Overview Of Dark Matter Searches With H.E.S.S.

Emrah Birsin

H.E.S.S.

HUMBOLDT-UNIVERSITÄT ZU BERLIN

Overview

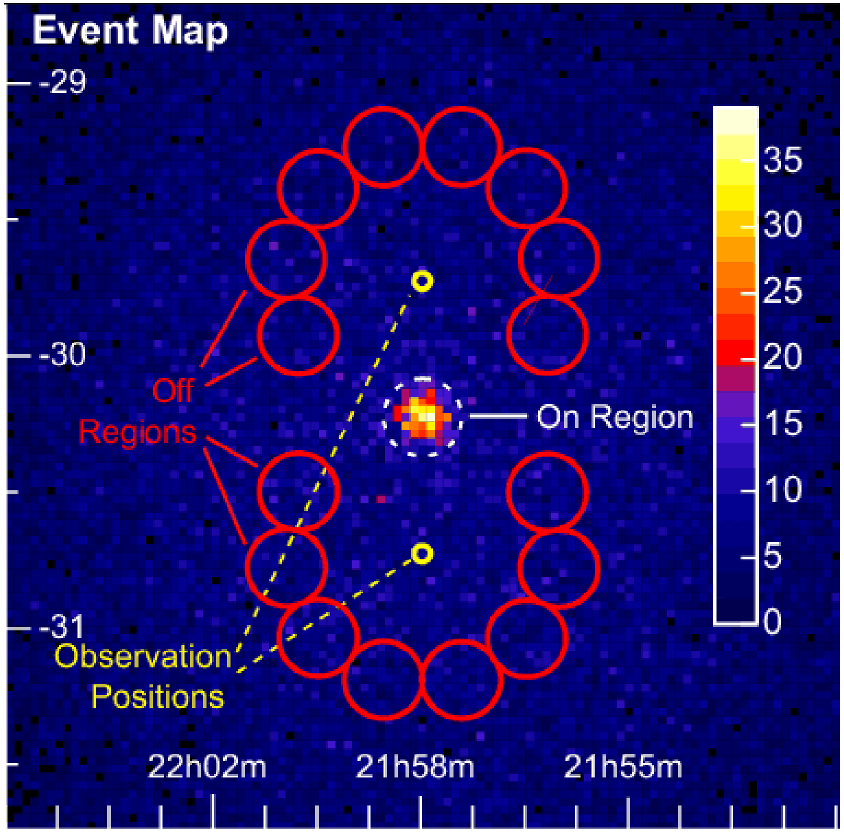
- The H.E.S.S. experiment
- Indirect DM searches
- Targets & Results
  - Sagittarius dwarf galaxy
  - Galactic center

The H.E.S.S. Array

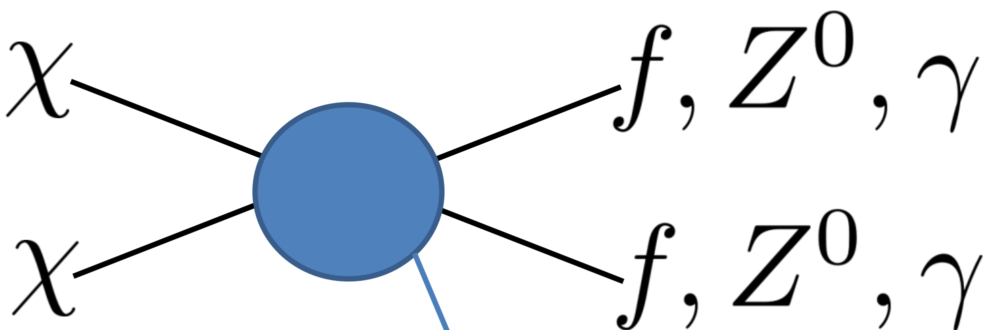
- Detects Cherenkov light from particle showers
- 4 telescopes ($108m^2$ mirror area each) on square with 120m side length
  - Energy threshold 100GeV
  - FoV 5°, angular resolution $\approx 0.1^\circ$, energy resolution 15%
- new 1 big ($614m^2$ mirror area) telescope in the center of the square
  - Lowered energy threshold ~30 GeV
- Background dominated → Background subtraction
- Dark matter results for H.E.S.S. I (4 small telescopes)

Background Estimation

- Acceptance radial symmetric around observation position
- Source free regions with same angular distance as Target area used for Background estimations



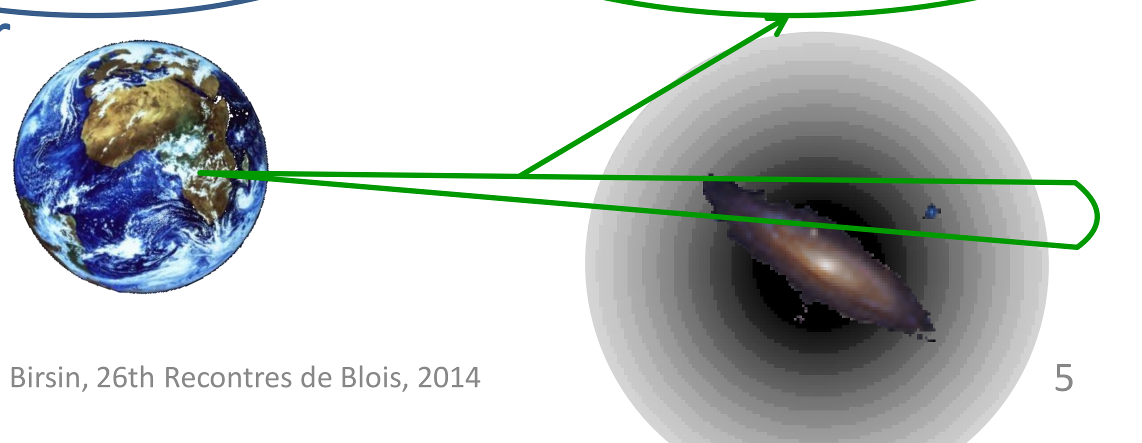
Indirect Dark Matter Searches



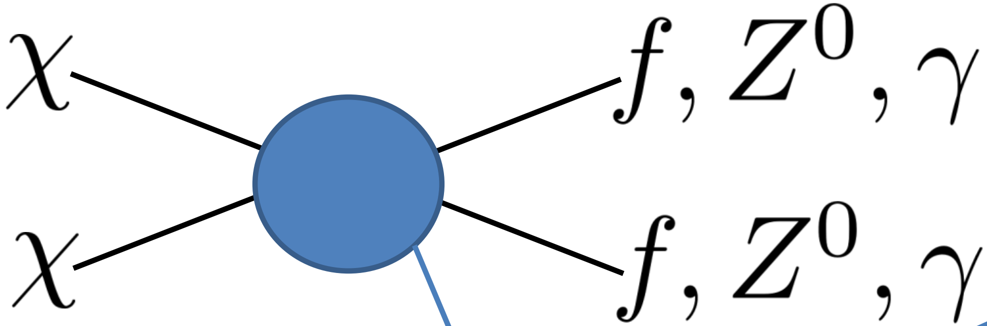
Astrophysical factor (J)

