Dynamically constrained model of Galactic subhalos and impact on dark matter searches

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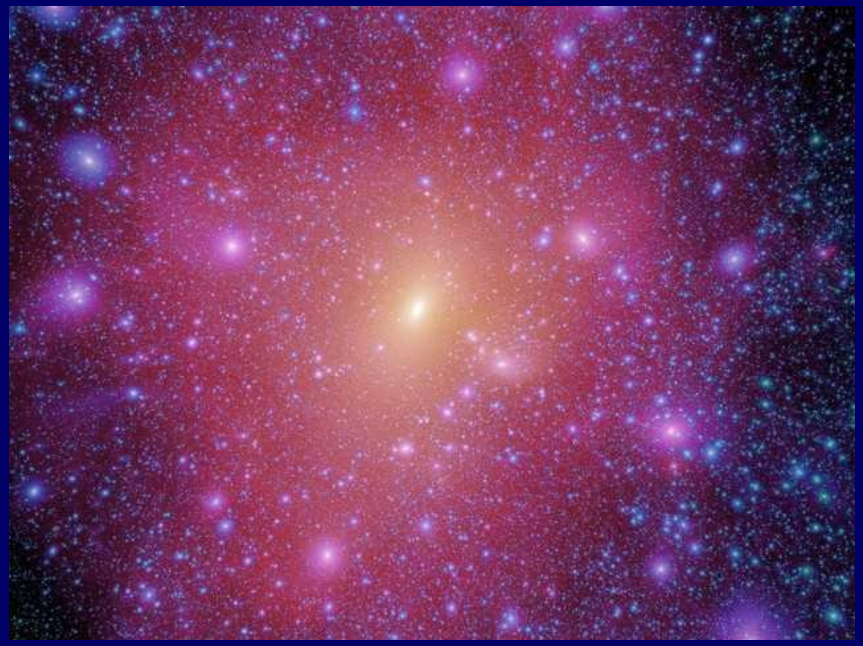
MS and Julien Lavalle, arXiv:1610.02233

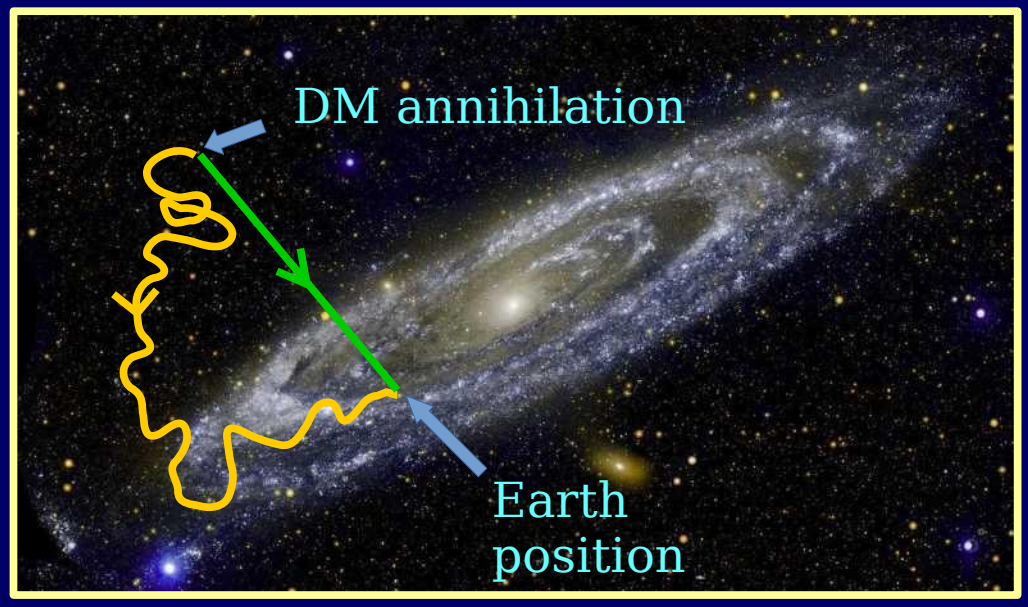
Cold Dark Matter Subhalos

Cold Dark Matter structures at scales much smaller than typical galaxies

A Milky-Way-like galaxy from the Aquarius simulation [Springel+ 08]



