Gamma-Ray and AntiMatter Survey (GRAMS) for antimatter detection

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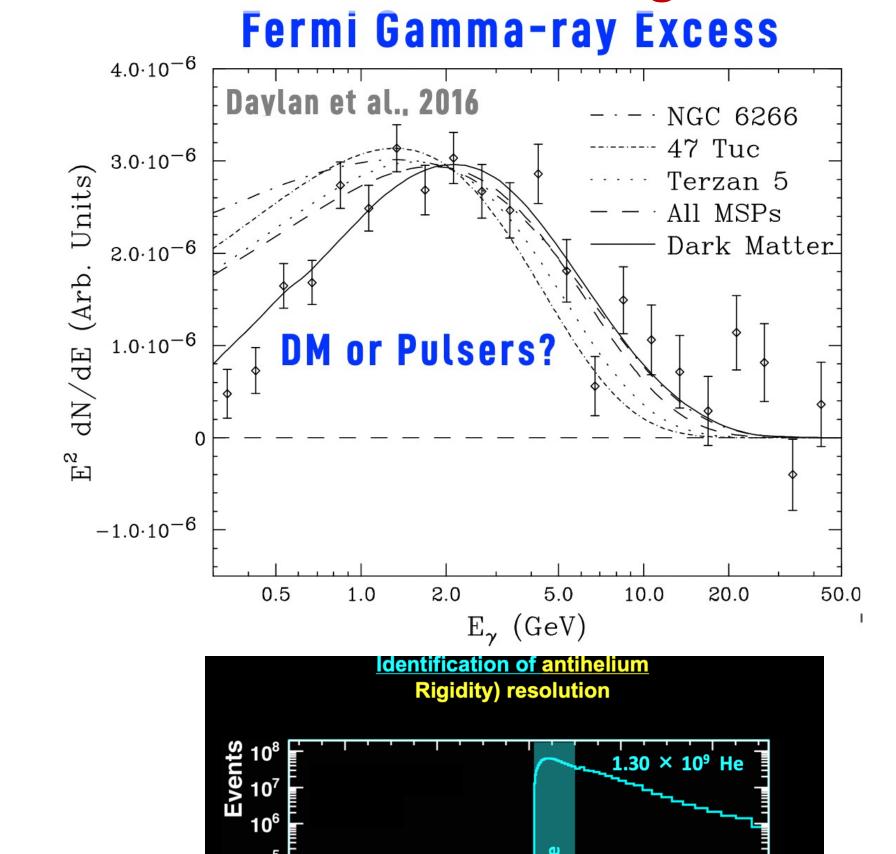
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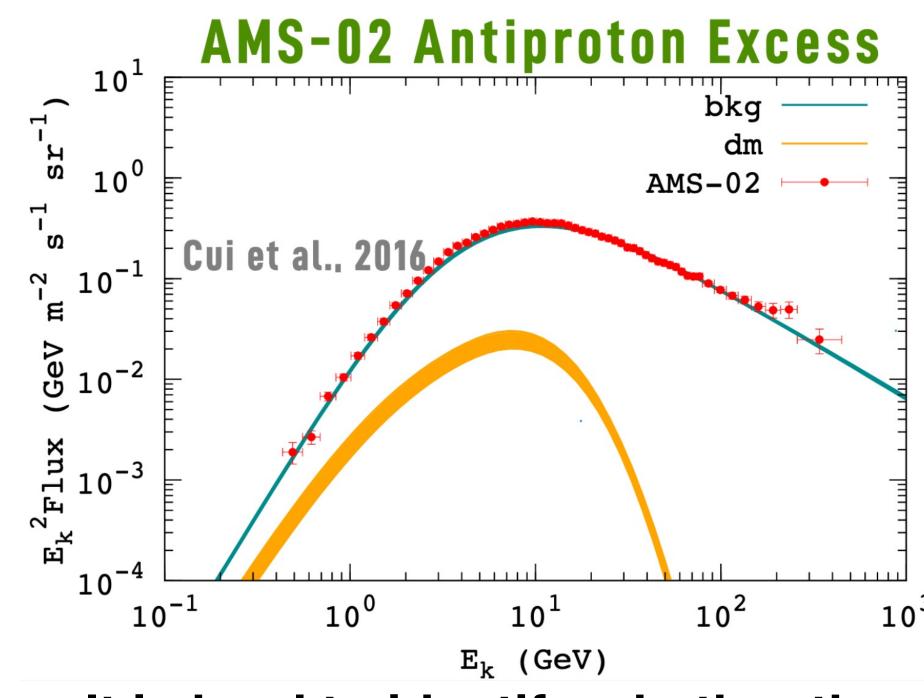