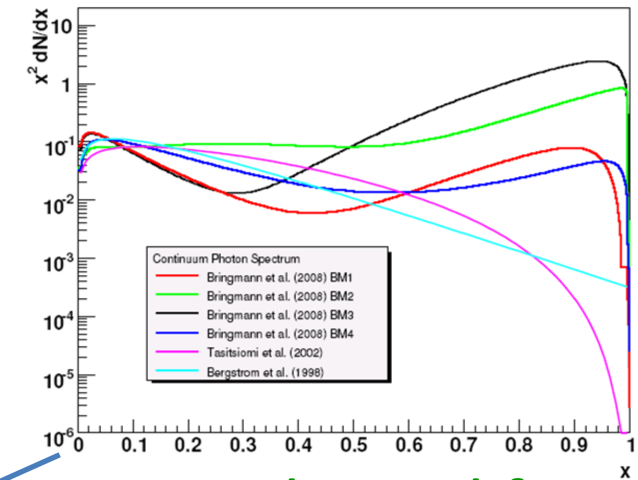
$$\frac{d\Phi}{dE} = \frac{1}{8\pi} \frac{1}{m_\chi^2} \frac{dN_\gamma}{dE} \langle \sigma v \rangle \int_{los} \rho^2 (\Omega)\, d\Omega$$

Particle physics factor



Indirect Dark Matter Searches





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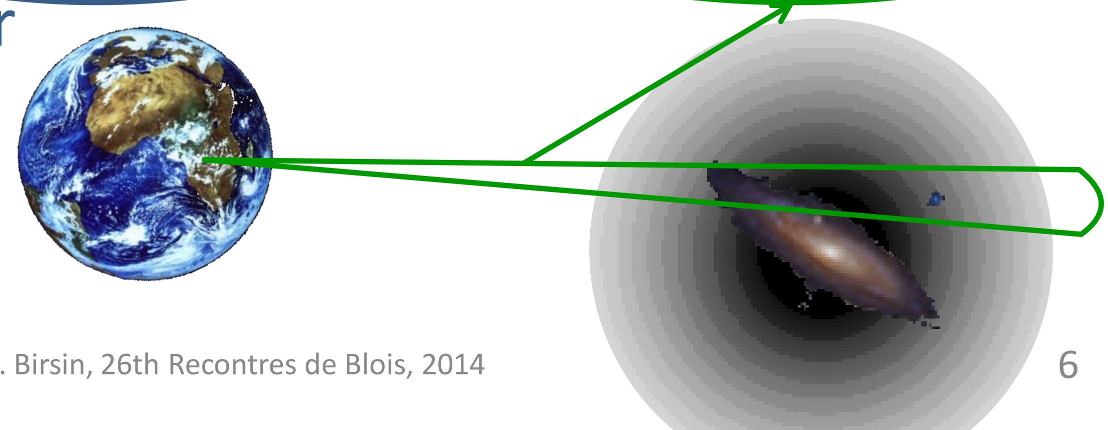
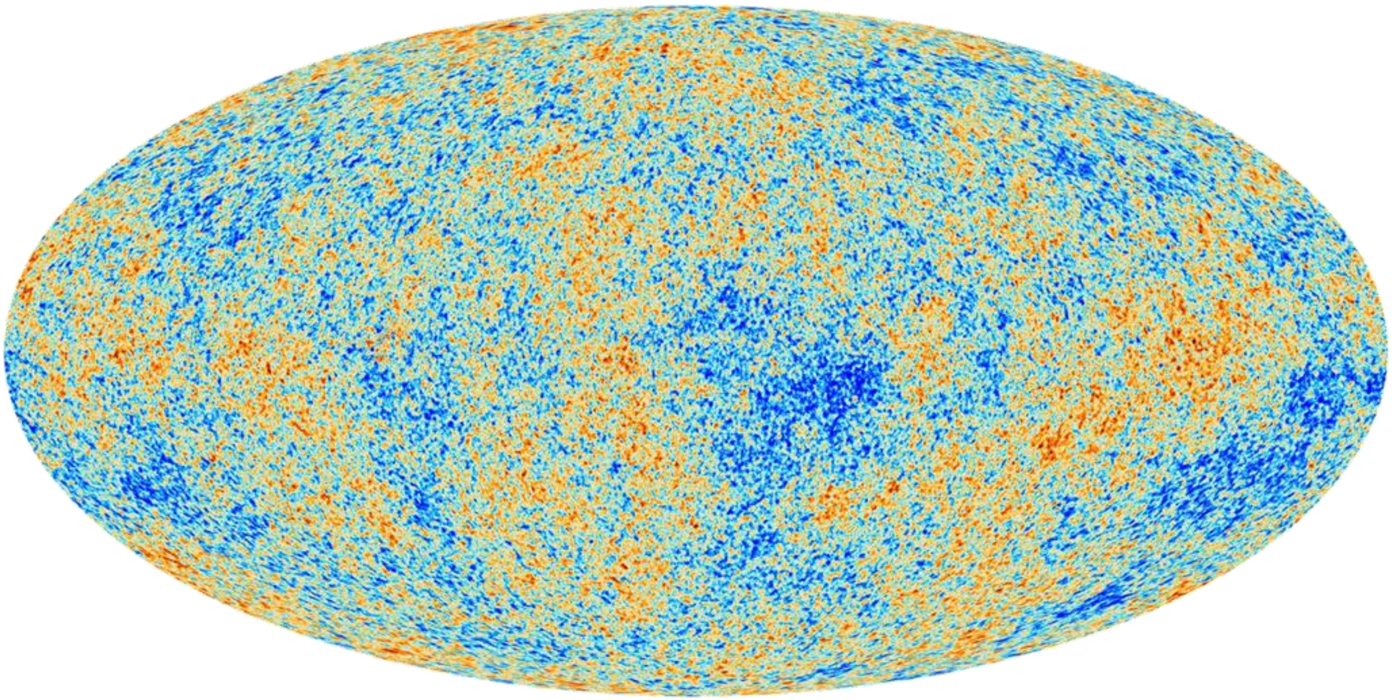


Thermal Dark Matter

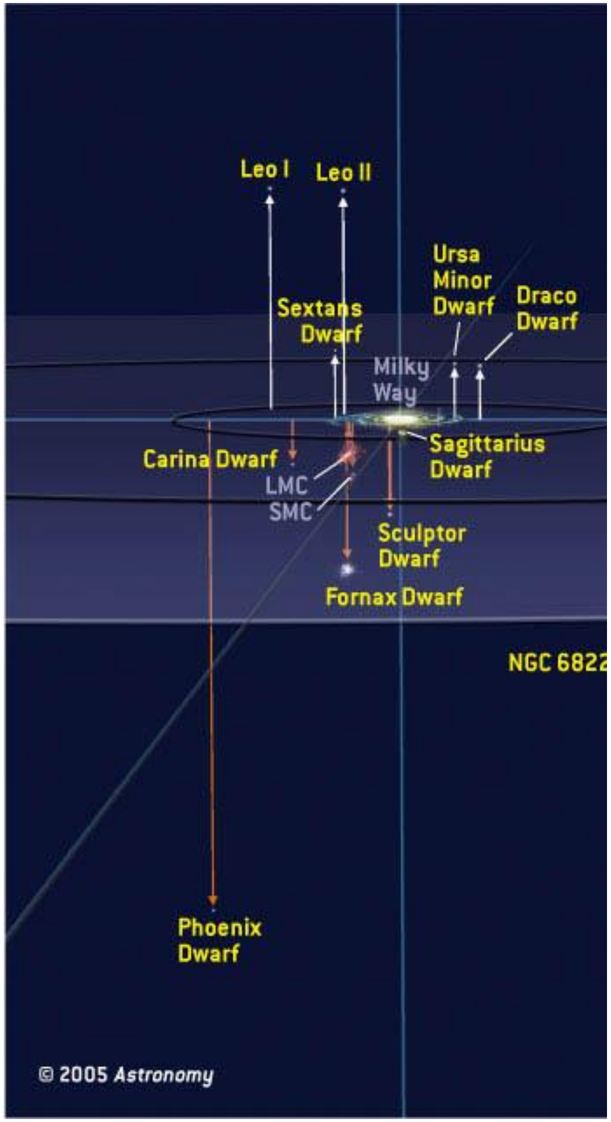
$$\Omega_{dm}h^2 \approx \frac{3\cdot 10^{-27} cm^3 s^{-1}}{\langle \sigma v \rangle} = 0.1$$

