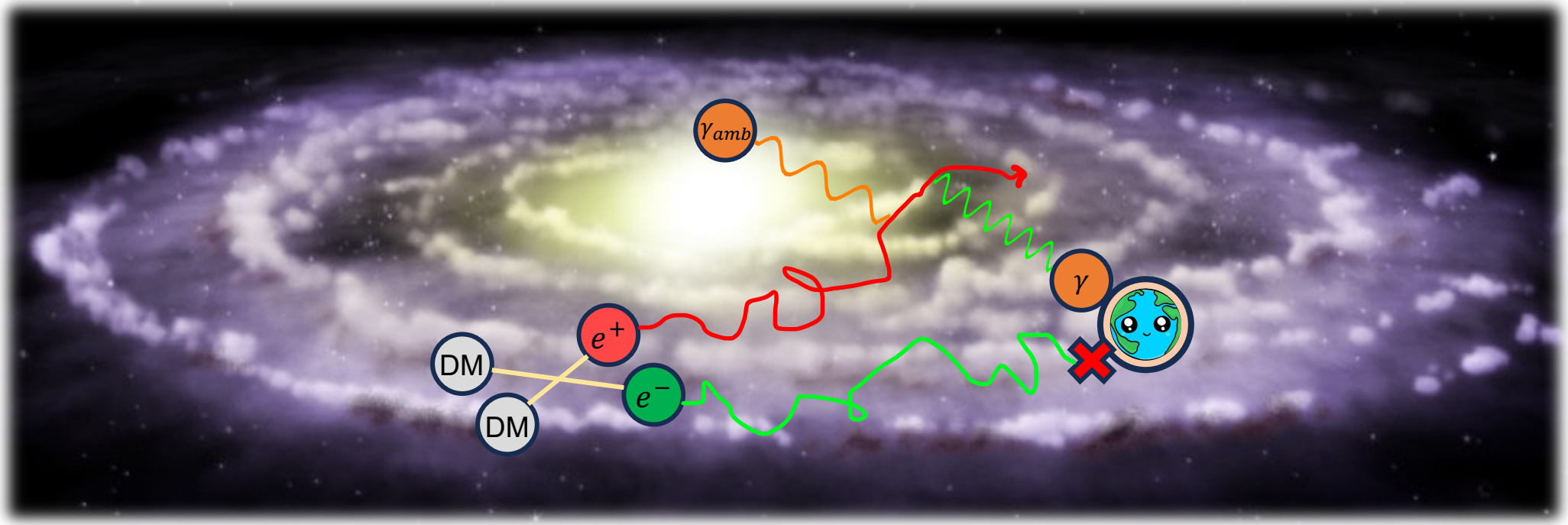
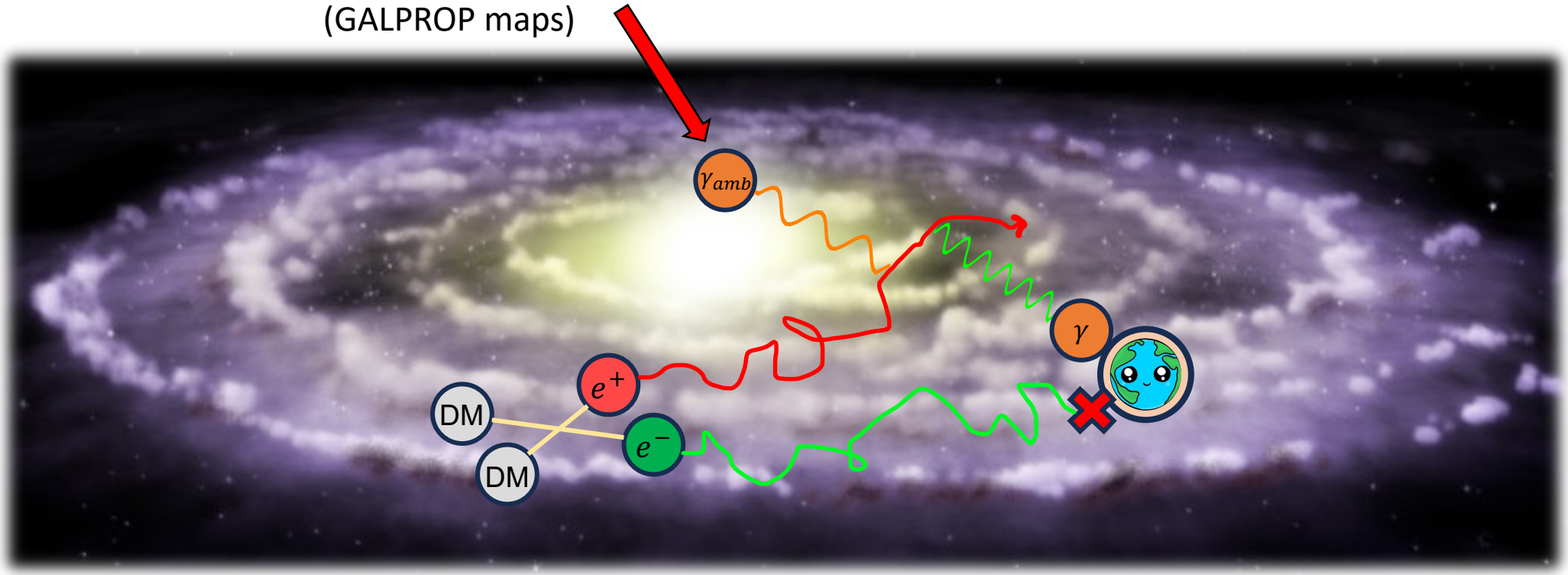
X-rays from sub-GeV DM