1. Introduction

GRAMS (Gamma-Ray and AntiMatter Survey) is a proposed balloon/satellite mission that will be the first to target both MeV gamma-ray observations and antimatter-based indirect dark matter searches with a LArTPC (Liquid Argon Time Projection Chamber) detector. We are currently building and testing a prototype detector, MiniGRAMS, that will be employed for the first balloon flight proposed in the mid-2020s.

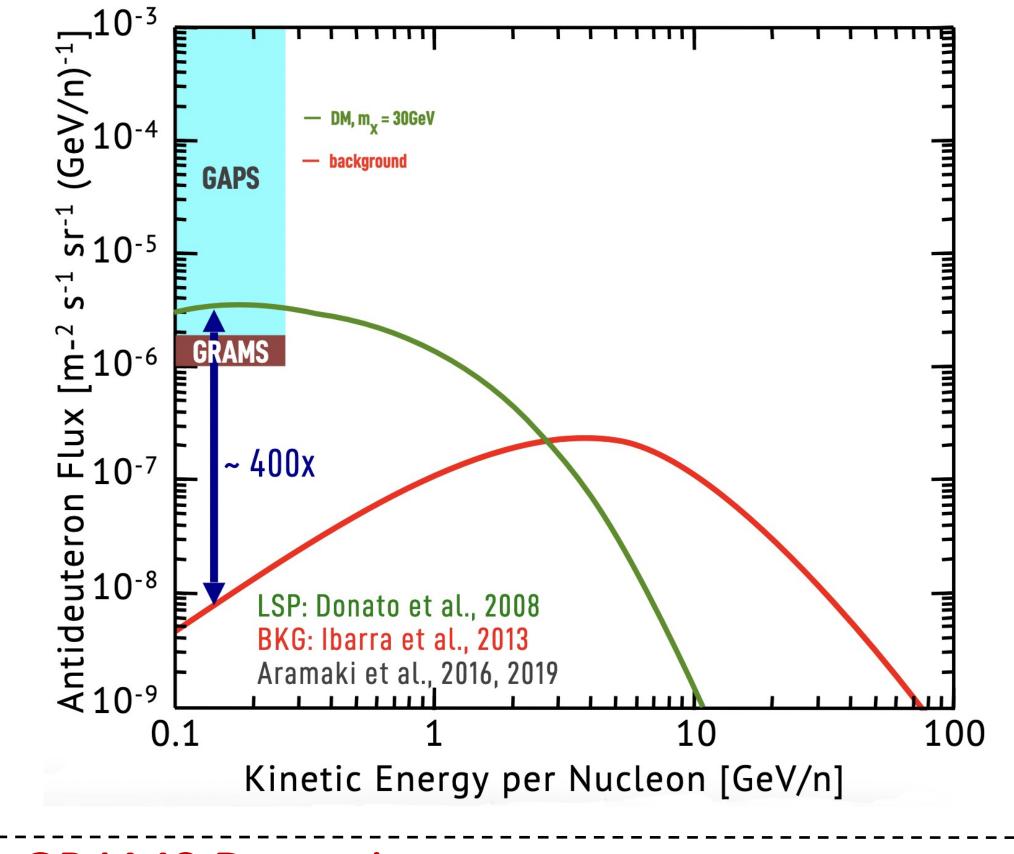
2. Potential dark matter signatures in the recent experiments





