MultiDark
Multimessenger Approach for Dark Matter Detection

Dark Matter indirect detection:

Gamma-rays and Cosmic-rays

Summary of WG activities

Coordinators:

J. A. Barrio, G. Bertone, N. Fornengo, R. A. Lineros and M. A. Sánchez-Conde

9th MULTIDARK meeting, Oct 6-9 2013, UAH

Scientific output

Since the Granada meeting

1303.4685 M. Lattanzi, S. Riemer-Sorensen, M.A. Tortola, J.W.F. Valle
Updated CMB, X- and gamma-ray constraints on majoron dark matter

1305.2124 J.A.R. Cembranos, A. de la Cruz-Dombriz, V. Gammaldi, R.A. Lineros, A.L. Maroto
Reliability of Monte Carlo event generators for gamma-ray dark matter searches

1305.2162 Domínguez, A.; Finke, J. D.; Prada, F.; Primack, J. R.; Kitaura, F. S.; Siana, B.; Paneque, D.
Detection of the Cosmic γ-Ray Horizon from Multiwavelength Observations of Blazars

1305.2163 Domínguez, Alberto; Prada, Francisco
Measurement of the Expansion Rate of the Universe from γ-Ray Attenuation

1305.4710 C. Weniger, M. Su, D. P. Finkbeiner, T. Bringmann, N. Mirabal
Closing in on the Fermi Line with a New Observation Strategy

1305.5597 Fermi LAT Collaboration (with G. A. Gómez-Vargas, A. Morselli, M. Sánchez-Conde)
Search for Gamma-ray Spectral Lines with the Fermi Large Area Telescope and DM Implications

1306.4171 N. Fornengo, L. Maccione, A. Vittino
Dark matter searches with cosmic antideuterons: status and perspectives

1308.3515 German A. Gomez-Vargas, Miguel A. Sanchez-Conde, Ji-Haeng Huh, Miguel Peiro, Francisco Prada, Aldo Morselli, Anatoly Klypin, David G. Cerdeno, Yann Mambrini, Carlos Munoz
Constraints on WIMP Annihilation for Contracted Dark Matter in the Inner Galaxy with the Fermi-LAT

1309.4630 R. A. Lineros
Radio constraints on Galactic WIMP dark matter

1310.0828 The Fermi-LAT Collaboration (with G. A. Gómez Vargas, A. Morseill, M.A. Sánchez-Conde)
DM constraints from Observations of 25 Milky Way Satellite Galaxies with the Fermi LAT

Remember to update the information in the MULTIDARK website

MultiDark

Multimessenger Approach for Dark Matter Detection

Español English

GOBIERNO DE ESPAÑA · MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD · PROGRAMA INGENIO 2010 · Consolider

- HOME

Project
- Presentation
- Objectives
- Organization
- Participants
- Hired Members
- Infrastructures
- Instrumentation

Calls
- Postdoctorals
- Ph. D. Students
- Summer Students

Activities

Publications

Remember to mention in the acknowledgements the support of the project. We suggest to write something like:We thank the support of the spanish MICINN's Consolider-Ingenio 2010 Programme under grant **MultiDark** CSD2009-00064

Author	Title	ePrint	
S. Heinemeyer et al.	Study of Electroweak Interactions at the Energy Frontier	1310.6708	All info
Pedro G. Ferreira, Antonio L. Maroto	A few cosmological implications of tensor nonlocalities	1310.1238	All info
The Fermi-LAT Collaboration (with A. Morselli and G. A. Gómez Vargas)	Dark Matter Constraints from Observations of 25 Milky Way Satellite Galaxies with the Fermi Large Area Telescope	1310.0828	All info
J.A.R. Cembranos, A.L. Maroto, S. J. Nunez Jareno	Solution to the Isotropy Problem for Cosmological Hidden Vector Models	1309.7447	All info

The Gamma and CR session

TALKS ON RECENT MULTIDARK WORK

1) A. Moralejo: "Observations of Segue 1 with the MAGIC telescopes”

2) K. Satalecka: "The search for unidentified Fermi Objects with MAGIC”

3) J.A. Barrio: "Status of CTA”

4) G. Gómez-Vargas: "Inner Galaxy & anisotropies studies with Fermi”

5) J. Palacio: "WIMP dark matter as radiative neutrino mass messenger”

DISCUSSION SESSION

More contributions/discussions still welcome!! Let us know.

Scientific activities

Workshop on DM tools and Hands-on Fermi analysis

Instituto de Física Teórica

Valencia, April 22-26, 2013

General
- Home
- Speakers
- Participants
- Program
- Organizers
- Venue
- Registration

- Practical Info
- Important Info

About the Dark Matter (DM) tools workshop:

DM research field has grown in complexity and variety. During the past years, several software have been released for studying DM phenomenology. The workshop is intended for researchers, students, who are interested to learn how to use some of the most popular tools as well as to learn some other interesting topics.

Organizers:
G. Gómez-Vargas, R. Lineros, M. Sánchez-Conde,
C. Muñoz, F. Prada, S. Hernández

Program

	DM tools	DM tools	Fermi tools	Fermi tools	Fermi tools
Hour	Monday 22/04	Tuesday 23/04	Wednesday 24/04	Thursday 25/04	Friday 26/04
1	10:00 The workshop roadmap (Roberto)	9:30 Pythia (Pradipta, Michael, Roberto)	9:15 The workshop roadmap (Roberto) 9:30 Introduction to the instrument. What is Fermi? How it works? (Rolf)	9:30 Simulations: interstellar emission + Extragalactic emission + point sources + DM (Rolf)	9:30 Work in the GC fitting (Maja, Rolf,
2	10:15 1st dark review: “Dark matter evidences and the LCDM cosmological model” (Miguel)	10:30 Pythia (Pradipta, Michael, Roberto)	10:30 3rd dark review: “Present status of gamma-ray dark matter searches” (Miguel)	10:30 Exploring data: selecting regions, time periods, cuts in general, counts maps (Germán)	10:30 Work in the GC fitting (Maja, Rolf
11:30 – 12:00	Break	Break	Break	Break	Break
3	11:45 LanHEP/MicrOmegas (Roberto, Joaquim)	12:00 2nd dark review: “Shedding light to the dark with N-body cosmological simulations” (Miguel)	12:00 Introduction to the analysis method (Likelihood) (Germán)	12:00 Likelihood analysis: the pipeline (Maja)	12:00 Work in the GC fitting (Maja, Rolf
13:00 -- 15:00	Lunch	Lunch	Lunch	Lunch	End
4	15:00 LanHEP/MicrOmegas (Roberto, Joaquim)	15:00 Pythia (Pradipta, Michael, Roberto)	15:00 Introduction to the basic tools, gtobssim, gtselect, gtmktime, gtbin, gtexpmap2, gtltcube, gtlike, gtsrcmap (Maja)	15:00 Start the GC fitting (Maja, Rolf, Germán)	
16:00 -- 16:30	Break	Break	Break	Break	
5	16:30 LanHEP/MicrOmegas (Roberto, Joaquim)	16:30 Pythia (Pradipta, Michael, Roberto)	16:30 Downloading data (Rolf)	16:30 Work in the GC fitting (Maja, Rolf, Germán)	
6 (18:00)	End	End	End	End	

35 participants!