X-rays from sub-GeV DM

Local number density of ambient photons
(GALPROP maps)



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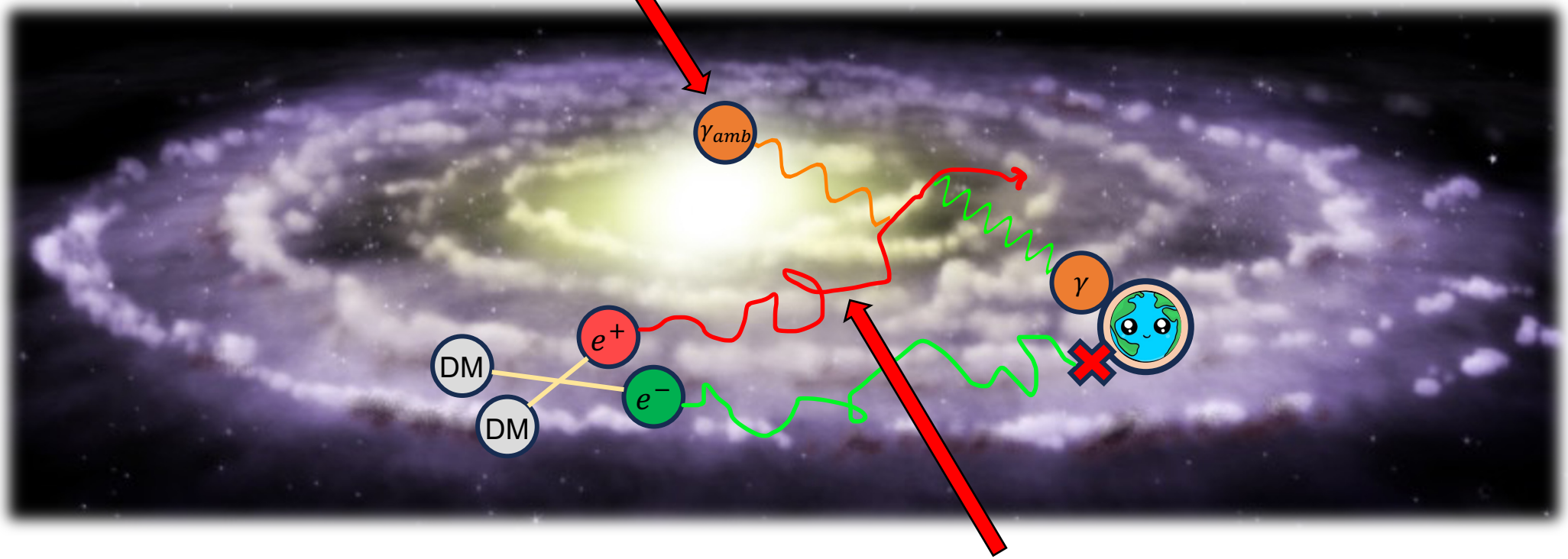
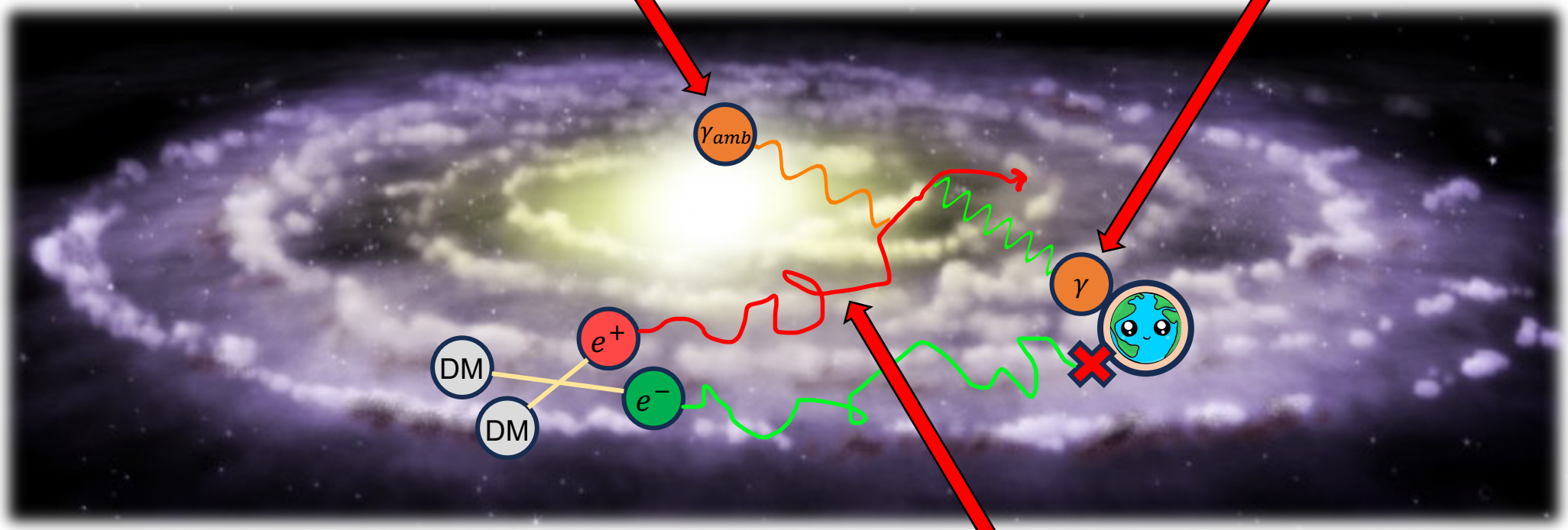


