Implications on Dark Matter from the Fermi-LAT measurement of anisotropies in the diffuse gamma-ray background

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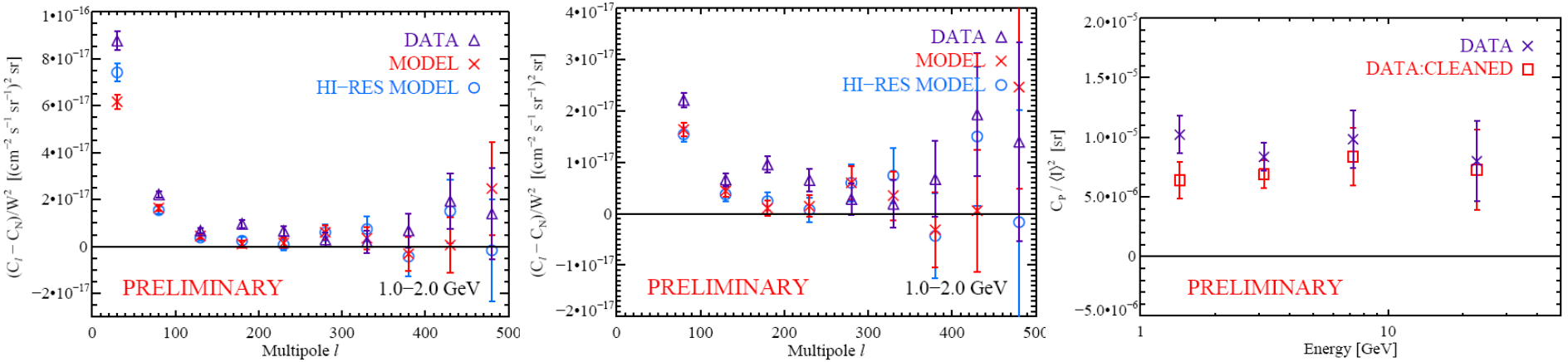
Fermi-LAT measurement of the APS

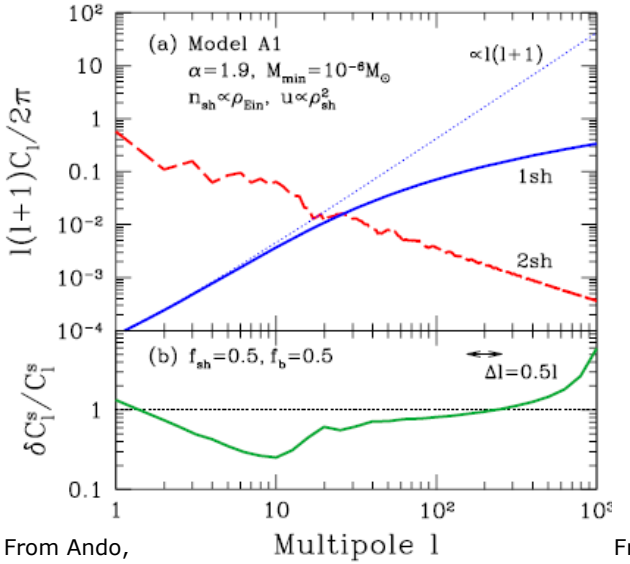


From Siegal-Gaskins's talk at the Fermi Symposium 2011

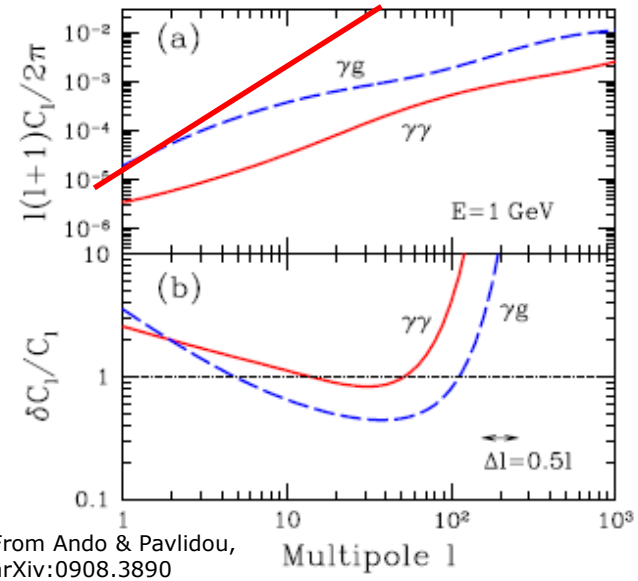
- data from the first 22 months
- 4 energy bins (from 1 GeV to 50 GeV)
- masking is applied covering point sources and Galactic plane
- data compared with a source MODEL
- results tested with different foreground models, latitude cuts, etc.