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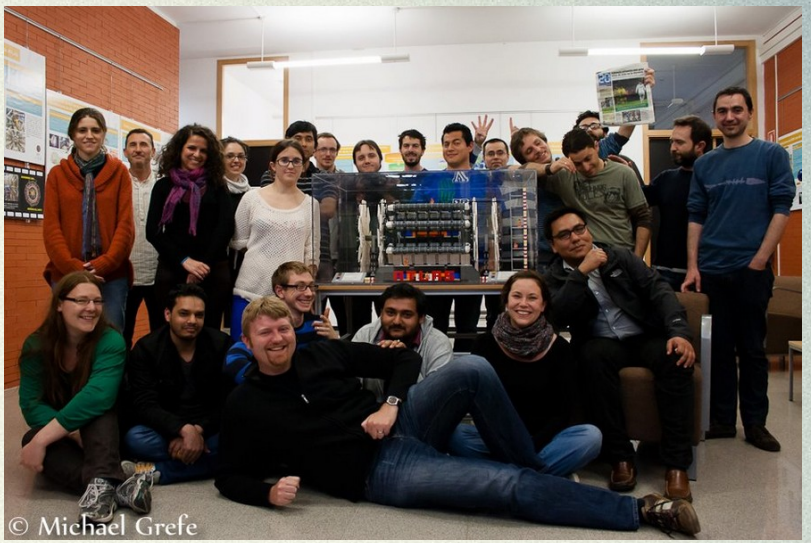
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Scientific highlights

Salamanca group

Available online at www.sciencedirect.com

SciVerse ScienceDirect

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Nuclear Physics B (Proc. Suppl.) 239–240 (2013) 193–198

NUCLEAR PHYSICS B PROCEEDINGS SUPPLEMENTS

www.elsevier.com/locate/npbps

Gamma-Light: High-Energy Astrophysics above 10 MeV

Aldo Morselli[a], Andrea Argan[b], Guido Barbiellini[c,d], Walter Bonvicini[c], Andrea Bulgarelli[e], Martina Cardillo[f], Andrew Chen[g], Paolo Coppi[h], Anna Maria Di Giorgio[i], Immacolata Donnarumma[i], Ettore Del Monte[i], Valentina Fioretti[e], Marcello Galli[j], Manuela Giusti[i], Attilio Ferrari[n], Fabio Fuschino[e], Paolo Giommi[o], Andrea Giuliani[p], Claudio Labanti[e], Paolo Lipari[o], Francesco Longo[c,d], Martino Marisaldi[i], Sergio Molinari[i], Carlos Muñoz[p], Torsten Neubert[q], Piotr Orleański[r], Josep M. Paredes[s], M. Ángeles Pérez-García[v], Giovanni Piano[i], Piergiorgio Picozza[a,f], Maura Pilia[w], Carlotta Pittori[u], Gianluca Pucella[l], Sabina Sabatini[i], Edoardo Striani[i,f,a], Marco Tavani[l,f,a], Alessio Trois[x], Andrea Vacchi[c], Stefano Vercellone[i], Francesco Verrecchia[u], Valerio Vittorini[i], Andrzej Zdziarski[i]

SHORT GRBS AND DARK MATTER SEEDING IN NEUTRON STARS

M. Ángeles Pérez-García[1], F. Daigne[2] and J. Silk[2,3]
[1] Departament of Fundamental Physics and IUFFyM,
University of Salamanca, Plaza de la Merced s/n 37008 Salamanca, Spain
[2] UPMC-CNRS, UMR7095, Institut d'Astrophysique de Paris, 75014 Paris, France
[3] Oxford Physics, University of Oxford, Keble Road OX1 3RH, Oxford, United Kingdom

Draft version March 13, 2013

ABSTRACT

We present a mechanism based on internal self-annihilation of dark matter accreted from the galactic halo in the inner regions of neutron stars that may trigger the full or partial conversion into a quark star. We explain how this effect may induce a gamma-ray burst that could be classified as short, according to the usual definition [illegible] short gamma-ray emission. This mechanism differs in many aspects from the [illegible] associating short gamma-ray bursts with compact object binary mergers. We list possible observational signatures that should help to distinguish between these two possible classes of progenitors.

Subject headings: short gamma ray burst, dark matter, neutron star, quark star.

Published!

Strangelets and the TeV-PeV cosmic-ray anisotropies

Kumiko Kotera[1,*], M. Angeles Perez-Garcia[2,†], and Joseph Silk[1,‡]
[1] *Institut d'Astrophysique de Paris, UMR 7095 - CNRS,*
Université Pierre & Marie Curie, 98 bis boulevard Arago, 75014, Paris, France
[2] *Department of Fundamental Physics and IUFFyM,*
University of Salamanca, Plaza de la Merced s/n 37008 Salamanca

(Dated: March 7, 2013)

Several experiments (e.g., Milagro and IceCube) have reported the presence in the sky of regions with significant excess in the arrival direction distributions of Galactic cosmic rays in the TeV to PeV energy range. Here we study the possibility that these hotspots are a manifestation of the peculiar nature of these cosmic rays, and of the presence of molecular clouds near the sources. We propose that stable quark matter blobs or so-called *strangelets* can be emitted in the course of the transition of a neutron star to a more compact [illegible] object. A fraction of these massive particles would lose their charge by spallation or electron capture in molecular clouds located in the immediate neighborhood of their source, and propagate rectilinearly without decaying further, hence inducing anisotropies of the order of the cloud size. With reasonable astrophysical assumptions regarding the neutron star transition rate, strangelet injection and neutralization rates, we can reproduce successfully the observed hotspot characteristics and their distribution in the sky.

Published!

Updated CMB, X- and γ–ray constraints on majoron dark matter

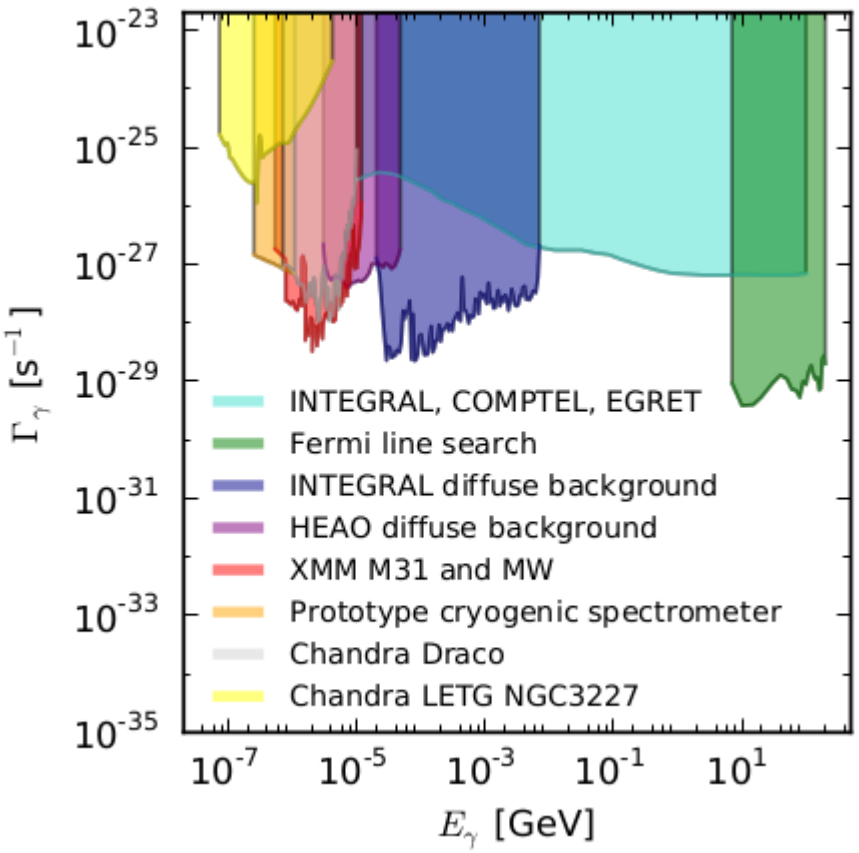
Massimiliano Lattanzi,[1,*] Signe Riemer-Sørensen,[2] Mariam Tórtola,[3] and J. W. F. Valle[3,†]