This impact DM indirect searches



Detection via photons, neutrinos or charged cosmic rays

$$\text{flux} \propto \langle \rho^2 \rangle_V > \langle \rho \rangle_V^2$$

If subhalos present in the galaxy, signal is boosted!
[Silk & Stebbins 93]

Dark matter subhalos in a dynamically constrained galaxy

The total DM density profile of the Milky Way is constrained by observations [*e.g.* McMillan 11, 17]

$$\rho_{\rm DM}(r) = \rho_{\rm sub}(r) + \rho_{\rm smooth}(r)$$

dynamically constrained

modeled /predicted

Dark matter subhalos in a dynamically constrained galaxy

Subhalos are assumed to *initially* follow the DM profile

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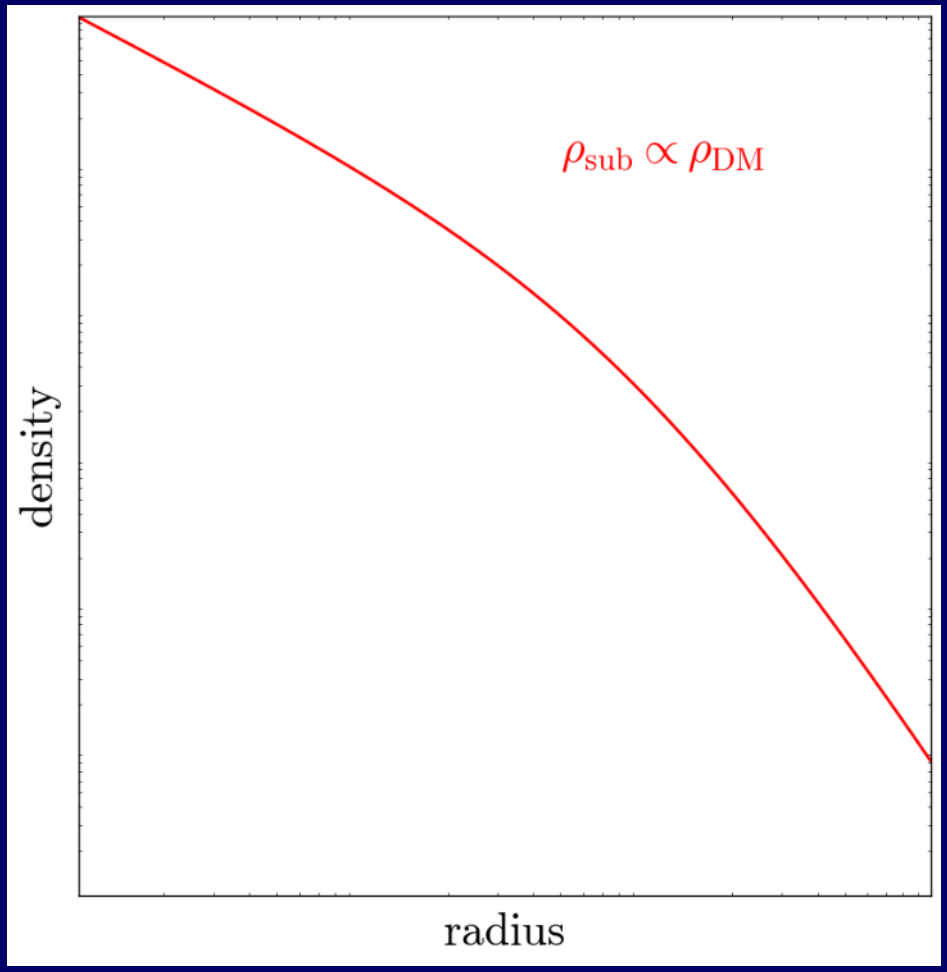