Angular power is detected with a signficance up to 7σ.
It is not compatible with APS from MODEL (between 1 and 2 GeV). It appears to be constant in multipole (155<l<504) and independent of energy.

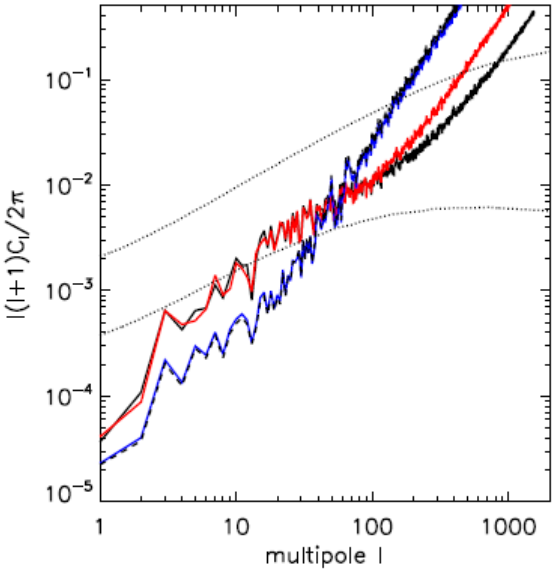
Independent of multipole



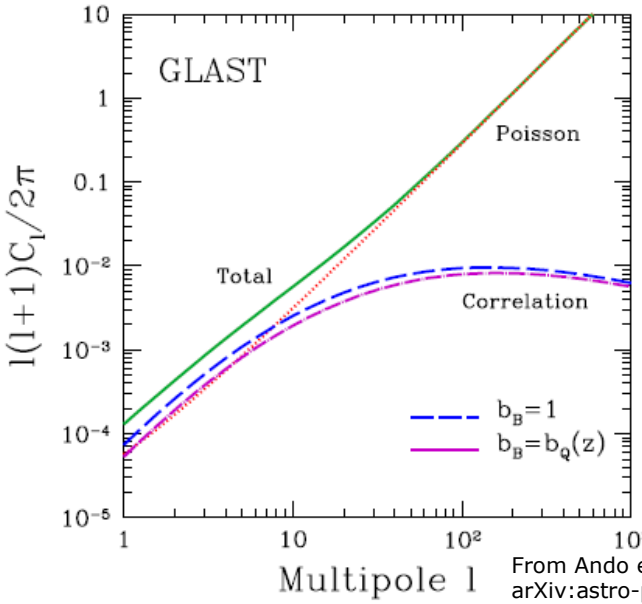
From Ando, arXiv:0903.4685



From Ando & Pavlidou, arXiv:0908.3890



From Zavala et al., arXiv:0908.2428



From Ando et al. arXiv:astro-ph/06124667

Poisson behaviour: unclustered, unresolved sources (Poisson signal, not noise)