Propagation of DM-produced $e^{\pm}$ using DRAGON2

X-rays from sub-GeV DM

Local number density of ambient photons (GALPROP maps)

Get the X-rays flux from ICS! using HERMES



Propagation of DM-produced $e^{\pm}$ using DRAGON2

Analysis

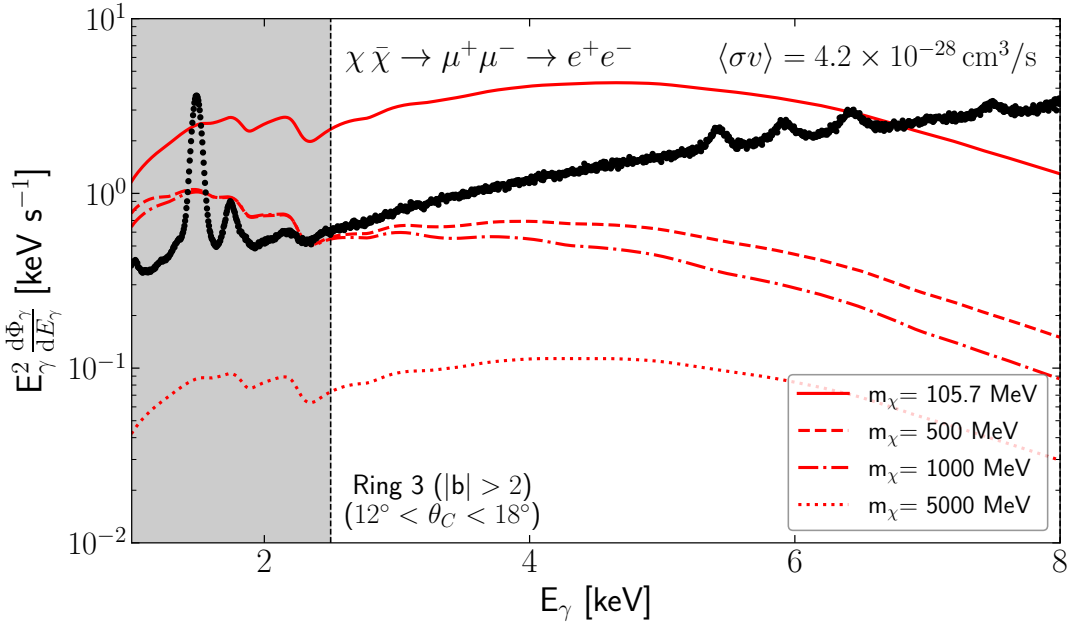
- In this study we keep a **conservative** approach:

$$\chi^2_{>}(p, m_{DM}) = \sum_{i \in \text{bins}} \frac{\text{Max}\left(\Phi_{DM\gamma,i}(p, m_{DM}) - \Phi_i, 0\right)^2}{\sigma_i^2}$$

$$p = \langle \sigma v \rangle \, , \Gamma$$

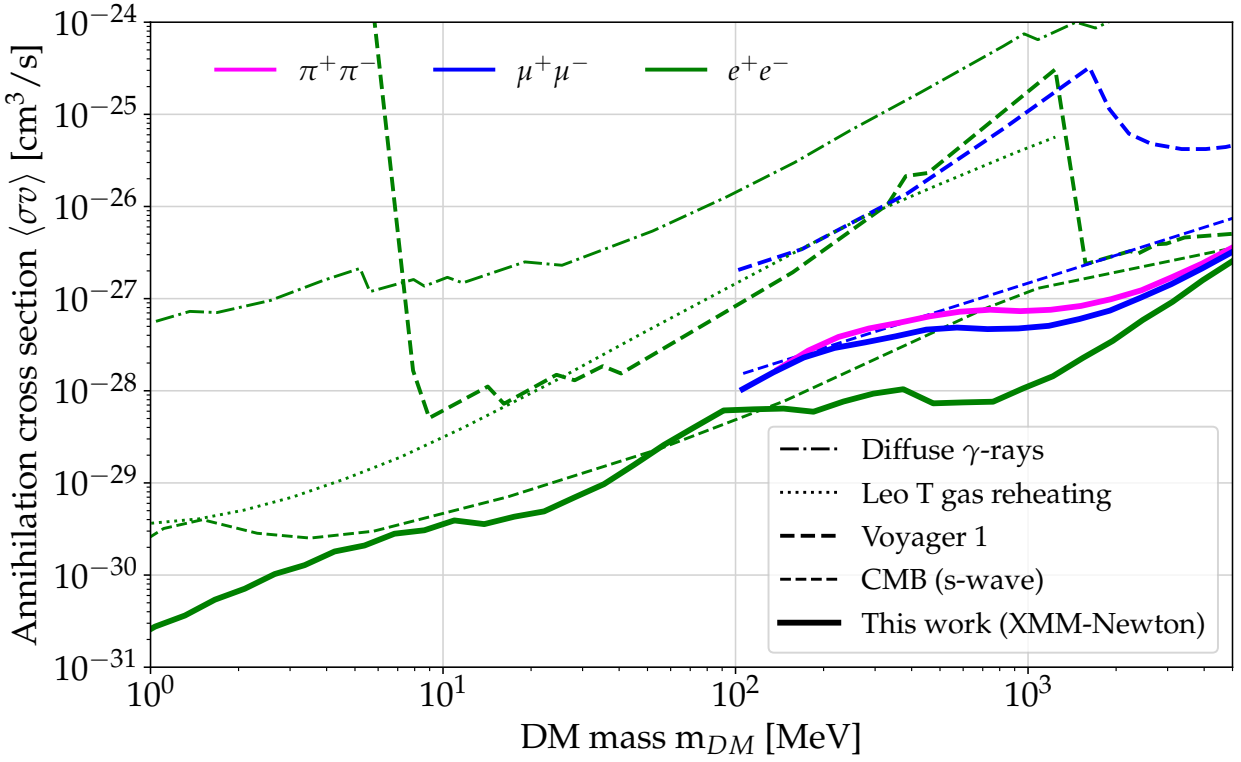
- Impose a (2σ) bound when $\chi^2_{>}(p, m_{DM}) \geq 4$