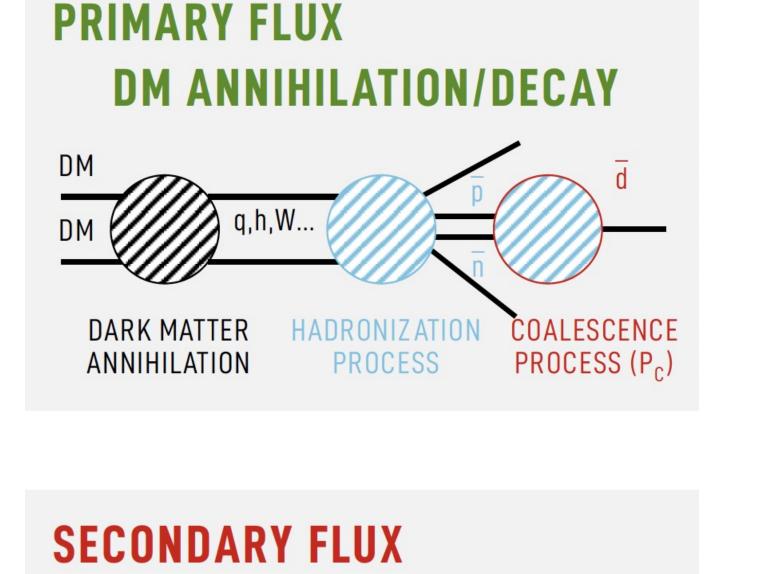
- It is hard to identify whether the signals we detect come from dark matter or background/uncertainty
- we need some new methods/approaches for these potential DM signatures

3. Low energy antiparticles for background-free dark matter search



Rigidity [GV]

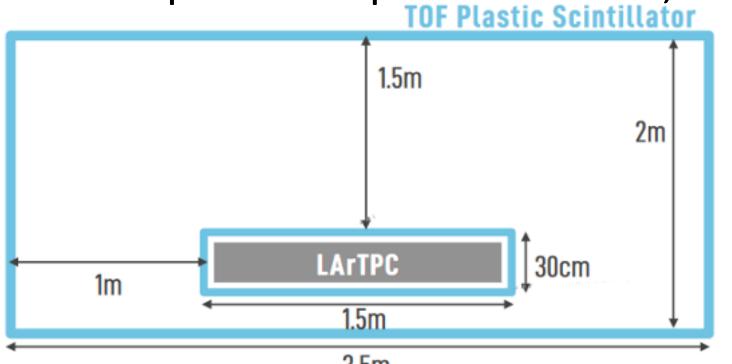
AMS-02 reported antihelium-like events

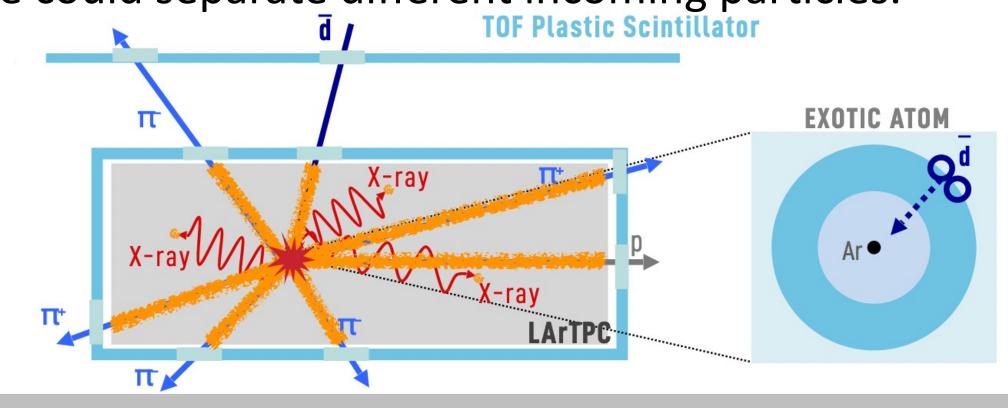


COSMIC RAY INTERACTION $p(CR) + H(ISM) \rightarrow p + H + p + n + (\bar{p} + \bar{n})$

4. GRAMS Detection concept

Time of Flight(TOF) is constructed of plastic scintillators that can measure the velocity of incoming antiparticles. LArTPC acts as both detector and stopping material. To collect and reconstruct produced particles' track, we could separate different incoming particles.