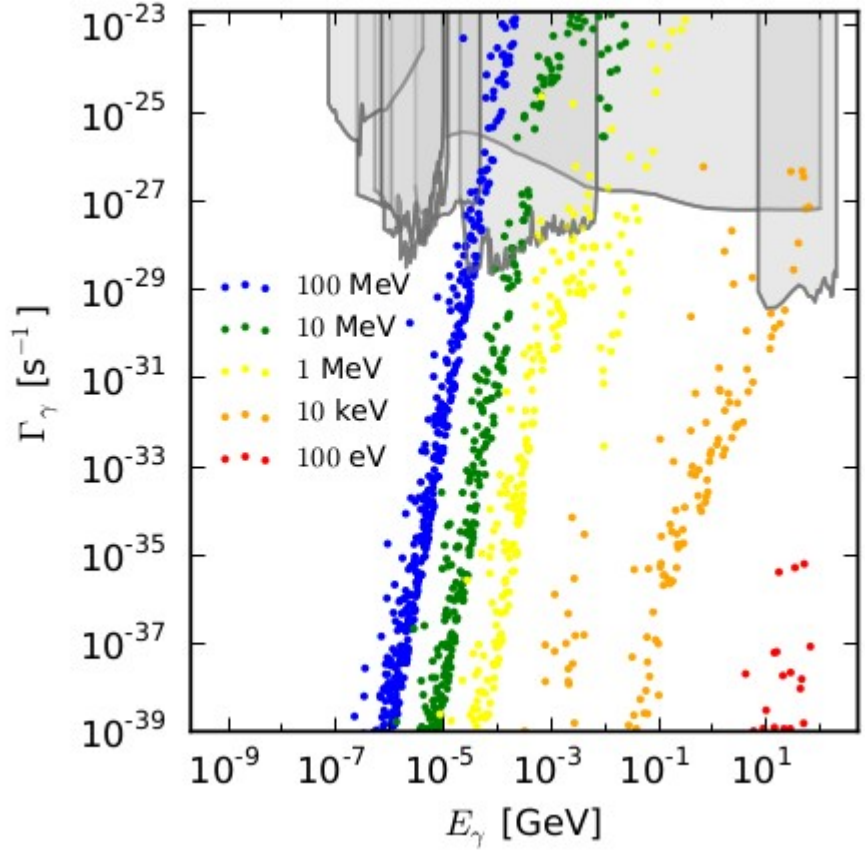
[1] *Dipartimento di Fisica e Science della Terra, Università di Ferrara and INFN, sezione di Ferrara, Polo Scientifico e Tecnologico - Edificio C Via Saragat, 1, I-44122 Ferrara Italy*

[2] *School of Mathematics and Physics, University of Queensland, St Lucia, Brisbane 4072, Queensland, Australia*

[3] *AHEP Group, Instituto de Física Corpuscular – C.S.I.C./Universitat de València Campus de Paterna, Apt 22085, E–46071 València, Spain*

The majoron provides an attractive dark matter candidate, directly associated to the mechanism responsible for spontaneous neutrino mass generation within the standard model $SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$ framework. Here we update the cosmological and astrophysical constraints on majoron dark matter coming from Cosmic Microwave Background (CMB) and a variety of X- and γ–ray observations.





Dark matter searches with cosmic antideuterons: status and perspectives

N. Fornengo, L. Maccione, A. Vittino

JCAP 1309 (2013) 031 arXiv:1306.4171

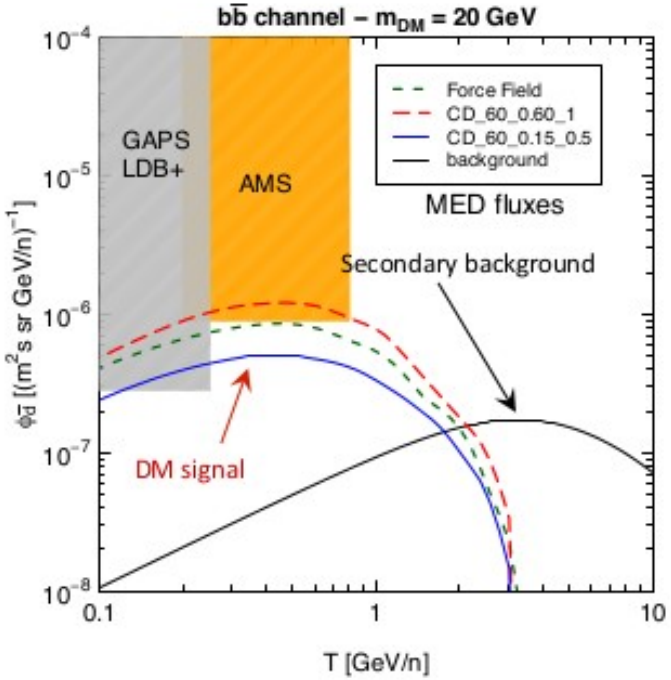
New, updated, analysis of the antideuteron signal from DM annihilation

The points that have been critically re-evaluated:

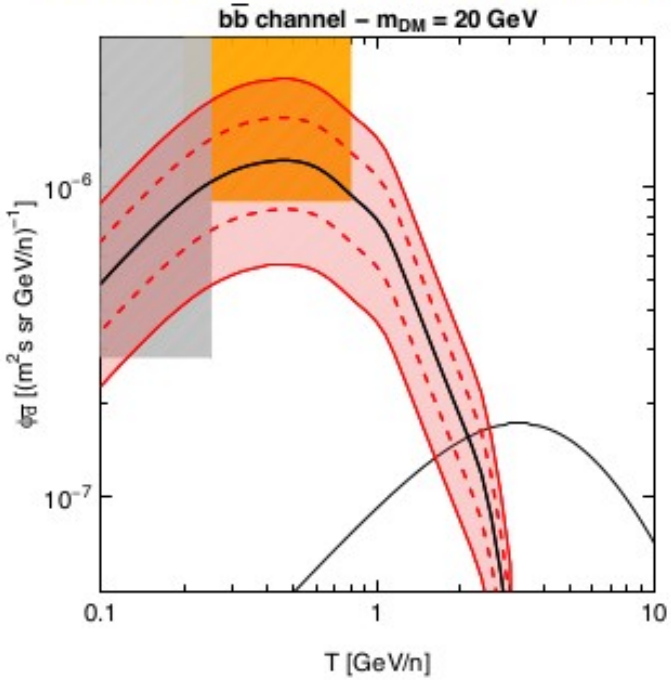
- Process of antideuteron formation: the coalescence mechanism
- Propagation in the heliosphere: solar modulation
- Expectations for proposed detectors (GAPS and AMS)

Prospects for AMS and GAPS re-determined: up to 10 antideuteron events possibile in both detectors

Detection prospects



Dependence on coalescence momentum



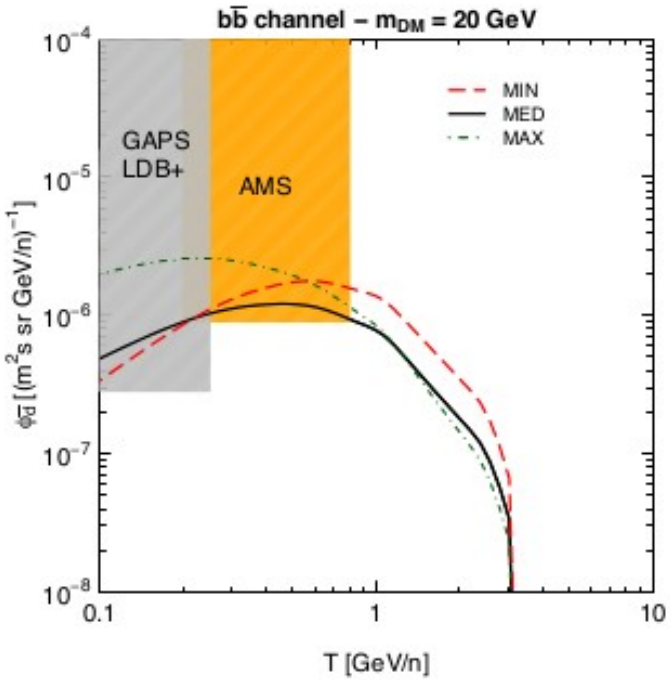
DM configurations allowed by antiproton bounds

Relevant detection prospects for Dbar energies below few Gev/n, where dependence on solar modulation modeling can have an impact on the DM signal up to a factor of 2

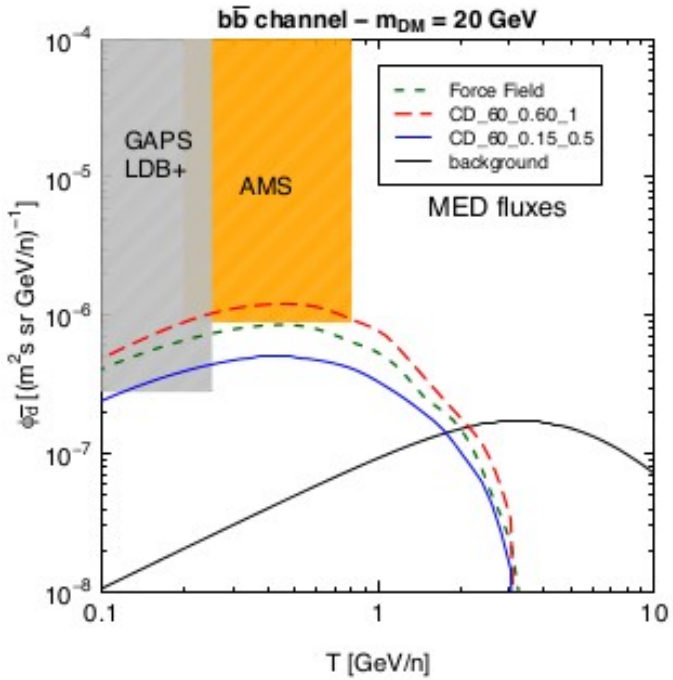
$$p_0 = (195 \pm 22)\ \mathrm{MeV}$$

Fornengo, Maccione, Vittino, JCAP 1309 (2013) 031 [arXiv:1306.4171]