$$C_{\rm P} = \int_0^{S_c} dS\; S^2 \frac{{\rm d}N}{{\rm d}S} \qquad (1)$$

Independent of energy - I

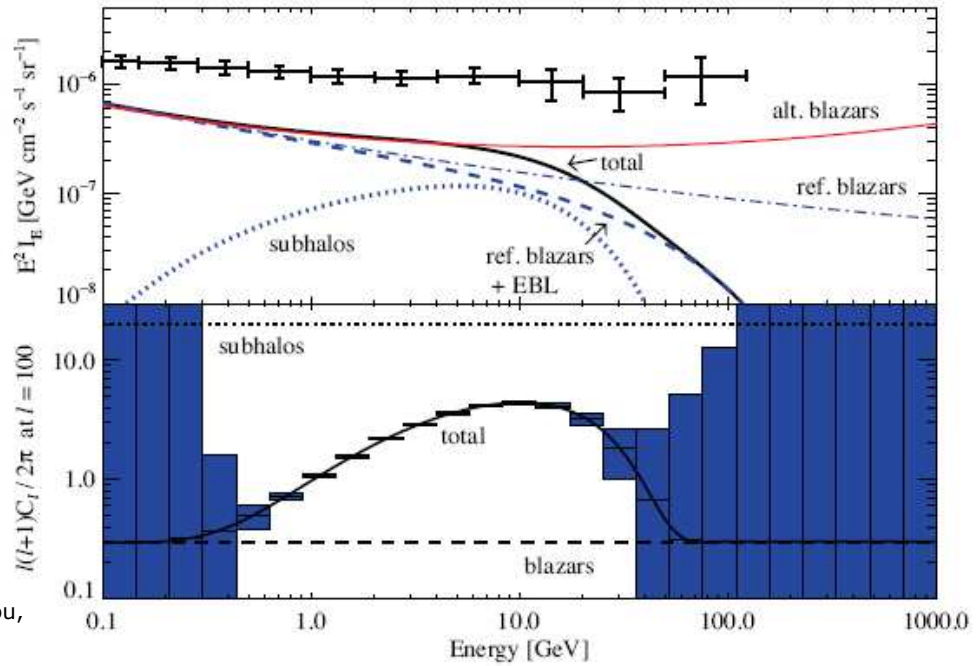
• distinguish intensity APS (measured in $cm^{-4}s^{-2}sr^{-1}$) and fluctutation APS (measured in sr)

$$I(\psi) = \sum_{\ell,m} a_{\ell m} Y_{\ell m}(\psi) \qquad C_\ell = \langle |a_{\ell m}|^2 \rangle \tag{2}$$

$$C_\ell / \langle I \rangle^2 \tag{3}$$

$$\frac{C_{\mathrm{P,tot}}}{\langle I_{\mathrm{tot}} \rangle^2} = f_1^2 \frac{C_{\mathrm{P},1}}{\langle I_1 \rangle^2} + f_2^2 \frac{C_{\mathrm{P},2}}{\langle I_2 \rangle^2} + \ldots \tag{4}$$

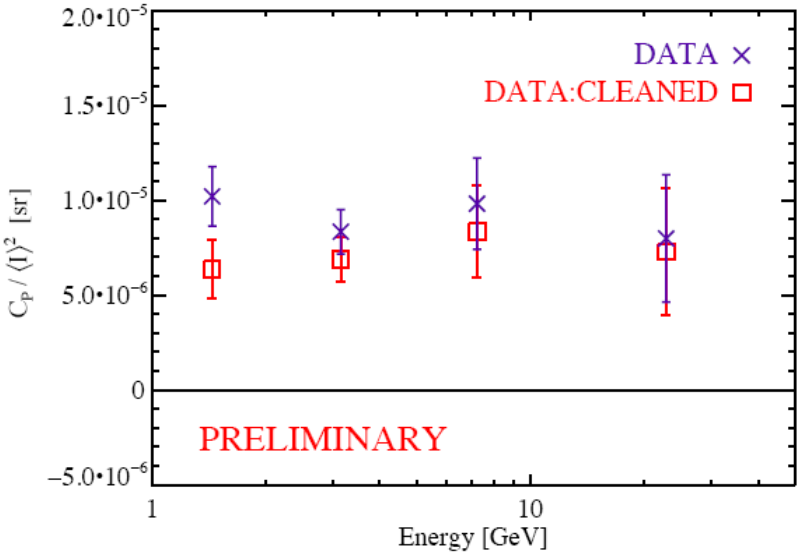
• multipole components to the fluctuation APS sum as in Eq.4 and can cause a modulation in the total APS (anistropy energy spectrum)