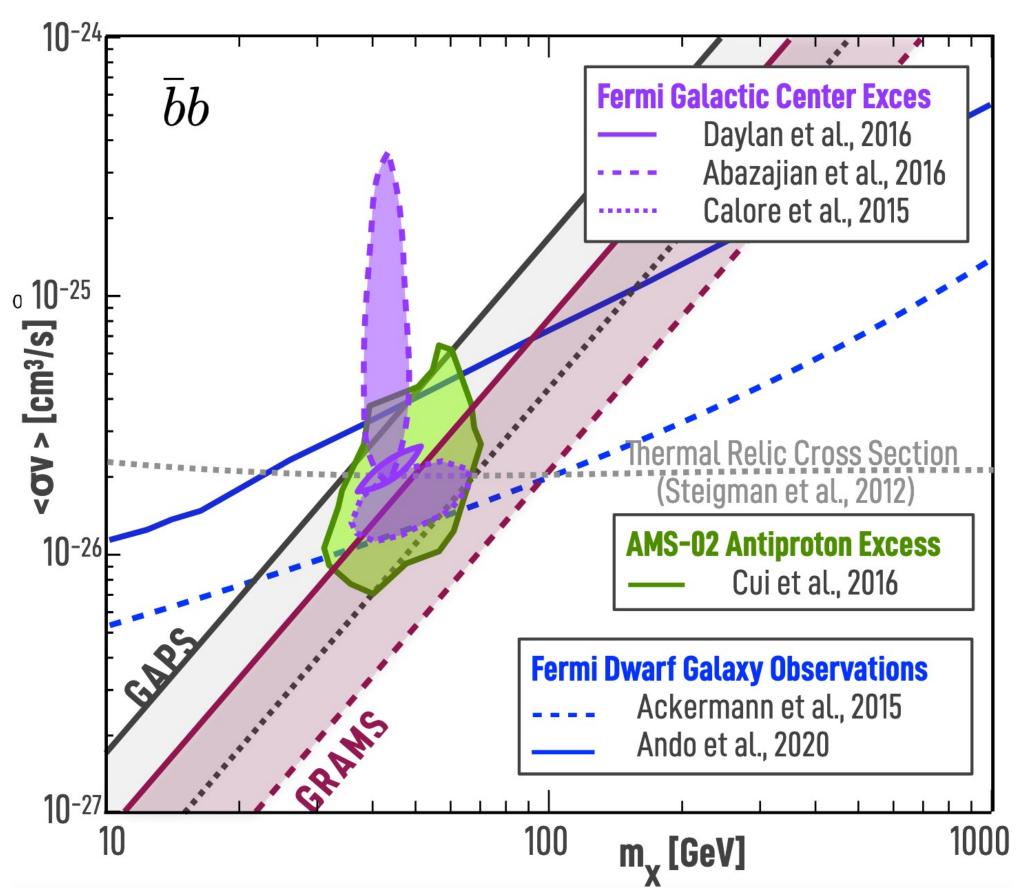
5. \overline{d} and $\frac{3}{2}\overline{He}$ Identification Techniques