Expect to see WIMP Dark Matter around $\langle \sigma v \rangle = 3 \cdot 10^{-26} cm^3 s^{-1}$

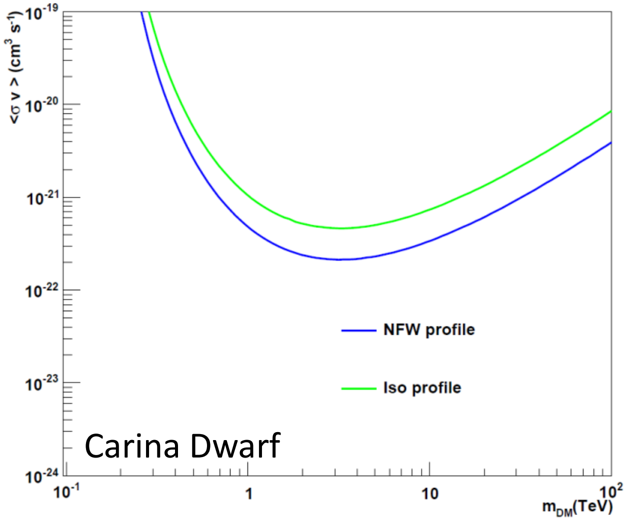


Dwarf Galaxies I

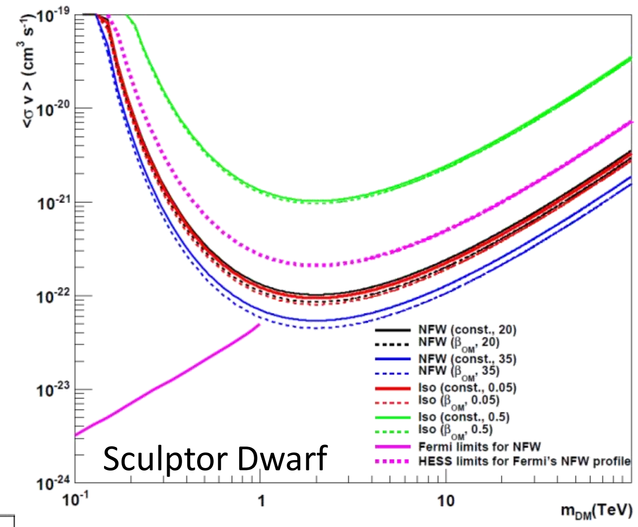
- Close by $\mathcal{O}(10kpc)$
- Dwarf galaxies are devoid of astrophysical γ-ray sources
- High mass-to-light ratios (5-100)
- Expected DM content inside a small angular size → no contamination of the background region