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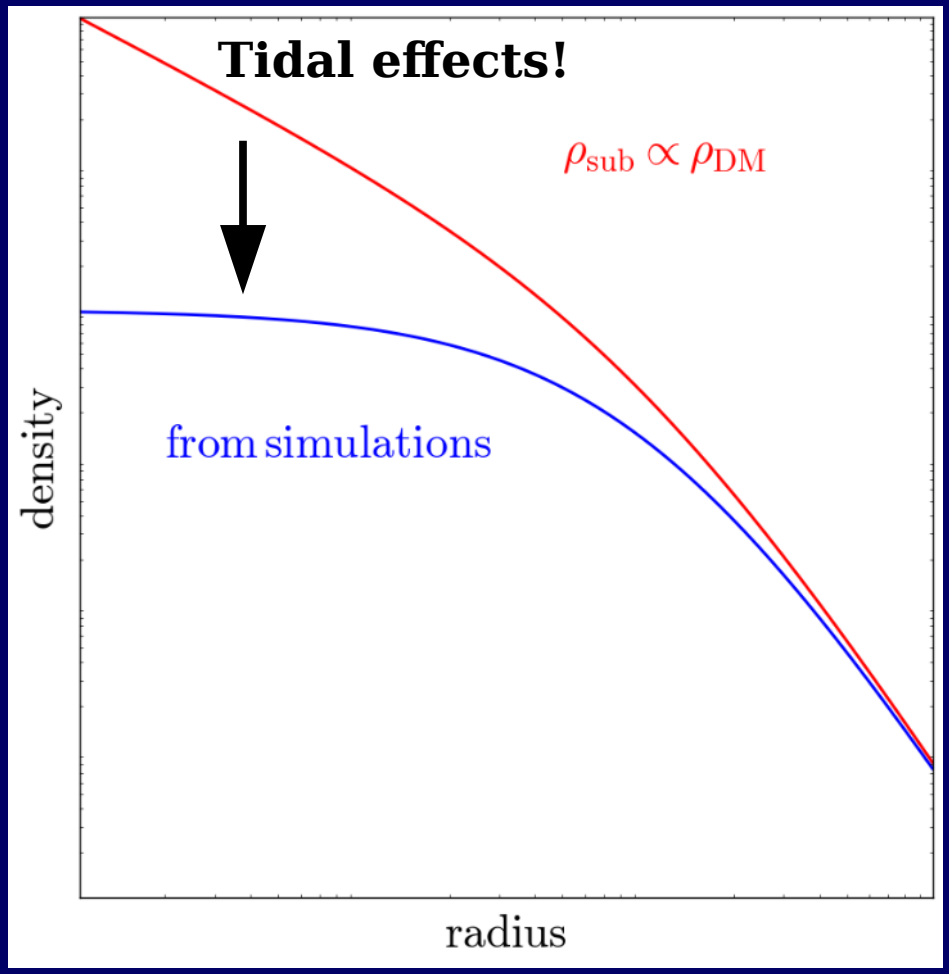


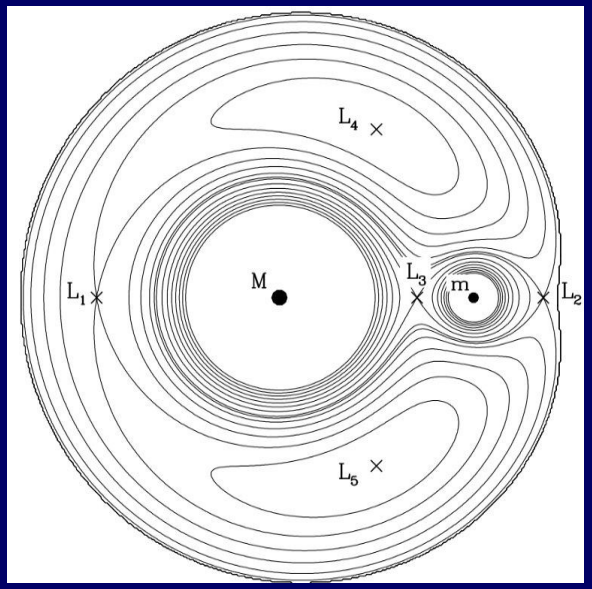
Tidal effects

Interaction of subhalos with external gravitational fields.