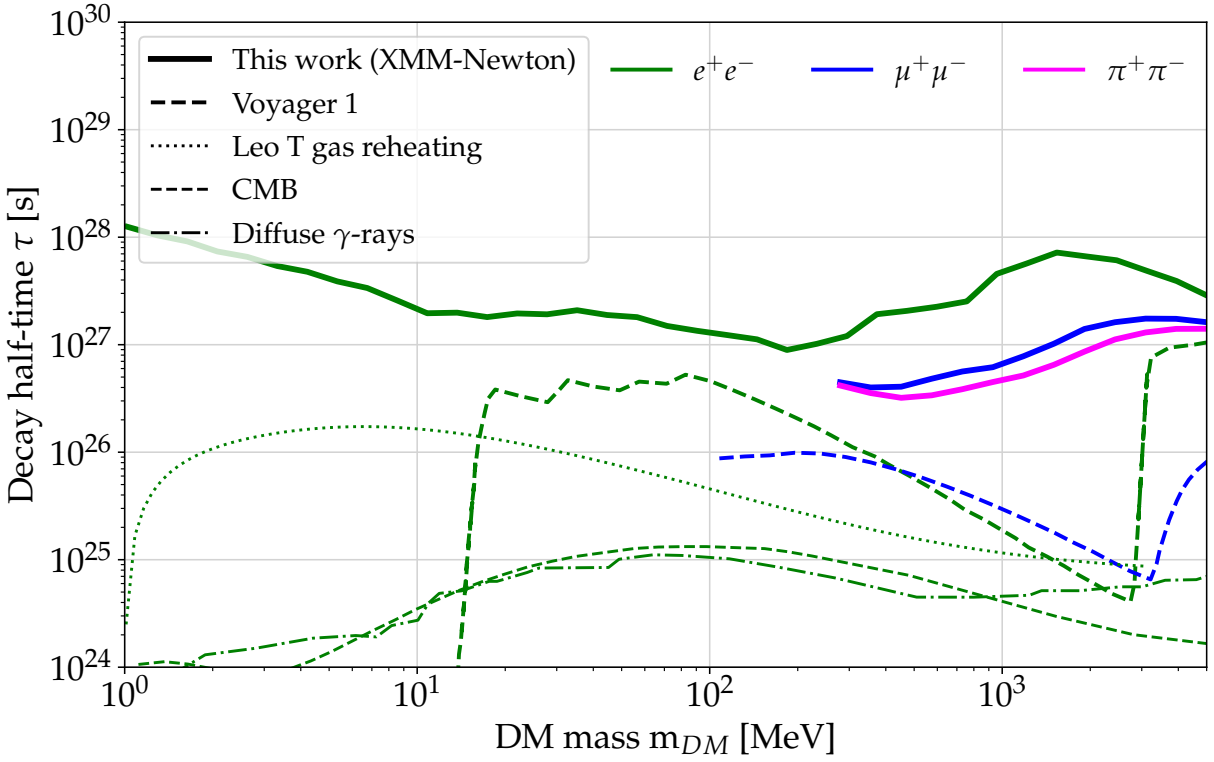
- Using XMM-Newton diffuse emission data