Dependence on galactic transport

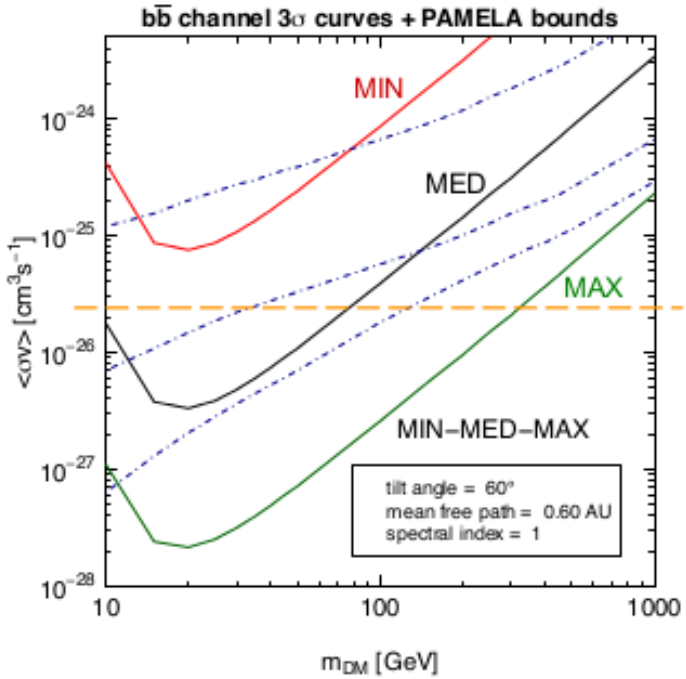


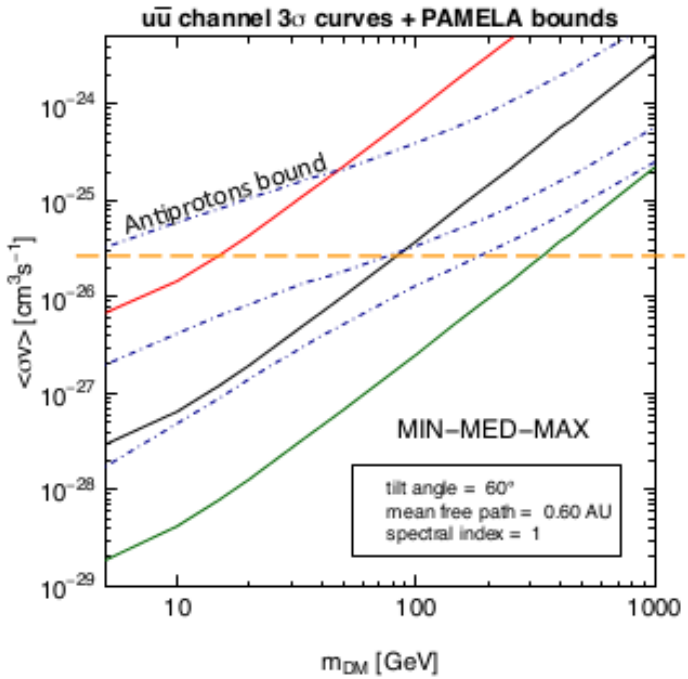
Dependence on heliosphere transport



Fornengo, Maccione, Vittino, JCAP 1309 (2013) 031 [arXiv:1306.4171]

Detection reachability at 3-sigma

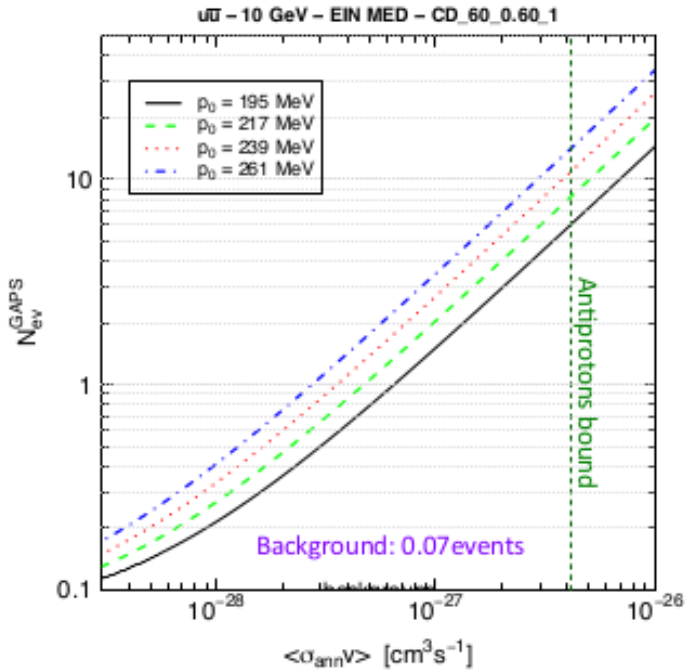


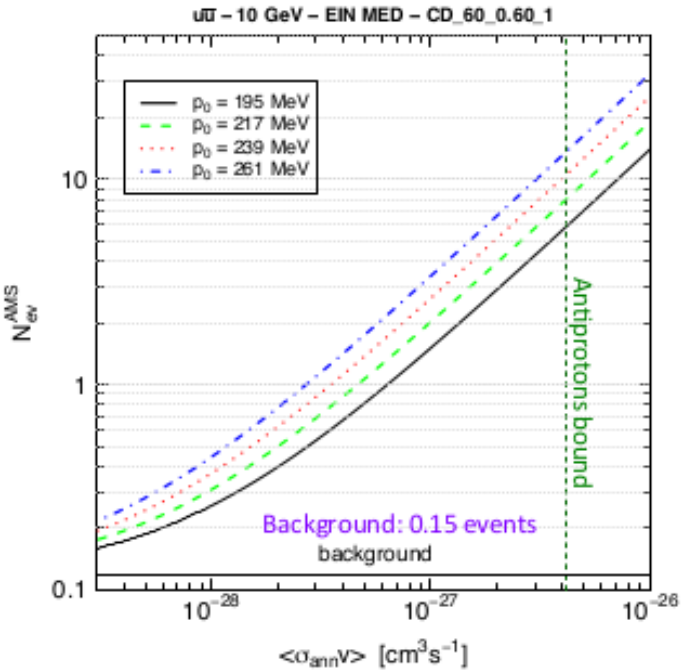


Example for GAPS LDB+ setup
3σ detection : N_{crit} = 1 events

Fornengo, Maccione, Vittino, JCAP 1309 (2013) 031 [arXiv:1306.4171]

Events expected in GAPS and AMS





For GAPS LDB+ setup

For AMS nominal sensitivity

Fornengo, Maccione, Vittino, JCAP 1309 (2013) 031 [arXiv:1306.4171]

Reliability of Monte Carlo event generators for gamma ray searches

Published!

$$\frac{\mathrm{d}\,\Phi_\gamma^{\mathrm{DM}}}{\mathrm{d}\,E_\gamma} = \frac{1}{4\pi M^2}\sum_i \langle\sigma_i v\rangle \frac{\mathrm{d}\,N_\gamma^i}{\mathrm{d}\,E_\gamma} \times \frac{1}{\Delta\Omega}\int_{\Delta\Omega}\mathrm{d}\Omega \int_{l.o.s.} \rho^2[(s)]\mathrm{d}s$$

Fortran Code: PYTHIA 6.4, HERWIG C++ Code: PYTHIA 8, HERWIG++

Intrinsic differences:

1) Parton Shower Evolution Variable
2) Hadronization Model (String in PYTHIAs o Cluster in HERWIGs)
3) QED Final State Radiation: 2->2 EW Processes and Bremsstrahlung
4) Top decay