Two different effects :

Halo stripping

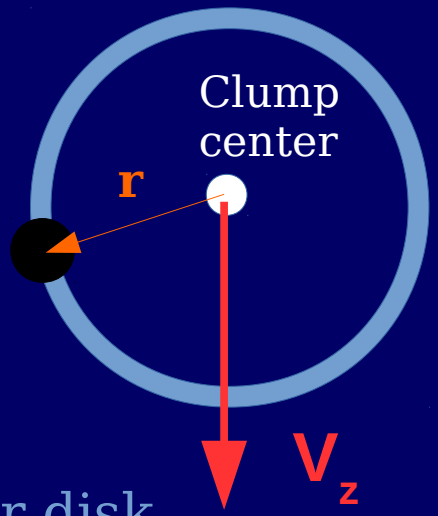
Subhalos are stripped by the potential of the Galaxy



[Binney & Tremaine 87]

$$r_{\rm f} = \left[\frac{m_{\rm sub}(r_{\rm f})}{3M(R)\left(1 - \frac{1}{3}\frac{d\ln M}{d\ln R}\right)} \right]^{1/3} R$$

Disk shocking



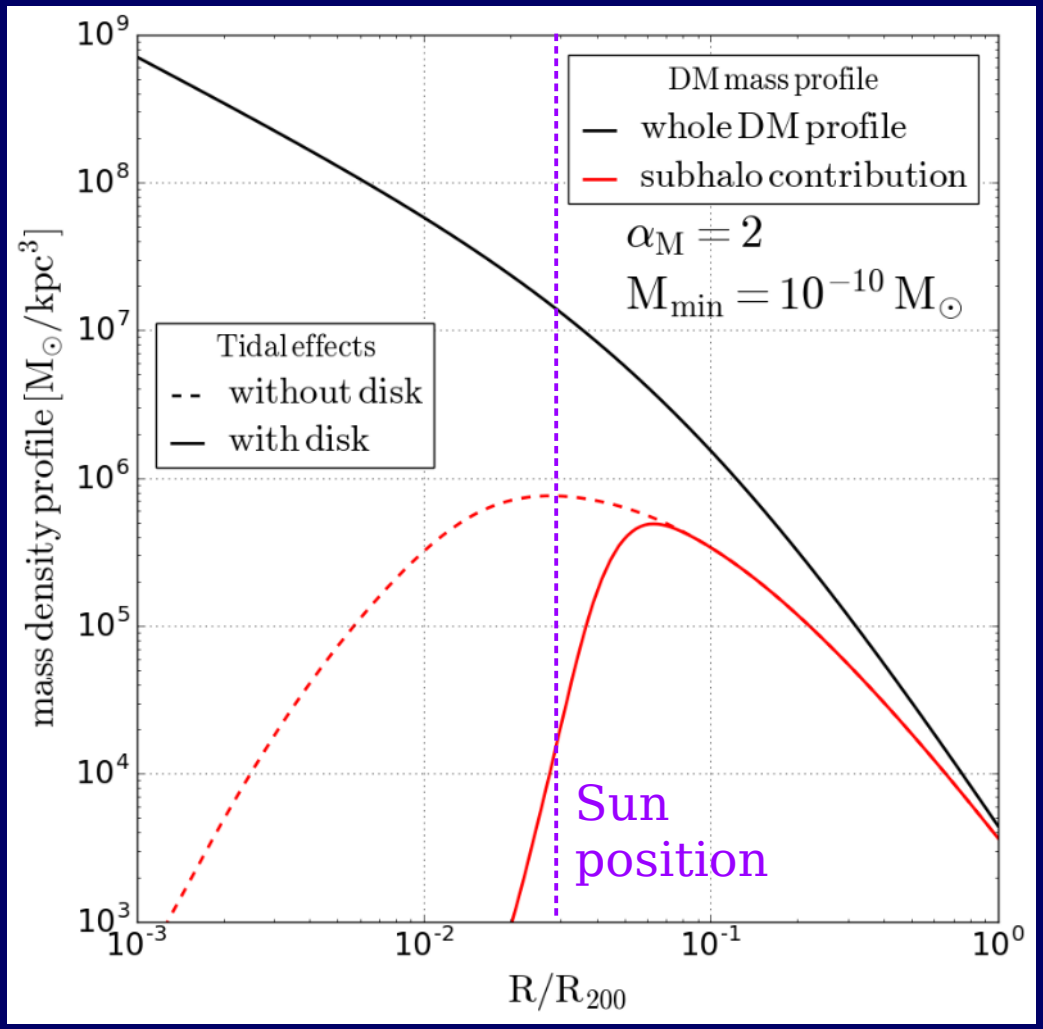
DM particles get a net velocity kick [Ostriker+ 72]