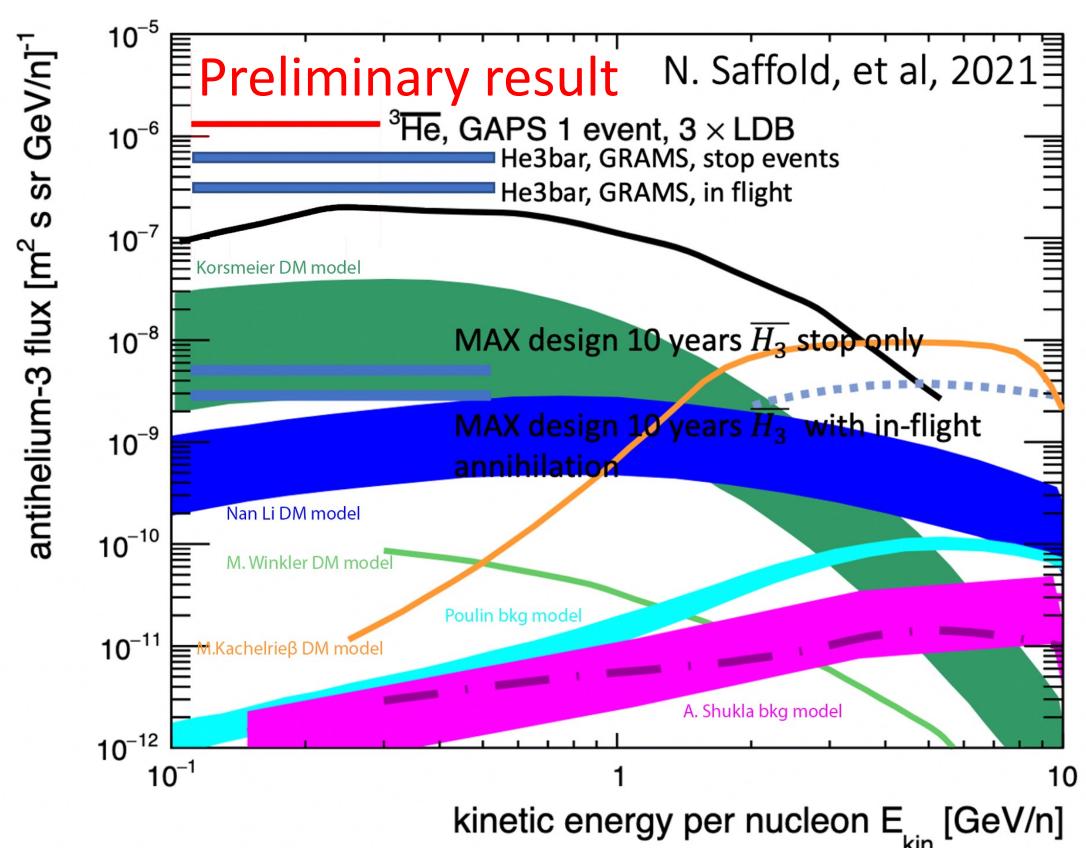
- Time of Flight targeting on low energy incoming particles($\sim 250 MeV/n$)
- Normal particles could not produce annihilation product, making secondary profile unique

$\overline{m{d}}$	$\frac{3}{2}\overline{He}$	$\overline{m{d}}$	$\frac{3}{2}\overline{He}$
Secondary profile	Secondary profile	Secondary profile	Secondary profile
Respect to normal particles		atomic X-ray	atomic X-ray
(p,d,He,e^{\pm})		Depth sensing	dE/dx in TOF
		dE/dx in LArTPC	•••

Respect to antiproton

6. Preliminary GRAMS Antihelium-3 Sensitivity





GRAMS COULD EXTENSIVELY EXPLORER DM PARAMETER SPACE

7. References

[1] Aramaki T, Adrian P O H, Karagiorgi G, et al. Astroparticle Physics, 2020, 114: 107-114.

[2] T. Aramaki, C. J. Hailey, S. E. Boggs, P. von Doetinchem, H. Fuke, S. I. Mognet, R. A. Ong, K. Perez, and J. Zweerink, Astropart. Phys. 74, 6 (2016), 1506.02513

[3] Saffold N, Aramaki T, Bird R, et al. Astroparticle Physics, 2021, 130: 102580.

[4] GRAMS Web: https://grams.sites.northeastern.edu/