PRELIMINARY

Software	$t\bar{t}$ Process	leptonic Bremsstrahlung
PYTHIA 6.4	Not implemented	Implemented
PYTHIA 8	Implemented	Implemented
HERWIG	Implemented	Partially implemented
HERWIG++	Implemented	Not implemented

J.A.R. Cembranos, A. de la Cruz-Dombriz, V. Gammaldi, R. Lineros, A.L. Maroto. UCM-th and IFIC Valencia

Group members: J.A. Barrio, K. Satalecka, N. Mirabal, J.L. Contreras, ~~I. Lozano~~

A search for DM subhalo candidates in the γ-ray band

K. Satalecka, I. Lozano, D. Nieto, J.A. Barrio (UCM-GAE)

- Search for DM subhalo candidates among 2FGL UFOs

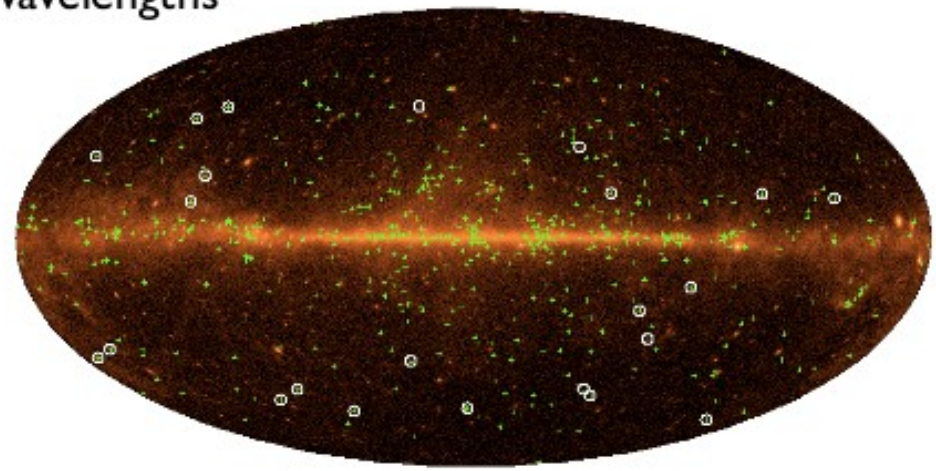
- Selection criteria:

–Location outside the Galactic Plane (b >10°)
–Non time-variable (var. index < 41.6)
–Hard spectrum + detection > 10 GeV

- Search for possible counterparts in other wavelengths

- Detection prospects for CTA and MAGIC

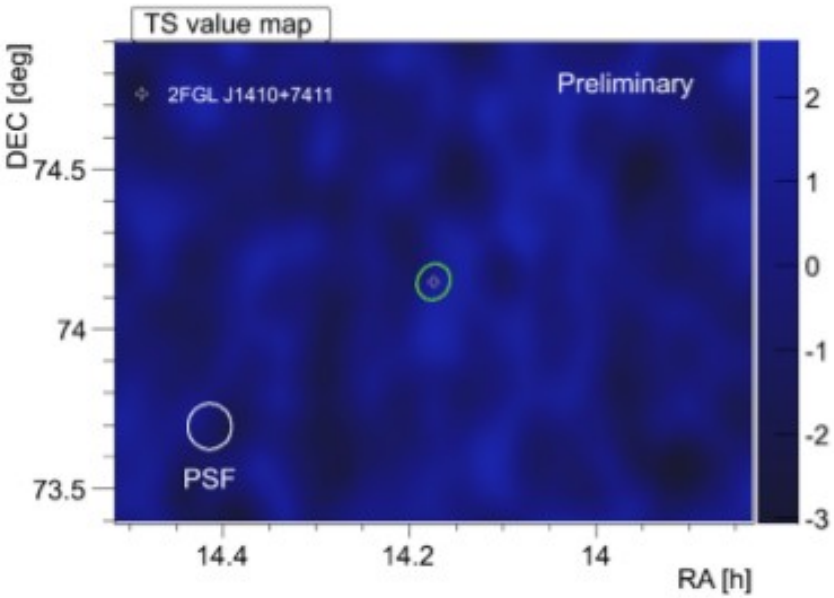
- Results: 23 candidates
  3 w/o counterparts (1 North, 2 South)

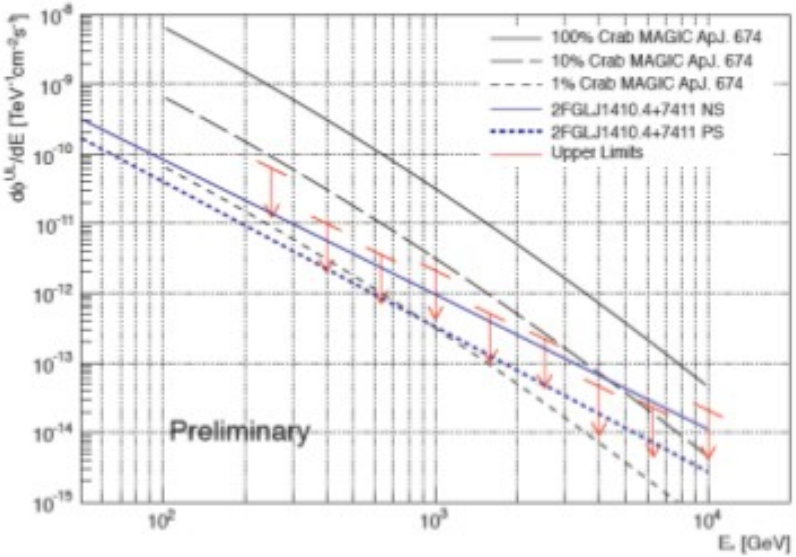


Stay tuned - paper coming soon!!!

MAGIC observations of DM subhalo candidate from 2FGL

K. Satalecka, I. Lozano, D. Nieto, J.A. Barrio (UCM-GAE)





- **2FGL J1410+7411** - best candidate for MAGIC:
- 36 h NS for 5 σ detection
- caveat: ZA > 45 deg
- 21 h observed ➡ only 7 h good quality data
- no signal found >200 GeV
- MAGIC ULs compatible with direct extrapolation of Fermi spectrum

Results presented on ICRC 2013
Stay tuned - MAGIC paper with 1FGL+2FGL UFO observations coming soon!!!

arXiv:1305.4710

A modified survey strategy for Fermi

Weniger, Su, Finkbeiner, Bringmann, Mirabal (UCM-GAE)

- Need to clarify significance of 130 GeV spectral feature at Galactic Center observed by Fermi LAT

- Fermi solicited new observing strategies beyond five years of operations

- Weniger et al. (2013) proposed a modified survey strategy that would increase exposure per orbit on the Galactic Center by a factor 2.2

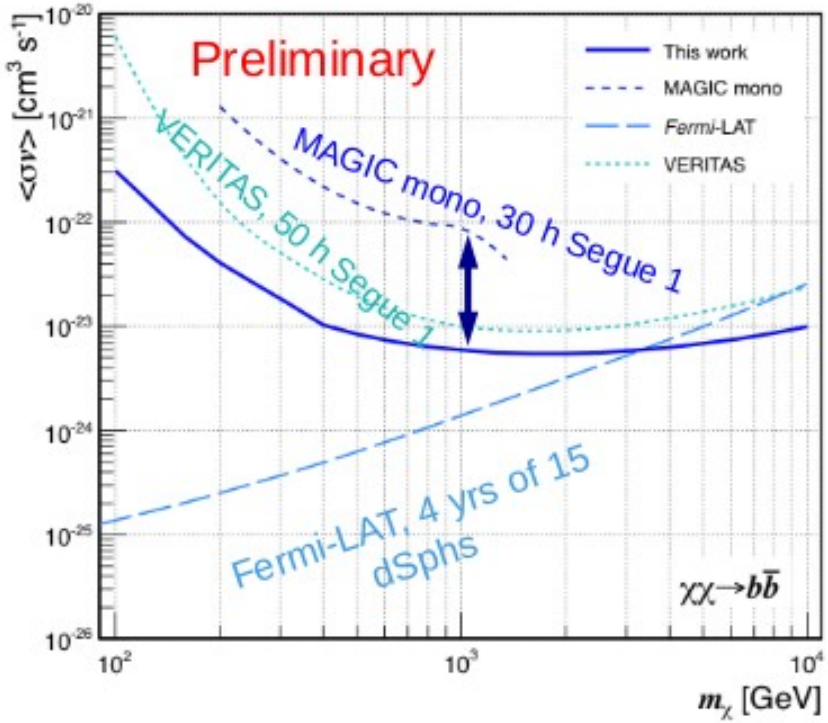
- This should help to discriminate signal for null hypothesis