Results

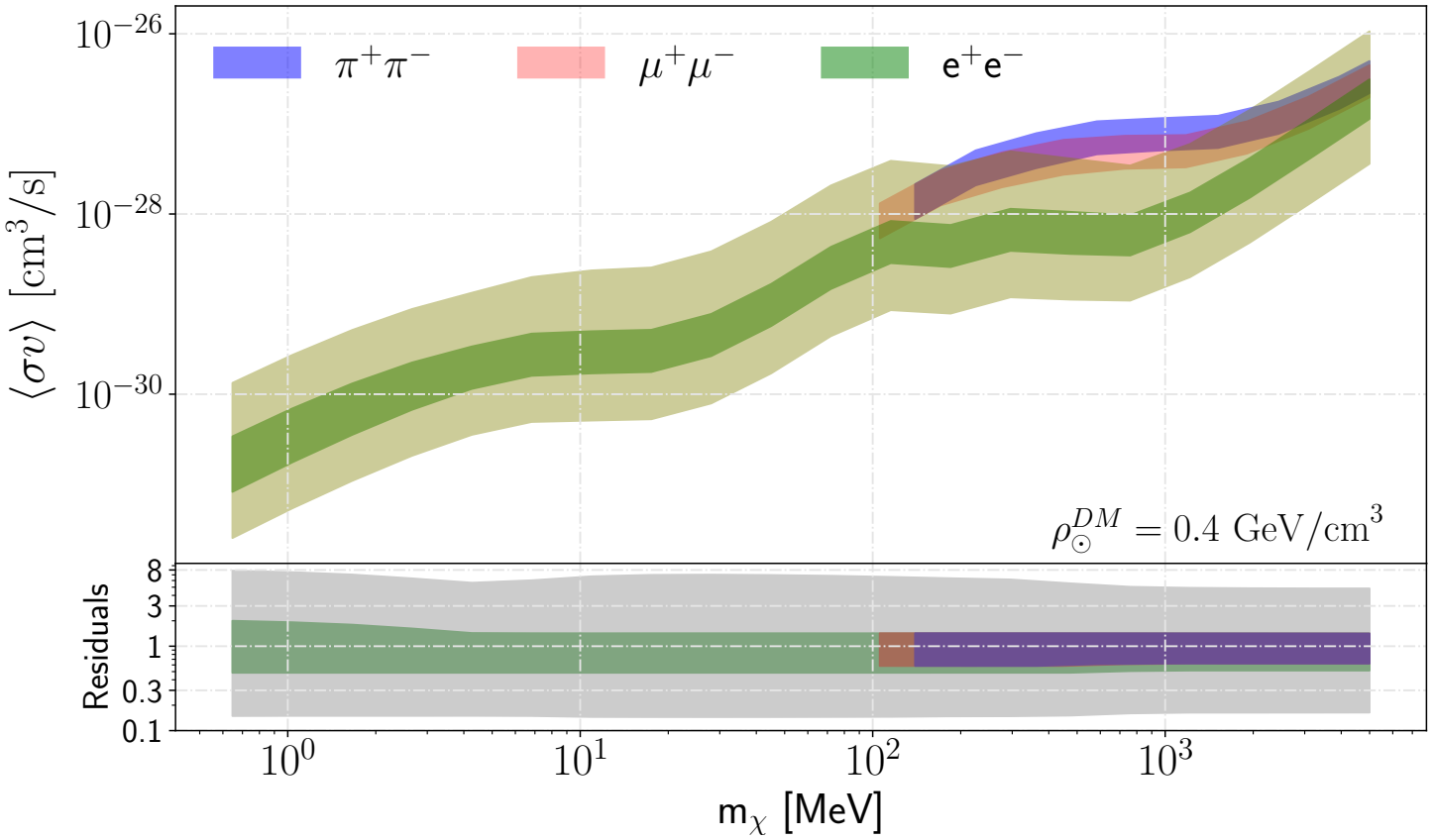
Diffuse γ-rays: Essig et al., *JHEP* '13 [arXiv:1309.4091]
Voyager 1: Boudaud et al., *Phys.Rev.Lett.* '17 [arXiv:1612.07698]
Leo T gas heating: Wakedar and Wang, *Phys.Rev.D* '22 [arXiv:2111.08025]
CMB: Slatyer, *Phys.Rev.D* '16 [arXiv:1506.03811]
Lopez-Honorez et al., *JCAP* '13 [arXiv:1303.5094]
Liu et al., *Phys.Rev.D* '16 [arXiv:1604.02457]





For $v_A = 13.4$ km/s

Results



Halo height	H	$8.00^{+2.35}_{-1.96}$ kpc
Norm. of Diffusion coeff.	D_0	$1.02^{+0.12}_{-0.10} \times 10^{29}$ cm^{2}s^{-1}
Norm. rigidity	R_0	4 GV
Diffusion spectral index	δ	0.49 ± 0.01
β exponent	η	$-0.75^{+0.06}_{-0.07}$
Alfvén velocity	v_A	$13.40^{+0.96}_{-1.02}$ km/s
Break rigidity	R_b	312 ± 31 GV
Index break	$\Delta\delta$	0.20 ± 0.03
Smooth. param.	s	0.04 ± 0.0015

DM profiles:

- NFW
- Burkert
- cNFW with $\gamma = 1.26$

Prospects

- Things to explore:
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  - Test BSM models that provide a light DM candidate:
    1) Injection spectra of $e^{\pm}$ from DM annihilation/decay channels
    2) Branching ratios
    3) Expression of $\langle \sigma v \rangle$ or Γ as a function of the couplings

Thank you for your attention!