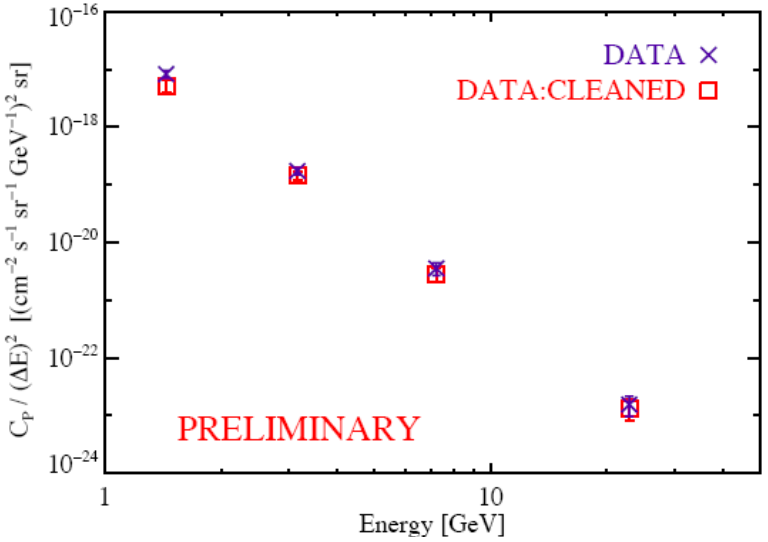


From Siegal-Gaskins & Pavlidou, arXiv:0901.3776

Independent of energy - II

Only one population contributing (maybe)





From Siegal-Gaskins's talk at the Fermi Symposium 2011

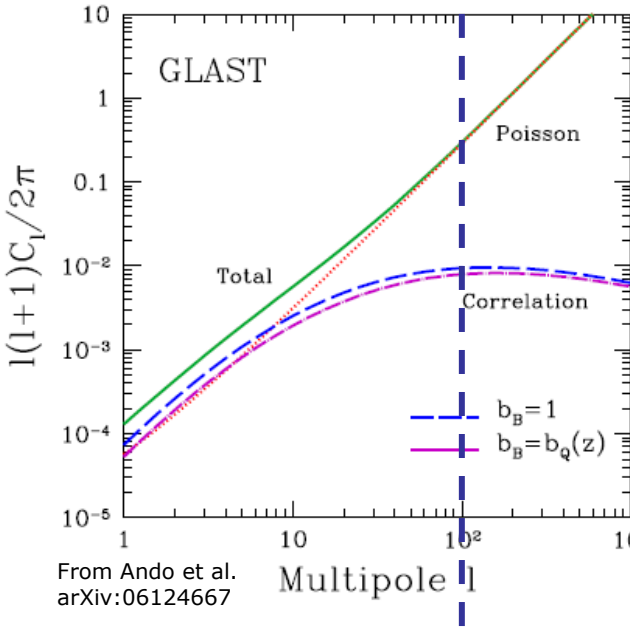
- intensity APS depends on the intensity of the signal
- it fits well with a power-law with slope of -4.8
- assuming it is due to one single population of source emitting with a power-law energy spectrum

Compatible with emission from sources with a power-law energy spectrum with slope equal to -2.40±0.07, as for the measured EGB

Amplitude of the signal

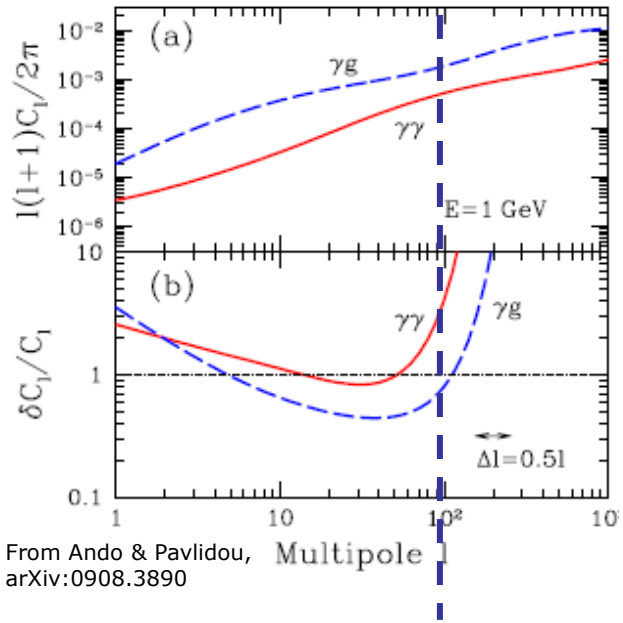
Assuming only one source population contributes to the APS, the data can be used to determine the maximum fraction of the total EGB that source accounts for