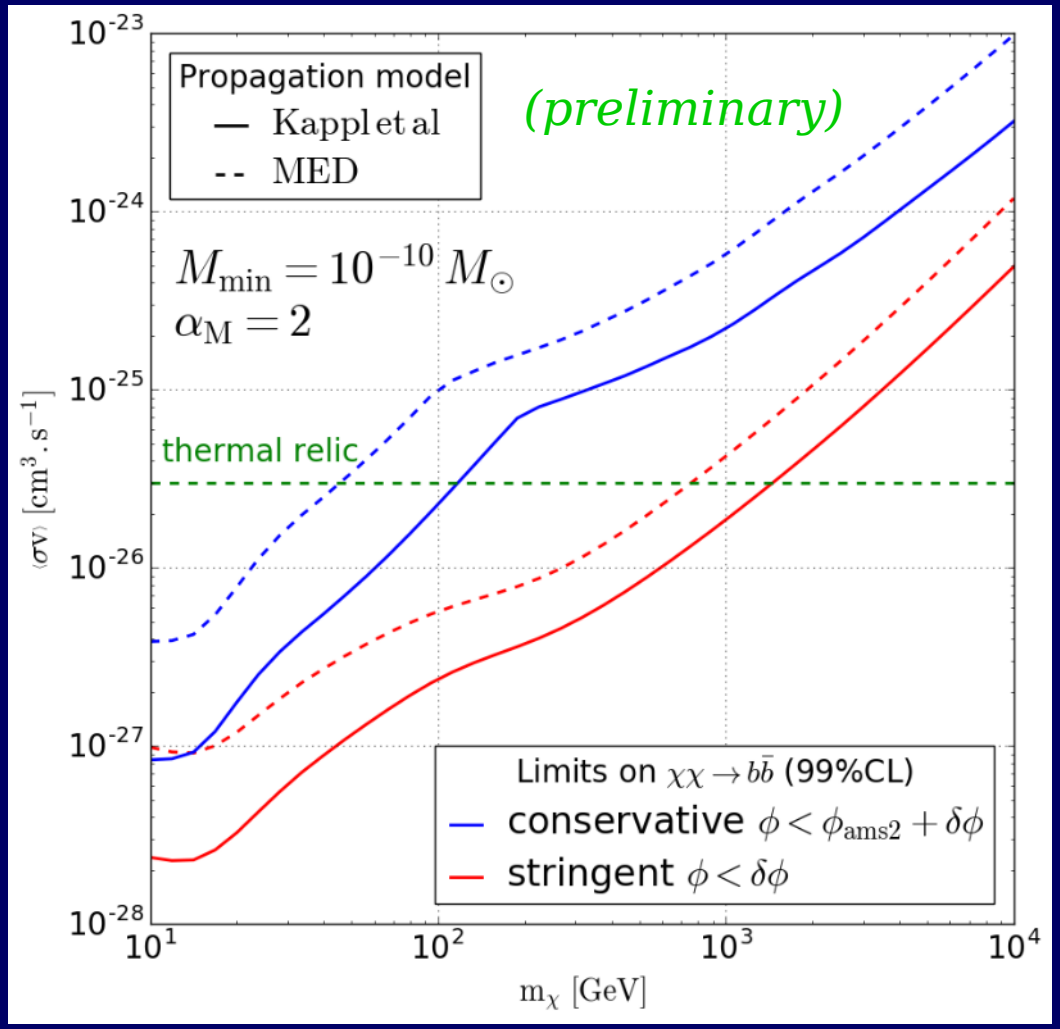
$$\langle \delta\epsilon \rangle \propto \frac{g_{\rm z,disk}^2 r^2}{V_{\rm z}^2}$$