New strategy recommended by Fermi committee to start in 2014, needs to be confirmed

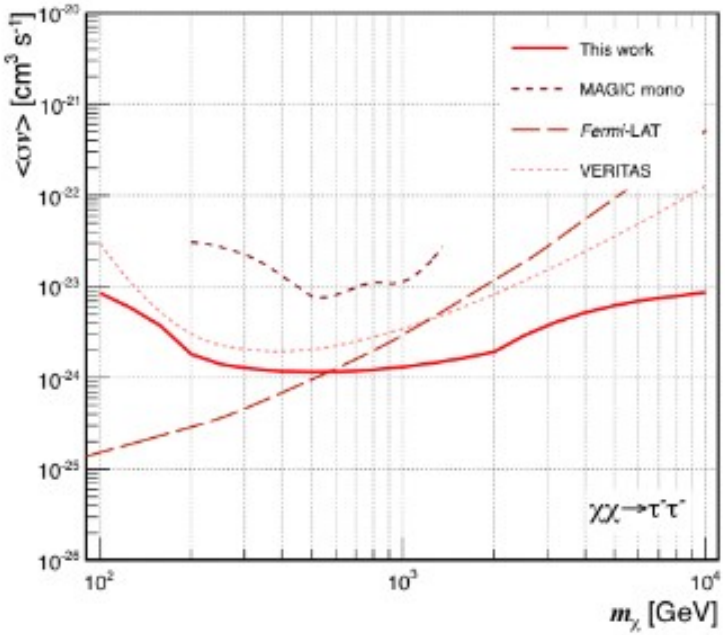
Dark Matter Searches with MAGIC

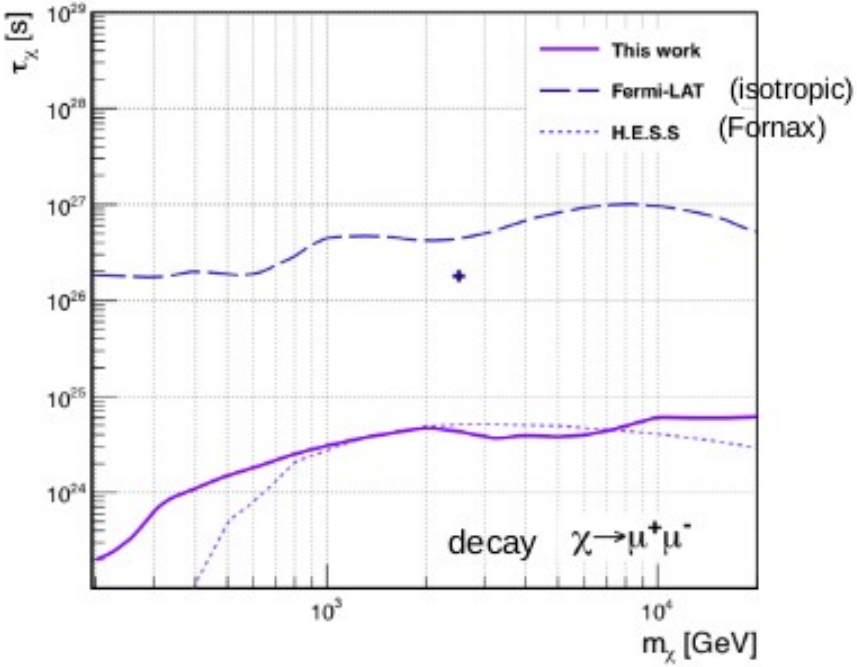
- Sustained effort in indirect dark matter searches
- All previously published results with MAGIC-I only
- Results of first DM-dedicated campaign with the full MAGIC system presented this summer (ICRC, HEP)
- Journal paper now in internal refereeing stage

  - Period: January 2011 – February 2013
- 157.9 hours of good quality observations of the dwarf spheroidal galaxy Segue-I
- No signal found ($S = -0.5\ \sigma$)
- Constraints on DM annihilation & decay, derived with a likelihood approach accounting for spectral features.
- m_χ in the 100 GeV – 10 TeV (200 GeV – 20 TeV) range

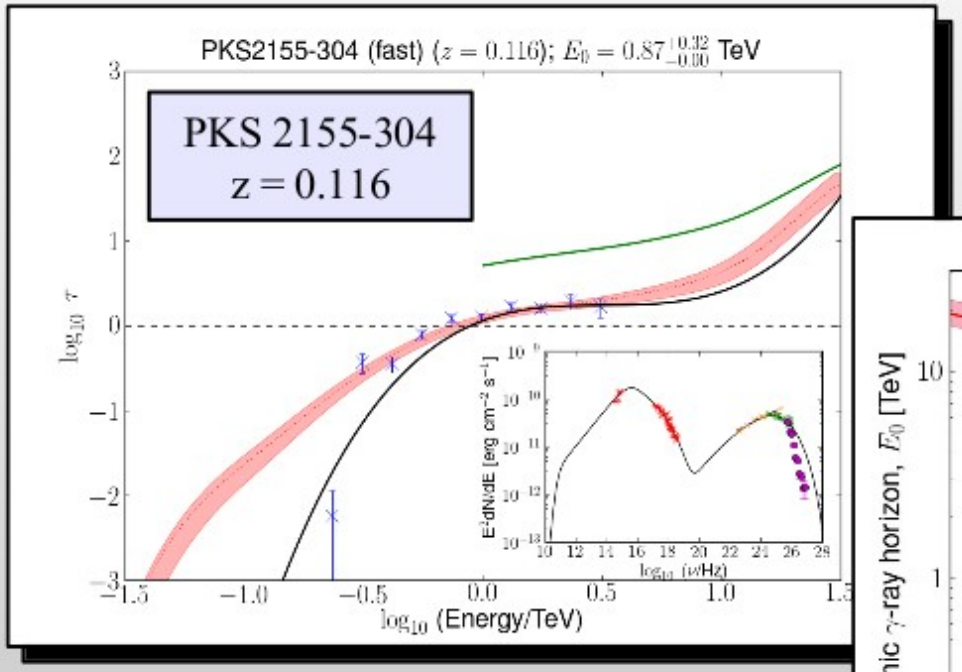


- O(10) improvement w.r.t. previous MAGIC result
- Best limits with IACTs on dSphs
- Ann. constraints competitive with Fermi-LAT in some mass range, depending on the

