Probing the nature of dark matter with gamma rays at the Galactic Centre

(what we learned from the Fermi LAT and prospects for the CTA)





Gabrijela Zaharijas

Center for Astrophysics and Cosmology, University of Nova Gorica, Slovenia INFN and University of Trieste on behalf of the CTA consortium

Gamma rays

atmosphere is not transparent to gamma rays Fermi LAT(AGILE
2008-→ satellitesImage: Image: Ima

→ or ground based:

i) Imaging Atmospheric Cherenkov Telescopes WHIPPLE 10m (1968-2013) - the beginning of gamma ray astronomy *H.E.S.S.* (2002 -), *MAGIC* (2004 -), *VERITAS* (2007 -)

ii) Air shower arrays ('with buckets of water') MILAGRO (2001-2008)

HAWC (2013 -)





Future



CTA - one of the biggest projects in high energy astrophysics



CTA

sites and example telescope layouts



CTA

sites and example telescope layouts



CTA Performance



CTA Performance





^{&#}x27;Science with the CTA', 1709.07997



Contains the **Key Science Projects** (KSPs) and **DM Programme**, developed over a period of several years.

Estimates the observational times needed at different targets to reach science goals.

KSP Breakdown





Estimated DM sensitivity in different targets.

Sensitivity at the **thermal cross section** level might be reached for the **Galactic Center 'halo'**.



γ-ray emission mechanisms



Challenges:







DM mass (TeV)

Ongoing studies

- Binned likelihood analysis, over the 'pixelized ' ROI (Silverwood+, JCAP (2015))
- optimization of the pixel size, mask etc
- dedicated study on the impact of different GDE models
- impact of (un-resolved) point sources



What GDE?



What GDE?



A analysis and DM limits What GDE? Fermi diffuse model 'Sample' Model Total model PS $\chi^2/dof = 1.21$ 10^{-3} Data Other Gas GC excess ICS **Bubbles** 10^{-4} see talk by JM. Low lat bubbles see talk by D. Isotropic $-01 \left(\frac{\text{GeV}}{\text{cm}^2 \text{s}}\right)$ Casandjian Malyshev $E^2 \frac{dN}{dE}$ 10^{-6} 10^{-7} [Ackermann+, ApJ. 840 (2017)] 10^{-8} 10^{2} 10^{-1} 10^{0} 10^{1} [Acero+, ApJS 223 (2016)] E (GeV)E²*Emissivity (MeV² s⁻¹ sr⁻¹ MeV⁻¹) E²*Emissivity (MeV² s⁻¹ sr⁻¹ MeV⁻¹) sr⁻¹ MeV⁻¹ CMZ0-1.5 kpc *(a)* 1.5-4.5 kpc (d)*(b)* Z>0 10⁻²⁴ Emissivity 10-25 10⁻² 10⁻² 10³ 10² 10² 10^{3} 10⁴ 10³ 10⁴ 10² 10^{4} 10² Energy (MeV) Energy (MeV) Energy (MeV)

Preliminary results

Einasto profile, WW channel, 500h 5deg ROI, 0.5 deg bins, no MASK, Single pointing



Cosmic Ray (CR)

Background

G Emis

D

Preliminary results

Mask the central band, |b|<0.25 deg

Einasto profile, WW channel, 500h 5deg ROI, 0.5 deg bins, no MASK, Single pointing





Next Steps

 What level of systematics is realistic to expect for different GDE models and masks? Use models tuned to LAT and HESS.



 Impact of single pointing vs survey observational strategy (larger ROI, less deep)

Final goal — define the most promising analysis and observational strategies to maximise the sensitivity to GDE and DM signals

20