[MS & Lavalle 17]

$$\langle \delta\epsilon \rangle = |\phi(r_{\rm f}) - \phi(r_{\rm i})|$$

Mass density profiles & cosmic-ray antiprotons

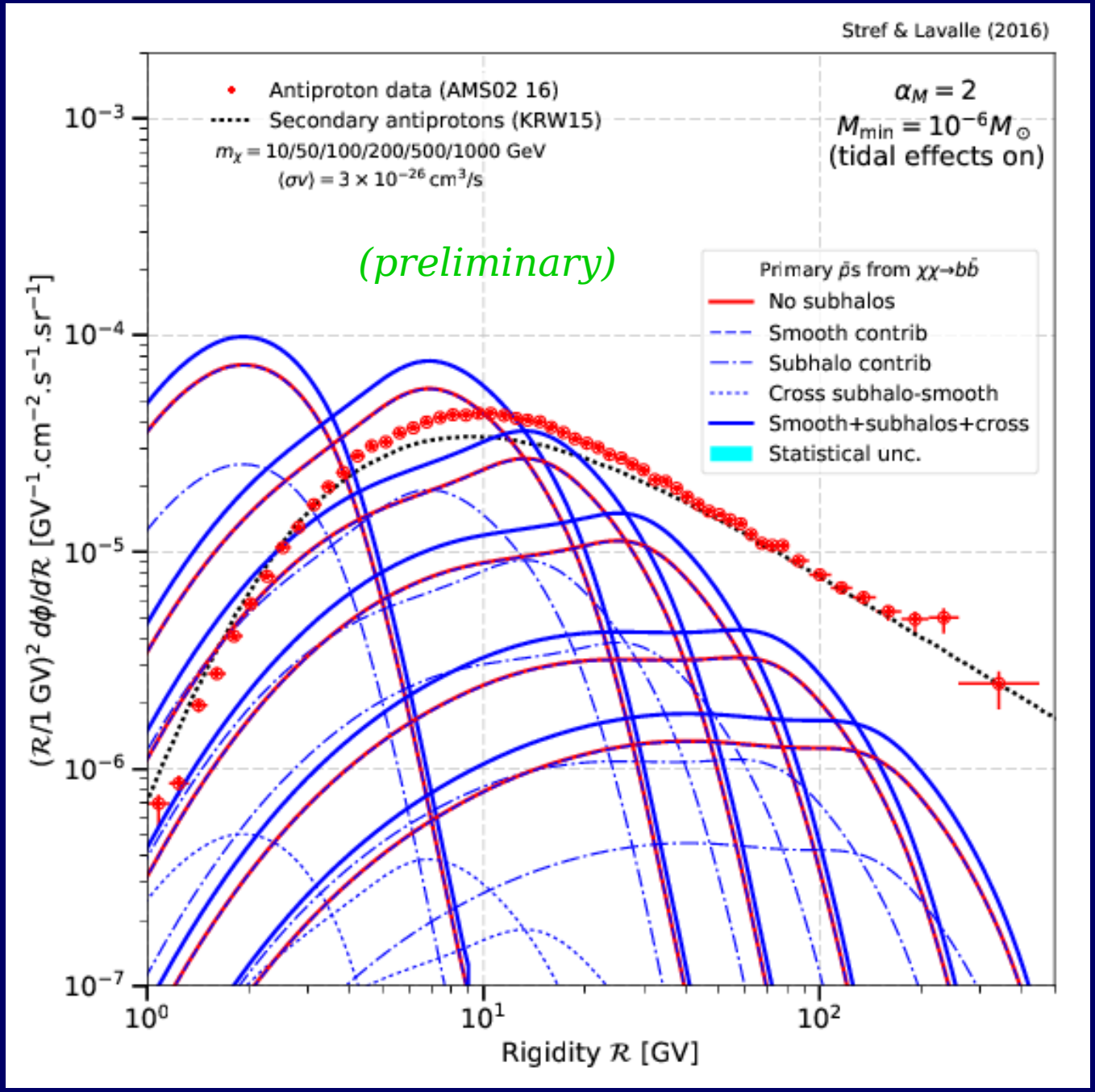