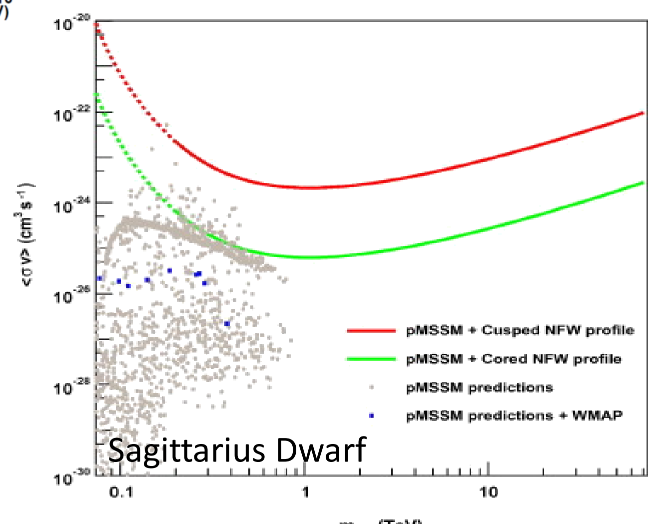


Dwarf Galaxies II



- Several dwarfs investigated
- limits strongly depends on astrophysical factor

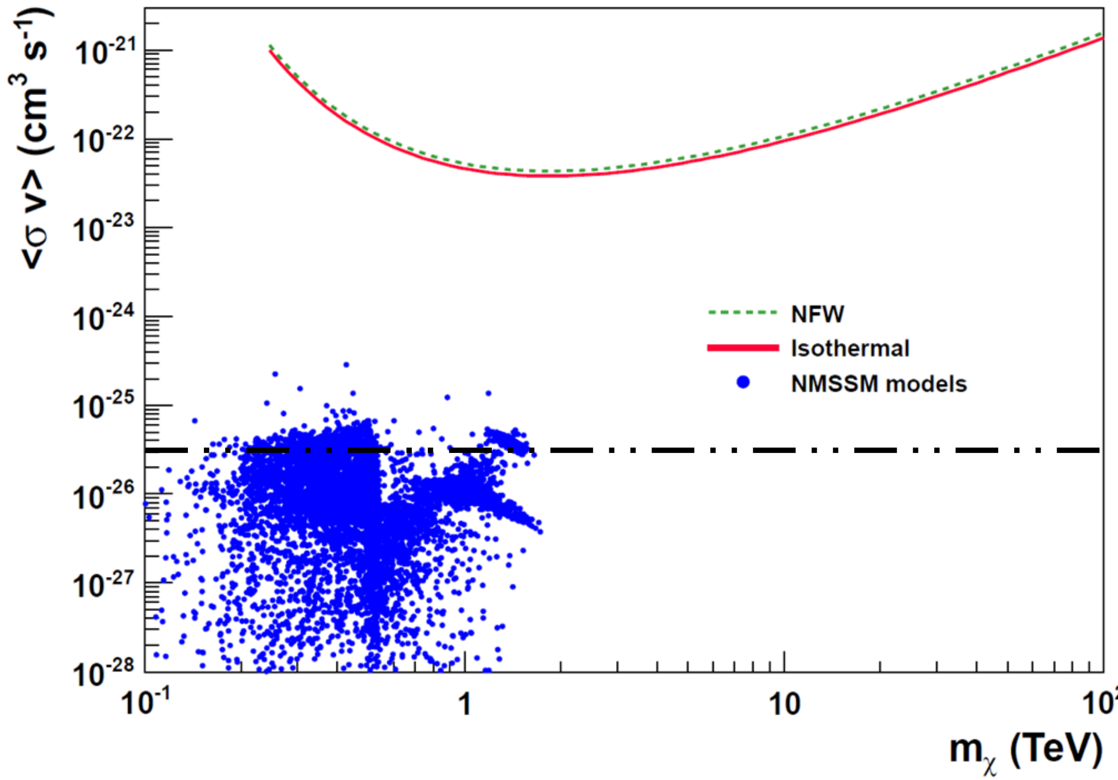




Sagittarius Dwarf Galaxy

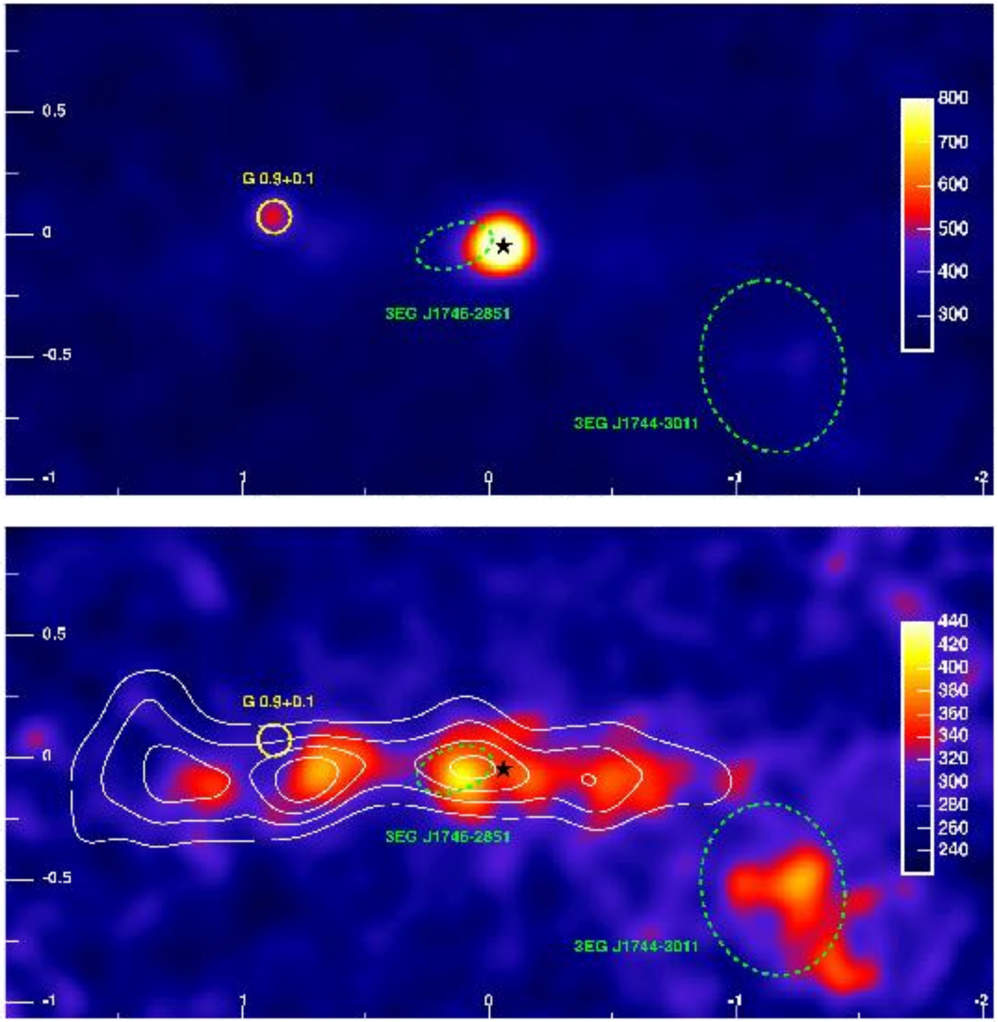
- 90h of data
- new J-factor takes into account tides

arXiv: 1307.4918



Galactic Center

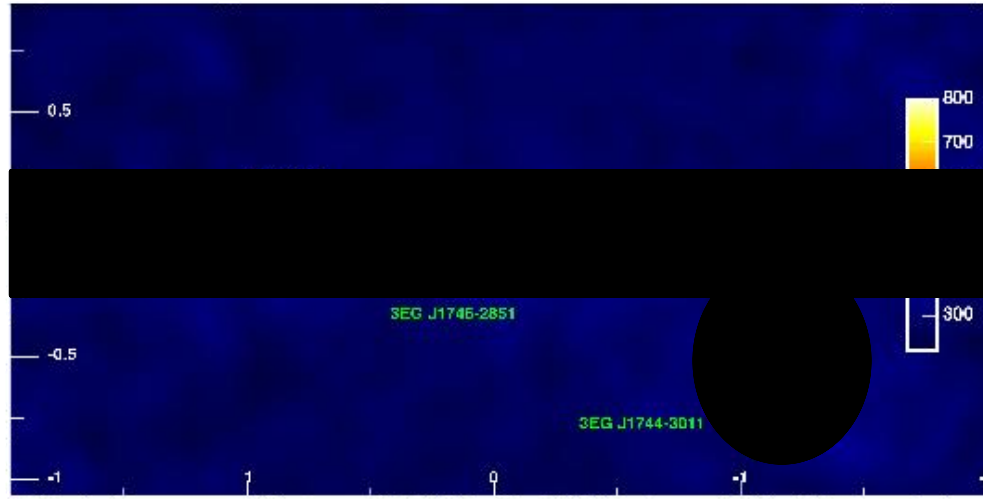
- Two strong point-like sources
  - GC source could be PWN or central black hole
- Diffuse emission along the galactic plane

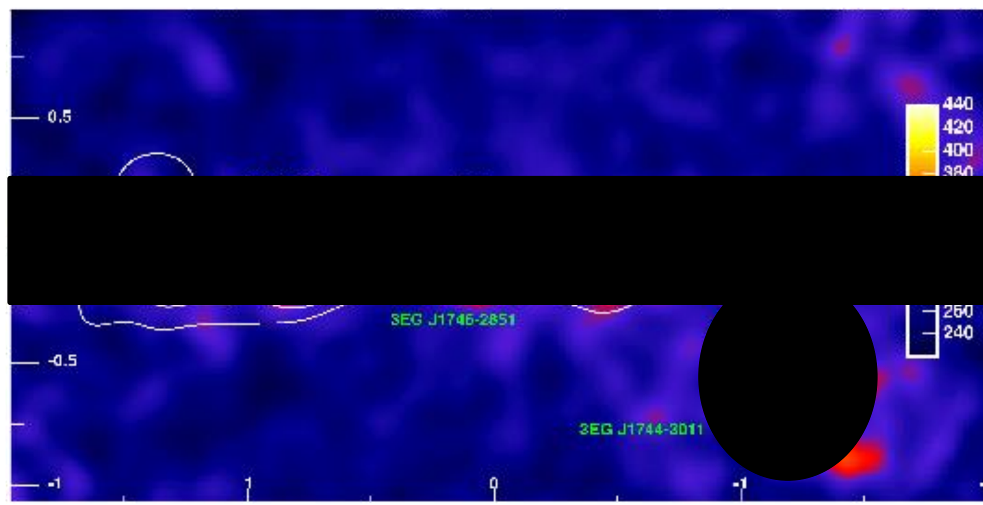


Galactic Center

- Two strong point-like sources
  - GC source could be PWN or central black hole
- Diffuse emission along the galactic plane