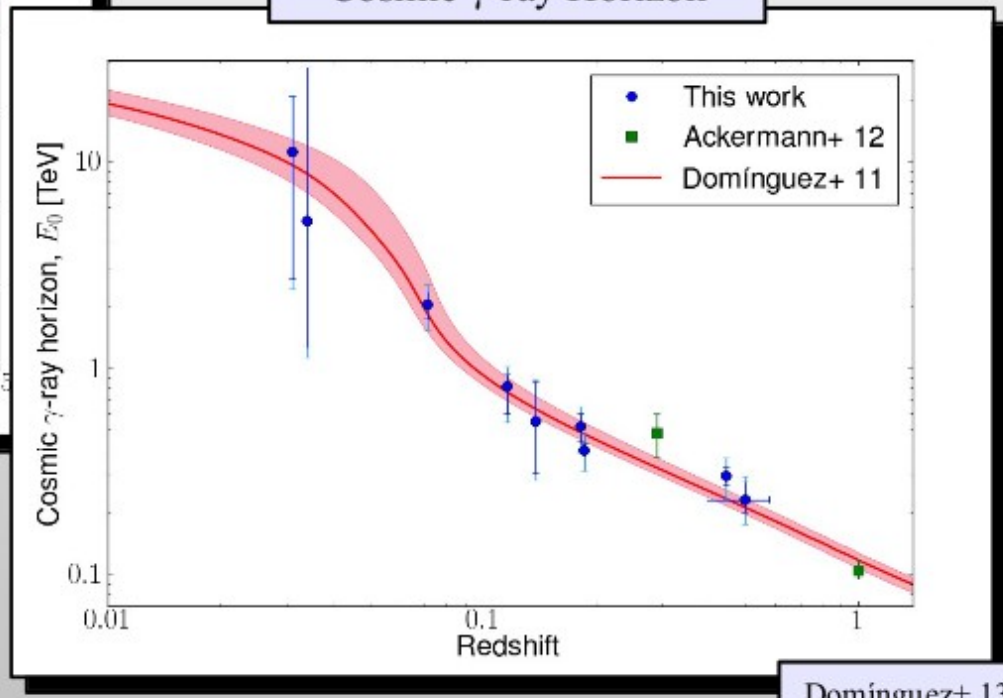




The Measurement of the Expansion Rate of the Universe from γ-ray Astronomy



The detection of the Cosmic γ-ray Horizon

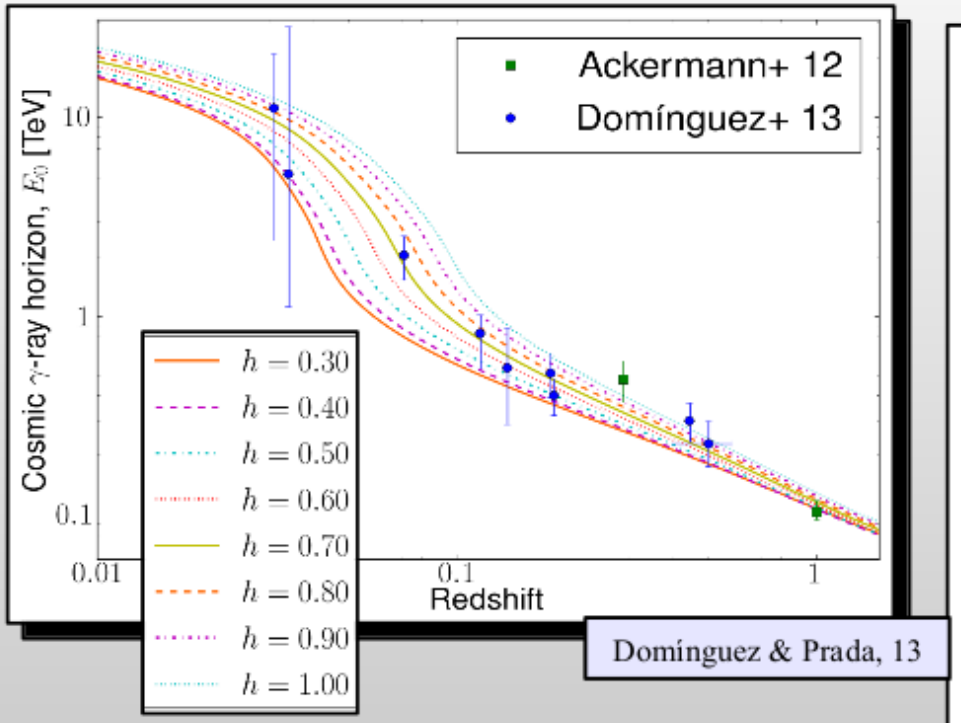


Domínguez+ 13

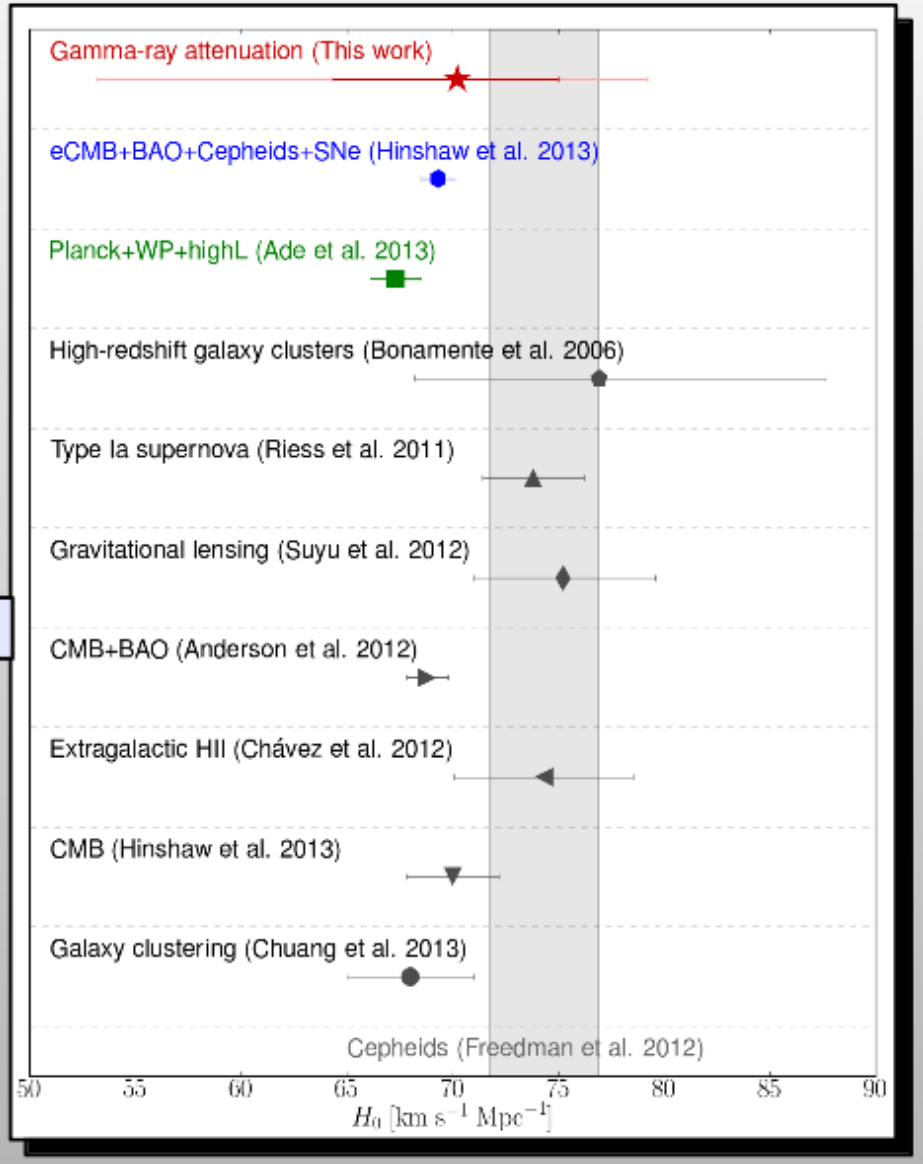
Published!

The measurement of the CGRH is a primary scientific goal of the Fermi Gamma-Ray Telescope (Hartmann 07; Stecker 07; Kashlinsky & Band 07)

The Measurement of the Expansion Rate of the Universe from γ-ray Astronomy



Domínguez & Prada, 13



$$H_0 = 70.2^{+4.8}_{-5.9}{}^{+7.6}_{-16.0}\ \text{km/s/Mpc}$$

Statistical uncertainties **Systematic uncertainties**

Published!

