

XMM-Newton Observations and Multi-Wavelength Studies of the TeV Source HESS J1427-608

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for the H.E.S.S. collaboration

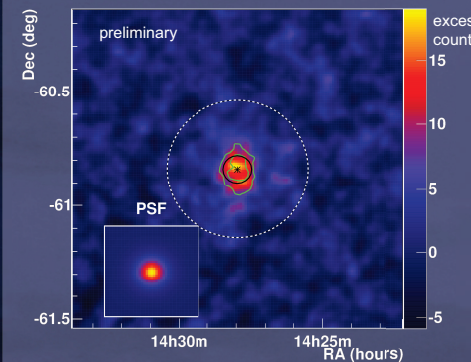
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Abstract

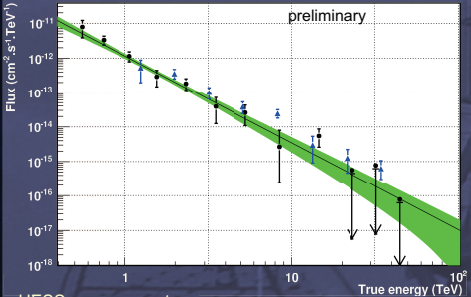
The TeV gamma-ray source HESS J1427-608 was discovered during the H.E.S.S. Galactic Plane Survey. At the time, there was no evidence for a counterpart at other wavelengths, and it was therefore considered a dark, or unidentified, source. In this contribution, we will present a new multi-wavelength view of this enigmatic source. Furthermore, additional H.E.S.S. observations have nearly doubled the exposure in the TeV domain, confirming earlier results. In order to investigate the keV X-ray environment in the direction of the TeV gamma-ray emission, dedicated observations were carried out with XMM-Newton. The results of a search for both point-like and diffuse X-ray emission will be shown. Archival radio data at 843 MHz from the Molonglo Galactic Plane Survey and ¹²CO line emission were also analysed to complement the high-energy view of this source and to search for any evidence of a coincident molecular cloud. We describe the spectral energy distribution with models for leptonic and hadronic emission. Different scenarios for the nature of this source, in particular a hypothetical pulsar wind nebula, will be discussed.

The TeV source HESS J1427-608

- discovered in the HESS Galactic Plane survey
 - no counterpart at other wavelengths [Aharonian et al. 2008]
- new data since discovery
 - currently 36h exposure
- source extended
 - RA 14^h27^m(58±7)^s, Dec 60°50'(35±41)''
 - intrinsic extension (corrected for the instrument's resolution): 0.06°±0.01° (1σ of 2-dimensional Gaussian source profile)



- smoothed HESS excess map (colour scale: excess counts)
 - 4 and 6σ significance contours (green)
 - intrinsic source size (best fit value, black circle)
 - spectrum extraction region (white circle)



- HESS energy spectrum
 - energy spectrum follows power law
 - index 2.5 ± 0.2
 - flux normalisation at 1 TeV: $(1.1 \pm 0.2) \cdot 10^{-12} \text{ TeV}^{-1} \text{ cm}^{-2} \text{ s}^{-1}$
 - energy flux between 1 and 10 TeV: $2.4 \cdot 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$
 - best fit spectrum (green) and reconstructed data points (black)
 - compatible with previous publication (blue)

Spectral Energy Distribution

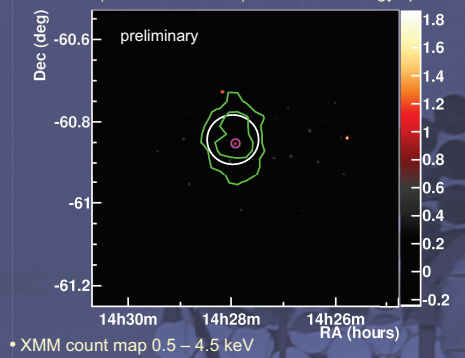
- data points:
 - radio MGPS J142755-605038 (black triangle) (Note: the radio source has a smaller angular extent.)
 - X-ray upper limit (blue line)
 - Fermi (blue boxes):
 - no counterpart in the 1st catalogue
 - the spectral data of the faintest source in 1st catalogue which is less than 5° from Galactic Plane (1FGL J0513.0+4048) is considered as upper limit
 - HESS (black circles)
- leptonic model:
 - electron spectrum with index 1.6 and exponential cut-off at 9 TeV
 - magnetic field of 3μG, inverse Compton scattering off CMB
- hadronic model:
 - proton spectrum with index 2.0 and exponential cut-off at 28 TeV