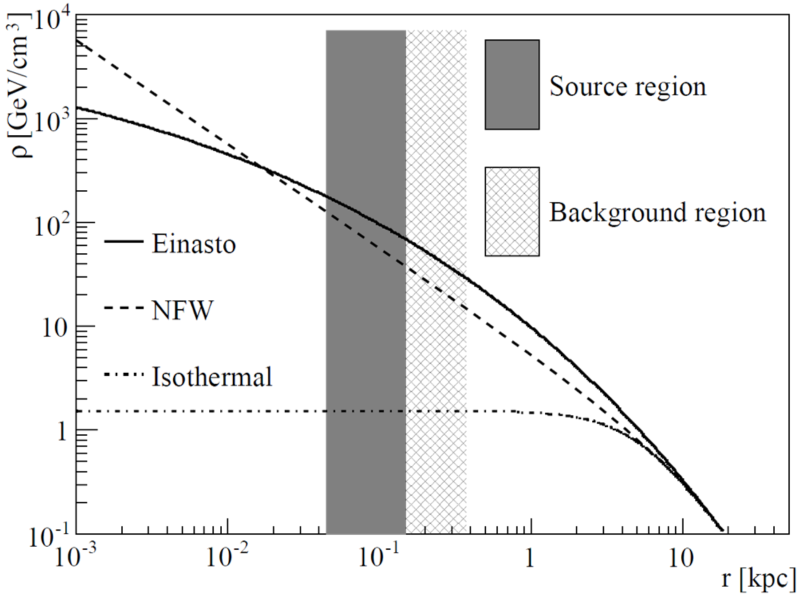
- Exclude known sources and the galactic plane

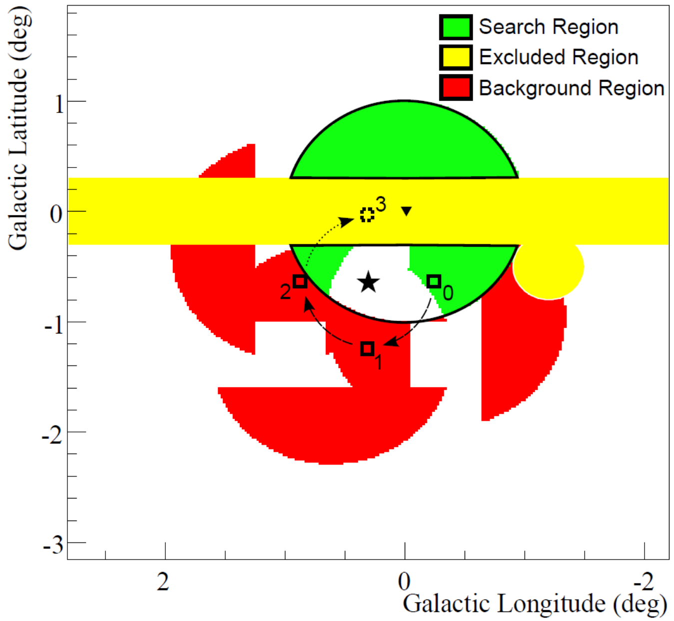




GC Halo Search

- less dependent on DM density profile
- 112h of data from GC
- Rotated pixel method, special version of a standard background method
  - background regions expected to contain dark matter annihilation