$$f_i^2 \leq \frac{C_{\mathrm{P,tot}}/\langle I_{\mathrm{tot}}\rangle^2}{C_{\mathrm{P},i}/\langle I_i\rangle^2} \qquad (5)$$



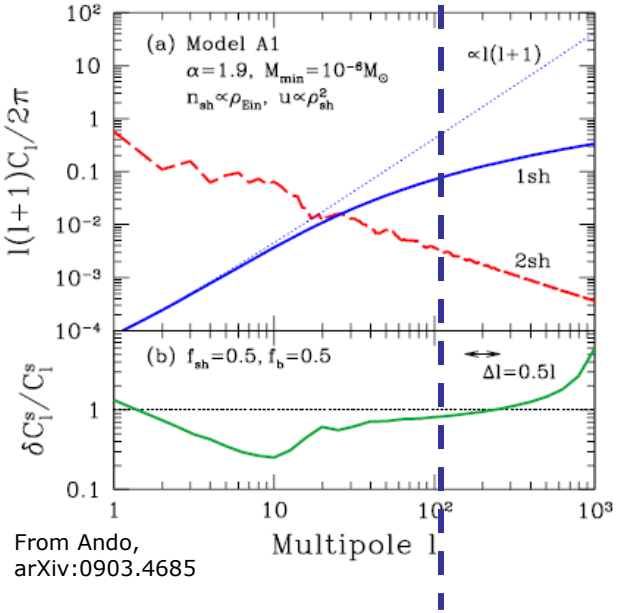
From Ando et al. arXiv:06124667

blazars: 2×10^{-4}sr
22% of the EGB



From Ando & Pavlidou, arXiv:0908.3890

star-forming galaxies:
2×10^{-7}sr negligeble



From Ando, arXiv:0903.4685

DM Galactic subhalos:
5×10^{-5}sr 45% of the EGB

Overview

Build a map of DM distribution around us that is as complete (and realistic) as possible:

- both Galactic and extra-galactic component will be taken into account
- maps are obtained directly from halos (and subhalos) catalogs of most recent *N*-body simulations (Millennium-II and Aquarius)
- extrapolation to the free-streaming minimal mass M_{min} is done
- possible effects of using *N*-body simulations with constrained initial conditions (CLUES) are also studied

Use it as a template studying the DM contribution to the APS of accounting for updated modelization of Fermi-LAT instrument response function:

- DM template maps are to be fed to Fermi simulation Tools
- APS will be computed from the simulated count maps
- uncertainties on the APS will be estimated
- constraints on the particle physics characteristics of DM will be derived