Discussion

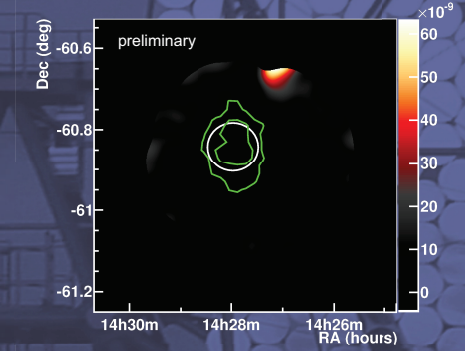
- TeV source with possible radio counterpart (angular size not matching)
- X-ray point-like source possibly related; no diffuse X-ray emission → upper limit on flux
- no MeV/GeV (Fermi) counterpart
- leptonic model likely: hypothetical pulsar would need spin-down power of $\sim 10^{34} (d/1 \text{ kpc})^2 \text{ erg s}^{-1}$
- Fermi non-detection disfavors hadronic model, further detailed analysis necessary

Search for X-ray counterpart

- XMM-Newton observations
 - ObsID 0504990101
 - 24ks exposure (15ks after flare removal)
- several faint point-like sources
 - XMM J142754-6051.1 in centre of TeV source, could be related to TeV source
 - too faint ($0.020 \pm 0.002 \text{ cts/s}$) for detailed energy spectrum



- XMM count map 0.5 – 4.5 keV
 - smoothed with Gaussian kernel of 18"
 - HESS significance contours (green)
 - HESS intrinsic source size (white)
 - point-like source XMM J142754-6051.1 (magenta)



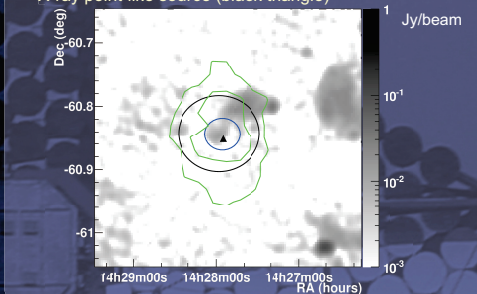
- XMM flux map 0.5 – 4.5 keV [$\text{cm}^{-2} \text{ s}^{-1}$]
 - point-like sources removed
 - instrumental background from blank sky observations [Carter & Read 2007]
 - smoothed with Gaussian kernel of 54"
 - no diffuse emission
 - upper limit on X-ray flux for HESS source
 - $I(0.5 - 4.5 \text{ keV}) < 7.5 \cdot 10^{-13} \text{ erg cm}^{-2} \text{ s}^{-1}$

The H.E.S.S. Detector

- High Energy Stereoscopic System
 - 4 Imaging Atmospheric Cherenkov telescopes
 - 107m² mirror surface each
 - photo-tube camera with 960 pixels
 - 5° field of view
 - energy range: ~100 GeV up to several 10 TeV
 - single shower resolution better than 0.1°
 - energy resolution ~15%

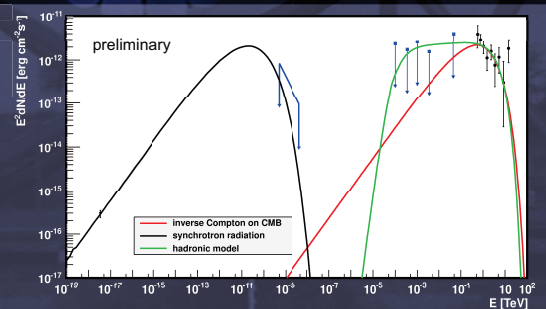
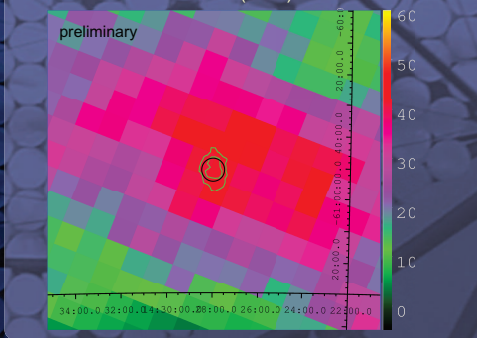
Archival Radio Data

- 2nd epoch Molonglo Galactic Plane Survey [Murphy et al. 2007]
- MGPS J142755-605038 (blue circle)
 - extended: 92.4" x 66.9"
 - but smaller than HESS source
 - 34.5 mJy
- 843 MHz radio image
 - HESS significance contours (green contours)
 - HESS intrinsic source size (black circle)
 - X-ray point-like source (black triangle)



Search for Molecular Clouds

- CO emission line data [Dame et al. 2001]
 - peak around -50 km s⁻¹
 - corresponds to 3 or 9 kpc
 - cloud has much larger spatial extent than HESS source
 - cloud is very dense:
 - if at 3 kpc: 1600 cm⁻³
 - if at 9 kpc: 360 cm⁻³
- CO intensity map
 - HESS significance contours (green)
 - HESS intrinsic source size (black)



Acknowledgements

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