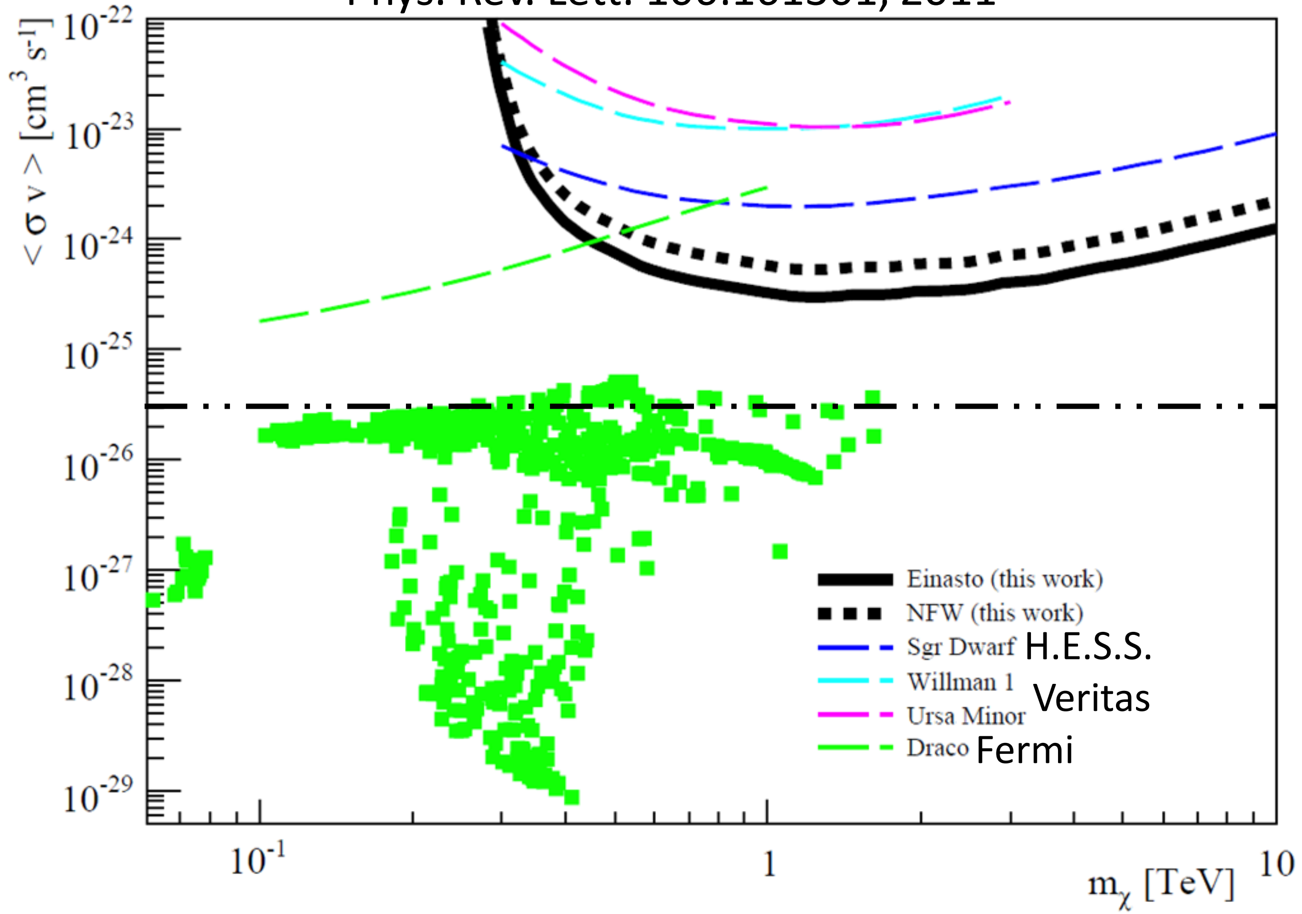




GC Halo Results

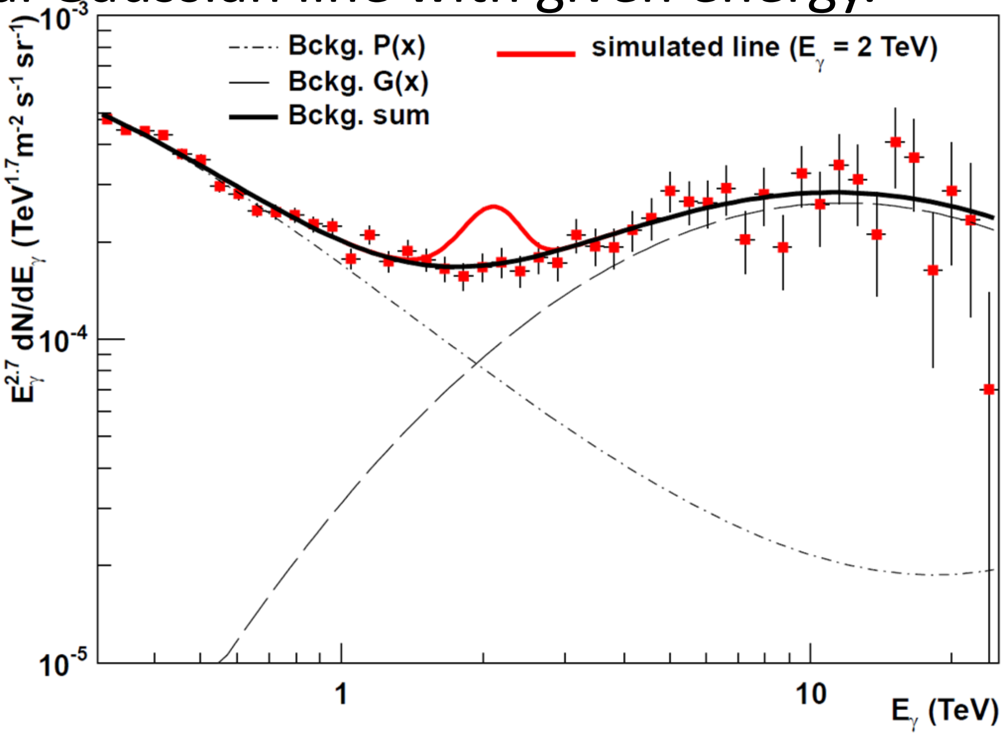
- Best limit
- best sensitivity at ~1 TeV
- still one order of magnitude above relic density prediction

Phys. Rev. Lett. 106:161301, 2011



GC Line Search

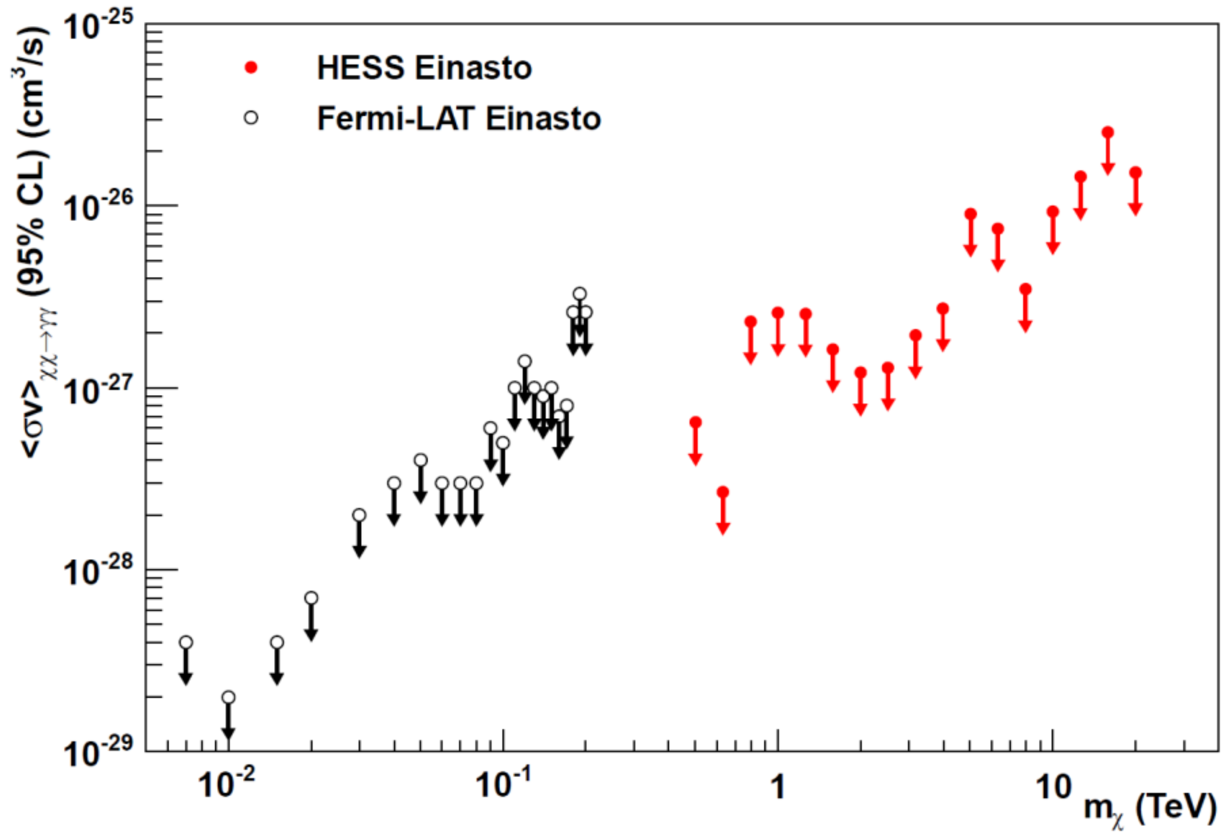
- Lines are smoking gun signatures
- Use all γ-ray like events in FoV, no background subtraction
- Fit Spectrum with additional Gaussian line with given energy.
- Not only sensitive to lines but also “peaks” like internal Bremsstrahlung



GC Line Search Results

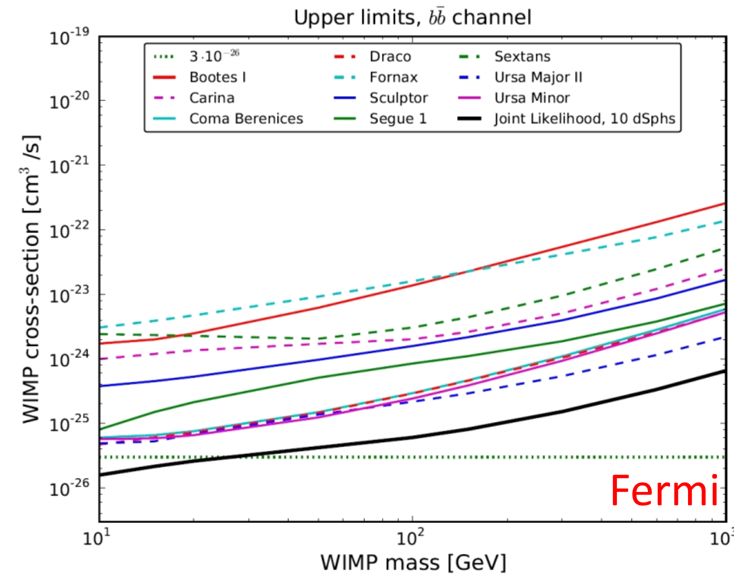
- Limits from binned Likelihood assuming Poisson fluctuations
- complimentary to Fermi “standard” line search