Contributors

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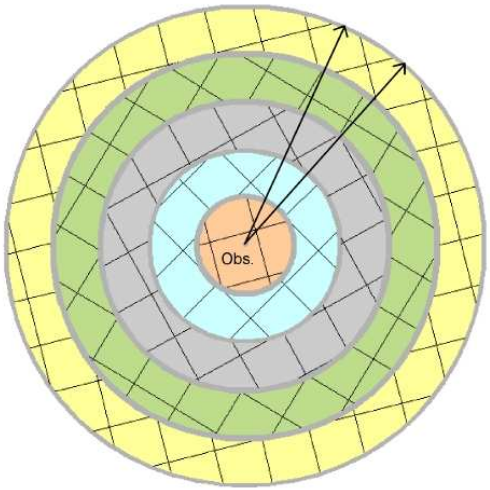
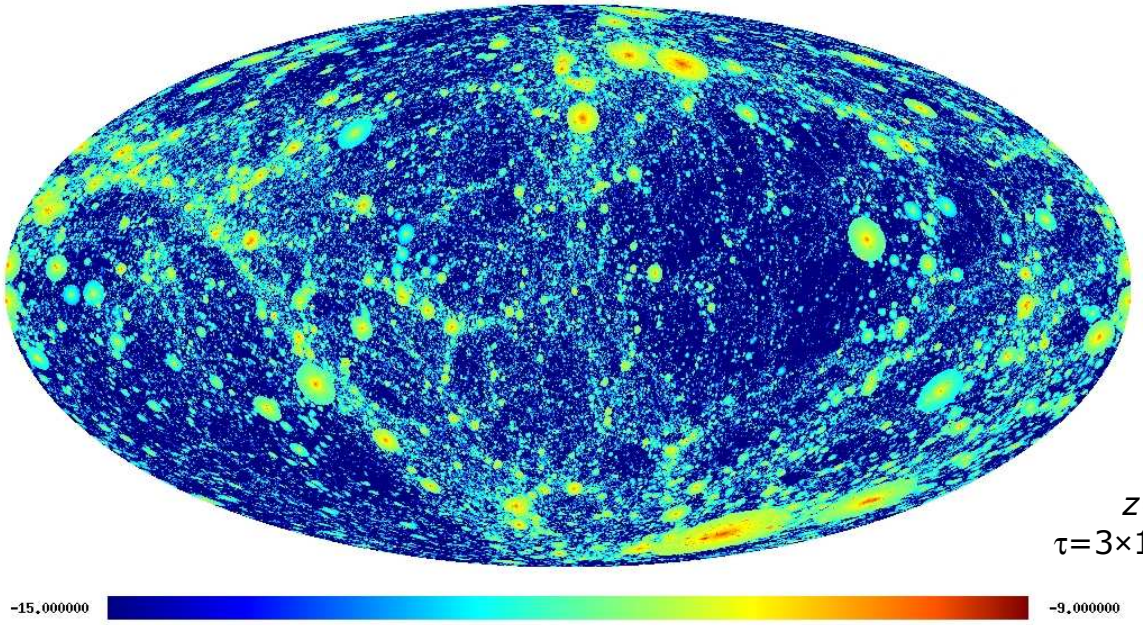
Extra-galactic DM structures from Millennium-II

Millennium-II catalogs for halos and subhalos heavier than $10^9\,M_\odot$ in 52 snapshots from z=0 and z=10



From Zavala et al., arXiv:0908.2428

- decaying DM candidates are considered too
- extended halos are mapped with their own DM profile
- EBL attenuation model by Dominguez et al.
- contribution of IC photons

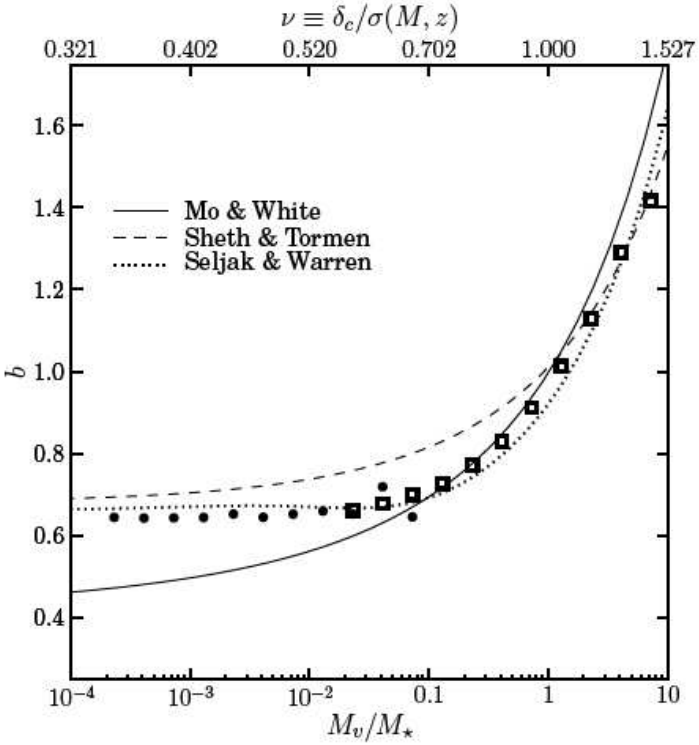


z=0, E=10 GeV, m_χ=2 TeV,
$\tau=3\times10^{27}$ s, decay into b quarks

Extrapolation to low mass halos

- two-point correlation function flattens out for the smallest halos of Millennium-II