Constraints on WIMP Annihilation for Contracted DM in the Inner Galaxy with the Fermi-LAT

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JCAP 10 (2013) 29

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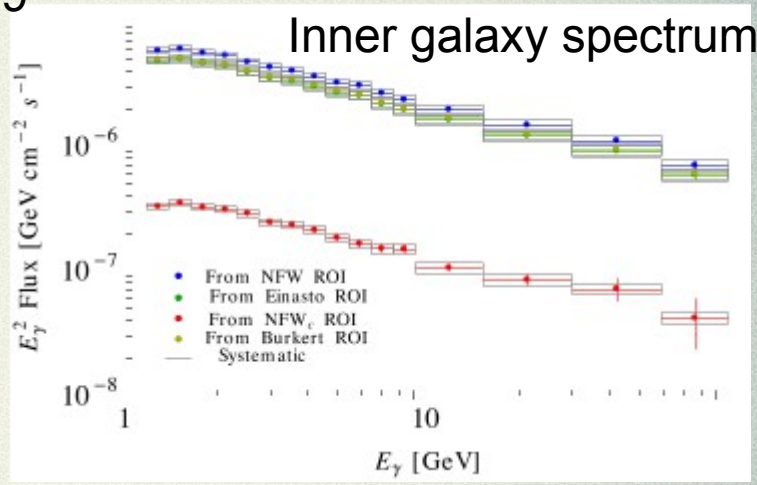
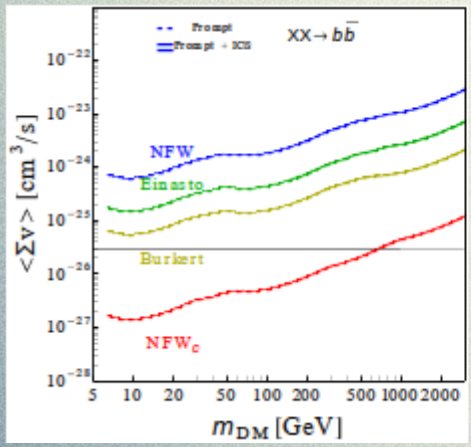
Profile	θ_1 [deg]	θ_2 [deg]	$\lvert b\rvert$ [deg]	$\Delta\Omega$ [sr]	$\bar{J}(\Delta\Omega)\,\Delta\Omega$ [$\times 10^{22}$ GeV^2 cm^{-5} sr]	Flux (1 – 100 GeV) [$\times 10^{-7}$ cm^{-2}s^{-1}]
Einasto	0.7	15.6	0.7	0.217	5.1	31.4 ± 0.3
NFW	0.6	16.7	0.6	0.253	3.3	38.0 ± 0.3
NFW$_c$	1.0	3.0	1.0	0.005	86.8	2.2 ± 0.1
Burkert	0.6	15.9	0.8	0.225	41.9	32.1 ± 0.3

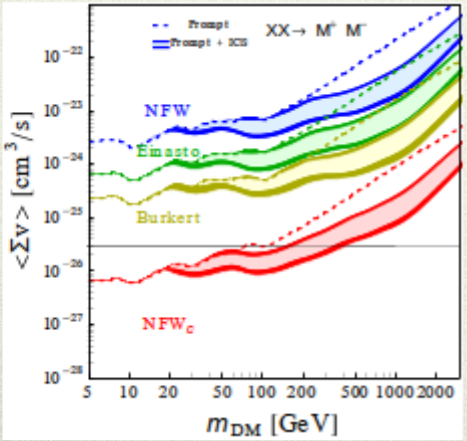
DM predictions for optimized regions

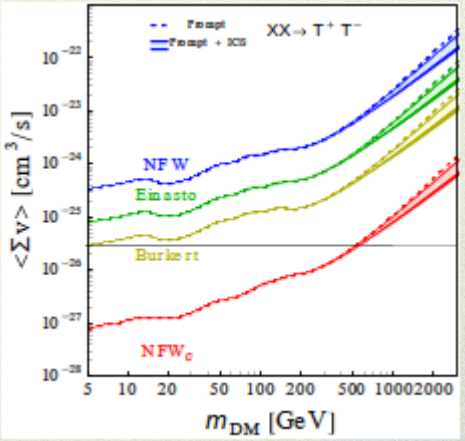
VS.

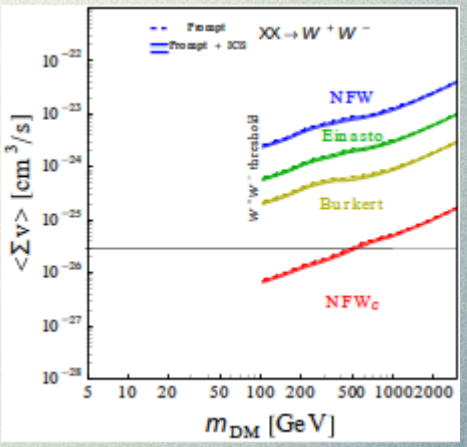
Inner galaxy spectrum







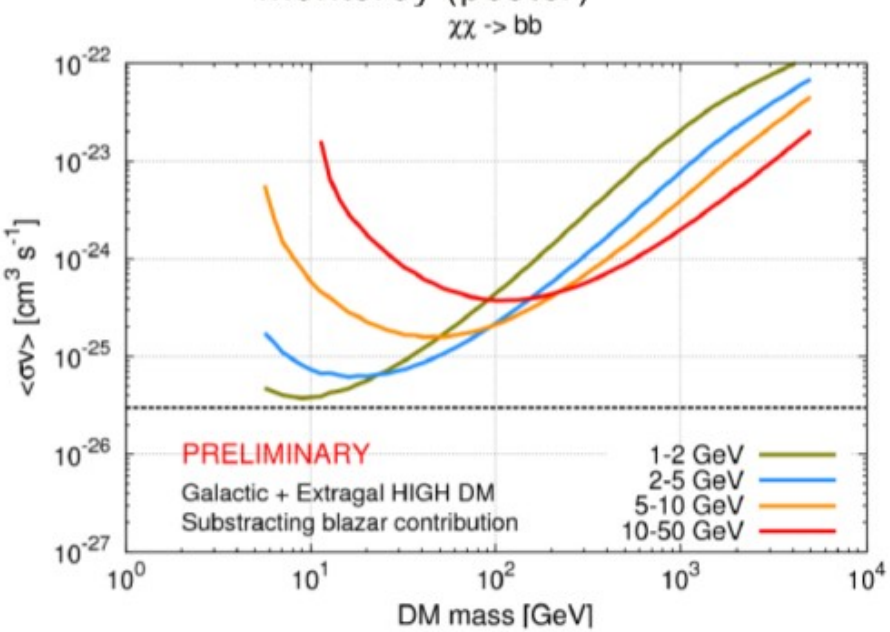


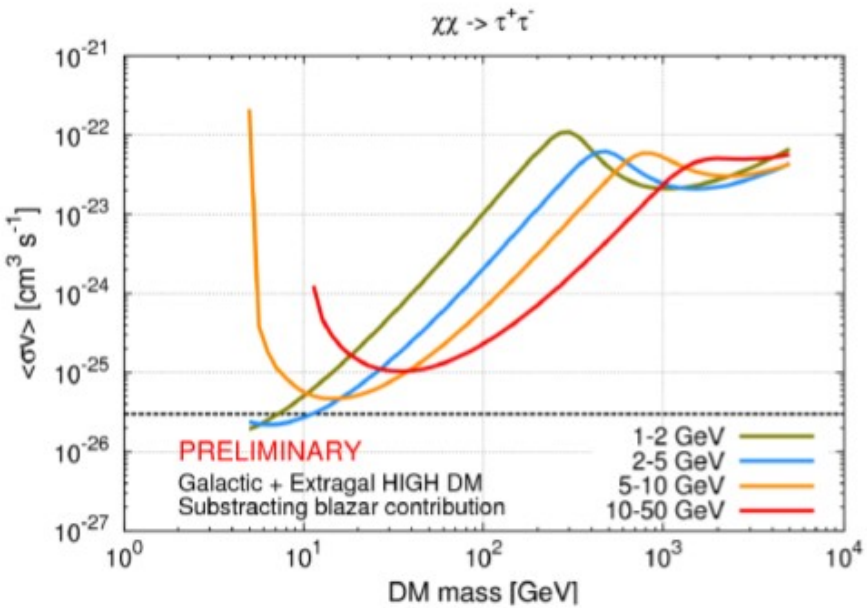


DM constraints from extragalactic anisotropies
(brief update)

Compare our model with the improved Fermi-LAT measurement of the anisotropies APS and put constraints on the DM

- new Fermi measurement! More energy bins, smaller statistical errors
- compute the APS from the DM-induced gamma-ray emission for a set of DM candidates (changing mass and annihilation channel) and put constraints on the cross section, requiring that the DM signal do not overshoot the data
- same for decaying DM
- results already presented at the 2012 Fermi Symposium Monterey (poster)





POINTS FOR DISCUSSION

- How to improve our synergies?
  - Brainstorming workshops between our members.
  - Participating in the mailing list.
  - Visiting other MD institutions.
  - Sending summary reports.
  - PLEASE PROPOSE!!
- Common gamma and CR activities
- Common WG activities with the other WGs

Mainly gammas
Mainly CRs
Other WGs already collaborating with ours

Thank you and

Don't forget to do the survey

http://goo.gl/2gHfAy

Backup

25 FERMI dwarf

Gamma-Light

FERMI survey strategy

Exclusion lines Segue I