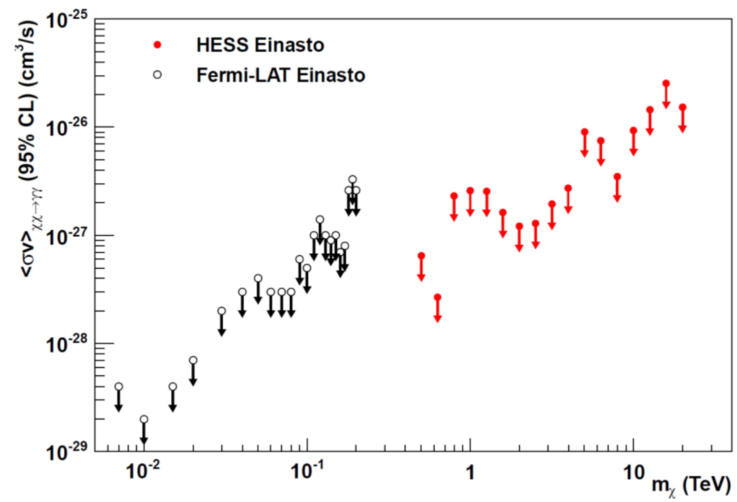
Phys.Rev.Lett. 110: 041301, 2013



Outlook (I)

- Dwarf stacking
  - combining results for better more robust limits
- H.E.S.S. II will lowers the energy threshold
  - close the gap to Fermi in the line search
  - look for the Fermi $130 GeV$ line

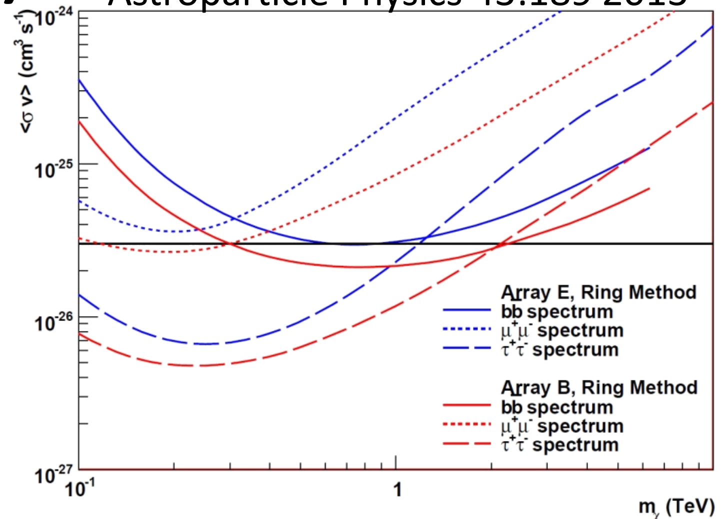


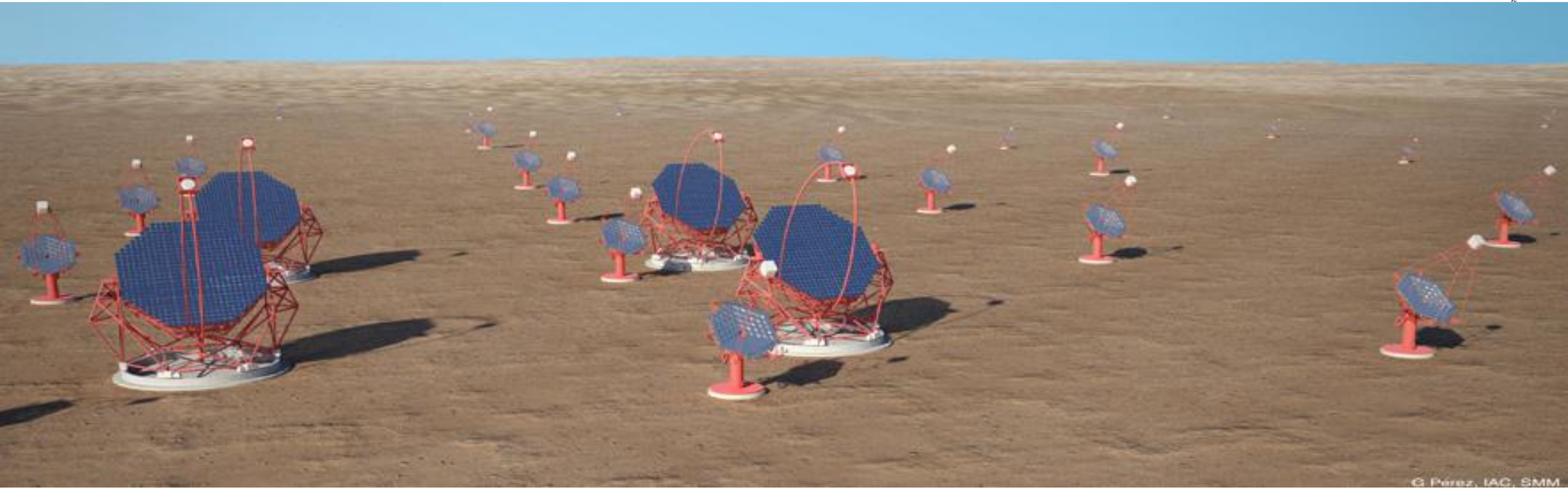


Outlook (II)

- CTA future Cherenkov telescope array
  - increase sensitivity by at least factor 10
  - lowered energy threshold $\mathcal{O}(10GeV)$
- CTA will improve Galactic Halo limits and probe interesting models

Astroparticle Physics 43:189 2013





Thanks for listening!

Backup

Fornax Galaxy Cluster

- Galaxy Clusters extended object, complicated structure
- Substructures can be important

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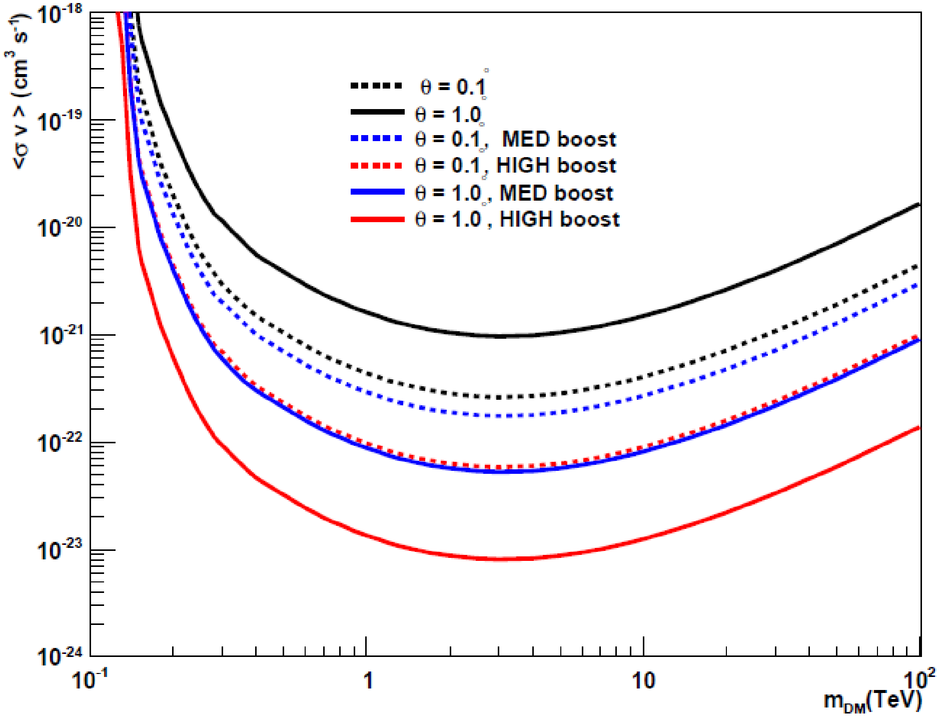
- Galaxy Clusters extended object, complicated structure
- Substructures can be important
- Several J-factors investigated