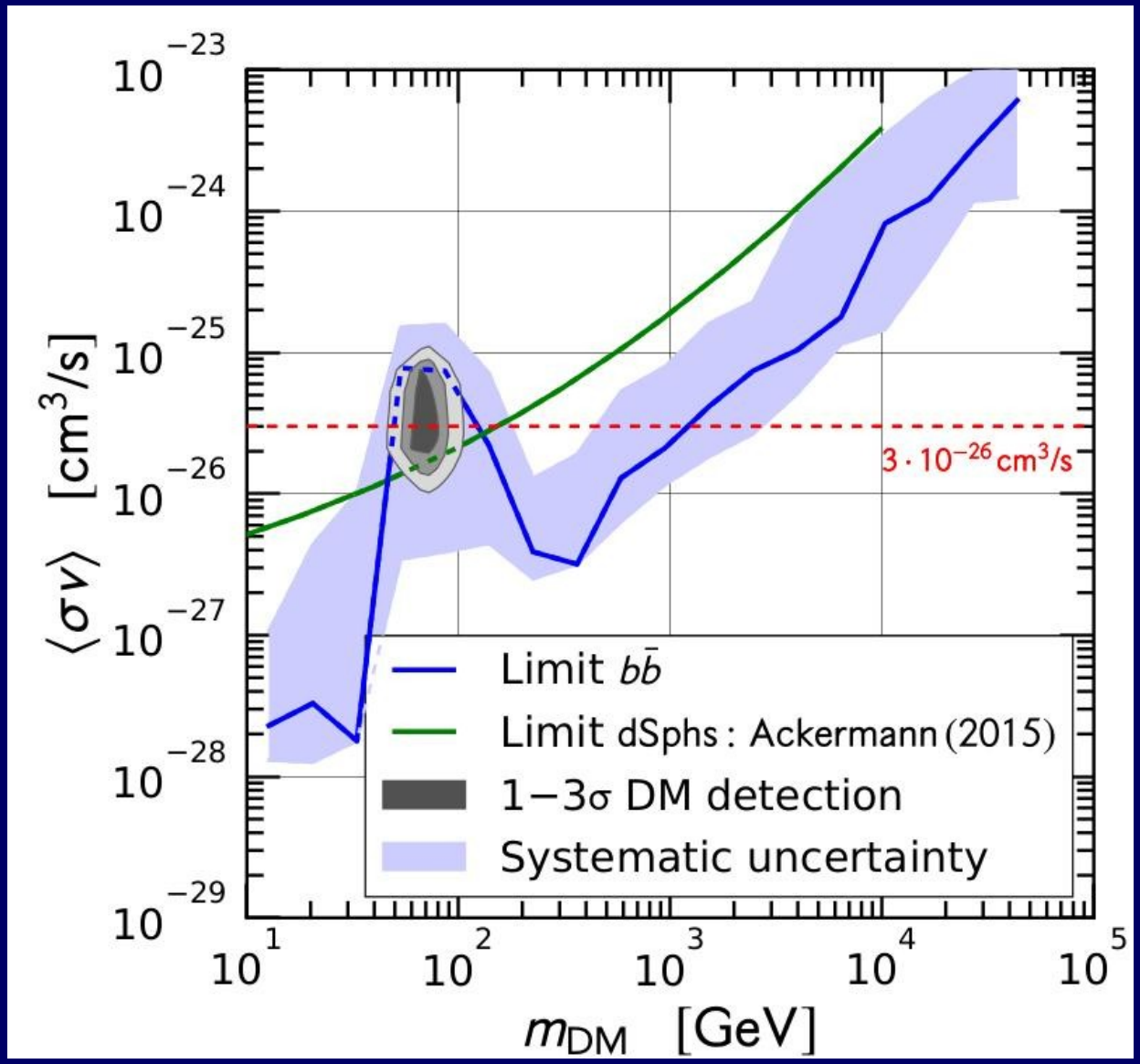
Antiprotons data from AMS-02 [Aguilar+ 16]

Thanks for your attention!

Antiprotons flux



The AMS-02 hot spot



[Cuoco+ ‘16]