Monte Carlo simulate main halos below the mass resolution of the simulation mimicking the distribution of main halos in Millennium-II with $200<N_P<2000$



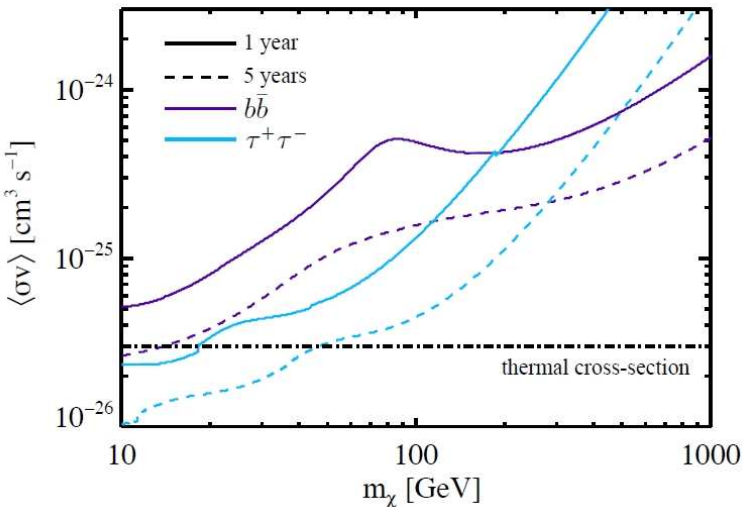
From Boylan-Kolchin et al., arXiv:0903.3041

Subhalos boost factor $B(r)$ determined from power-law tail in the probability distribution $P(\rho,r)$

- B(r) for MW halo following formalism of Kamionkowski et al., arXiv:1001.3144
- $P(\rho,r)$ fitted to N-body simulation

DM constraints from the APS

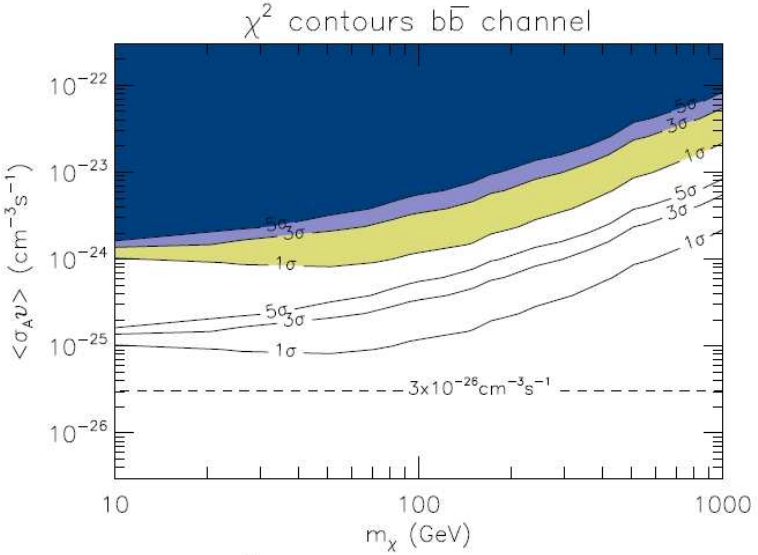
- DM maps will be included in the source model
- measure the amplitude of DM APS
- check if it improves the comparison with the data
- determine constraints in the (m_χ,σv) plane



From Hensley et al., arXiv:0912.1854

Active synergy of MultiDark with the Fermi-LAT collaboration

- different analysis pipelines are being tested
- many particle physics scenarios will be considered
- the systematic due to imperfect knowledge of Galactic diffuse emission will be studied (internal diffuse models)



From Cuoco et al., arXiv:1005.0843