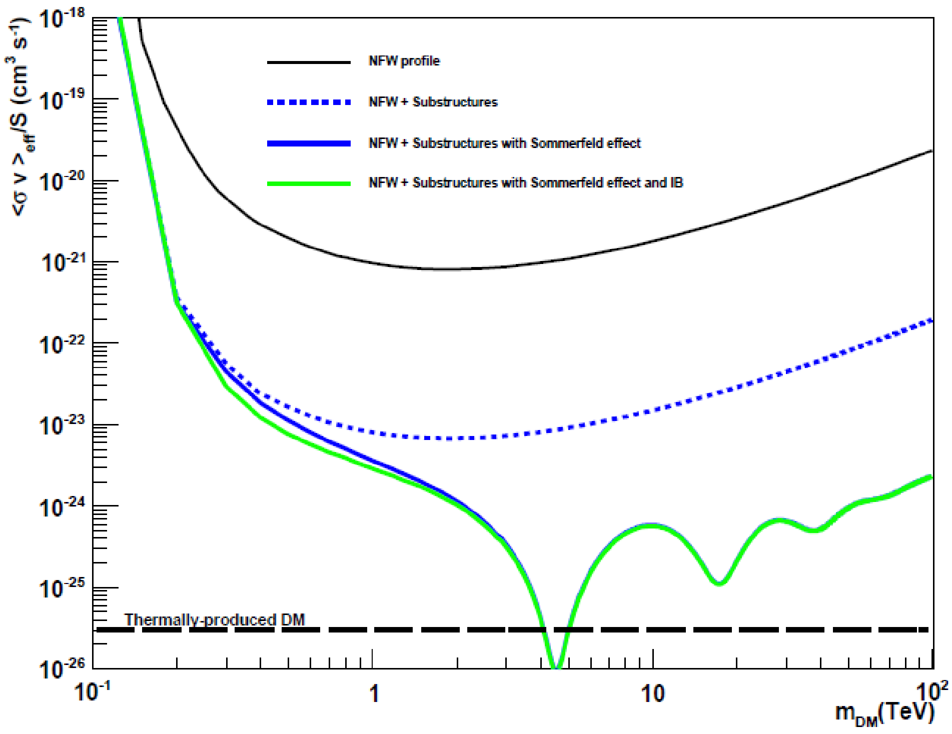
Astro. Phys. Jornal 750:123, 2012



Fornax Galaxy Cluster

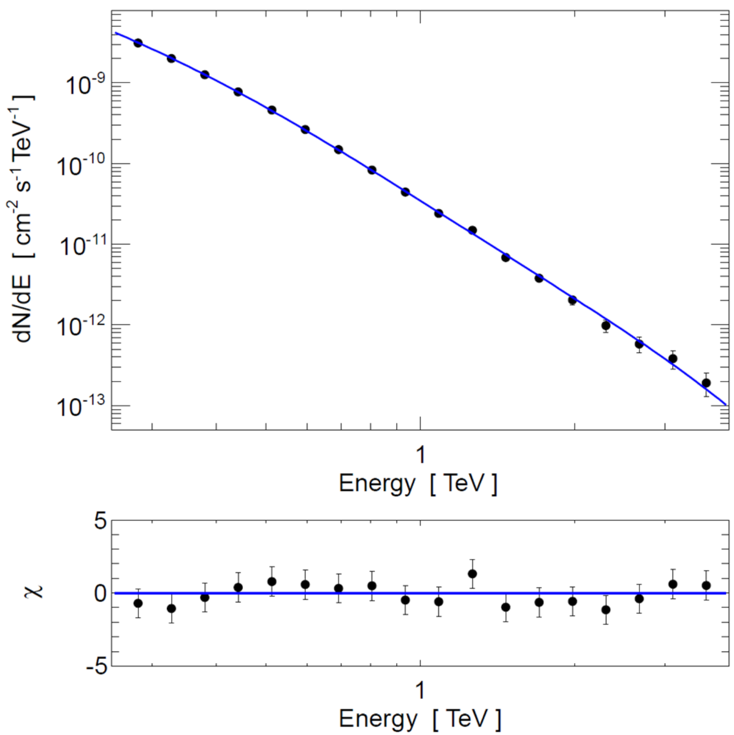
- Galaxy Clusters complicated structure
- Substructures can be important
- Several J-factors investigated
- Further enhancement studied
  - Sommerfeld Effect
  - Internal Bremsstrahlung

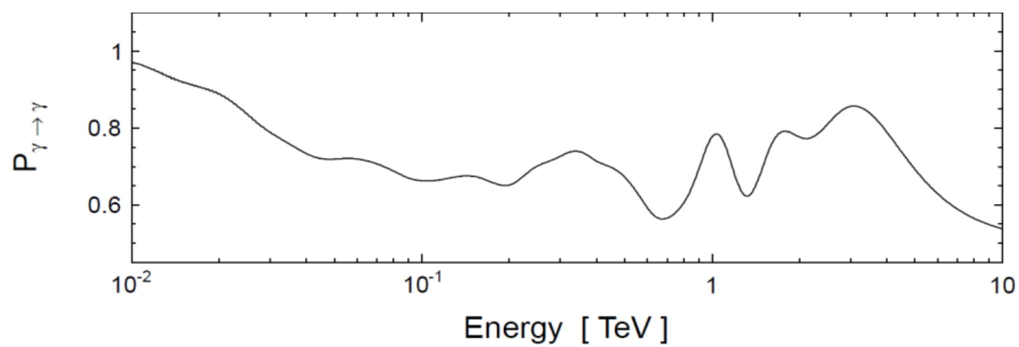
Astro. Phys. Jornal 750:123, 2012



Looking for Axions in PKS 2155-304

- PKS 2155-304 active galactic nucleus in a galaxy cluster
- Fit spectrum with log-parabola and EBL absorption
- Axionlike particles could induce bin-by-bin fluctuations in the spectrum





Looking for Axions in PKS 2155-304

- PKS 2155-304 active galactic nucleus
- Spectrum altered due to EBL absorption
- Axionlike particles could induce bin-by-bin fluctuations in the spectrum

Phys.Rev. D. 88: 102003 2013