The puzzling case of HESS J1640-465 and HESS J1641-463 as seen by the Fermi-LAT

H. Laffon1, M. Lemoine-Goumard1, M.-H. Grondin1, F. Acero2, T. Reposeur1 on behalf of the Fermi-LAT collaboration

1 Centre d’Etudes Nucléaires de Bordeaux-Gradignan, IN2P3-CNRS, Université de Bordeaux, BP 33-33175 Gradignan cedex, France
2 Laboratoire AIM, CEA-IRFU/CNRS/Université Paris-Diderot, SAp, CEA Saclay, 91191 GI sur Yvette, France

The discovery of a GeV counterpart to HESS J1641-463 with the Fermi-LAT shed new light on the origin of the gamma-ray emission from HESS J1640-465 and the neighboring bright source HESS J1641-463. A detailed analysis of this region and different scenarios for each source are presented.

Abstract

Thanks to a longer dataset and improved sensitivity afforded by the 77 reprocessed data of the Fermi Large Area Telescope (LAT), the TeV source HESS J1641-463 is now detected by the Fermi-LAT. This new detection implies a change in the GeV spectrum of the neighboring bright source associated to HESS J1640-465 which was previously contaminated by the Fermi source associated with HESS J1641-463. The newly obtained GeV spectrum associated with HESS J1640-465 is harder and links up naturally with the spectral points obtained by H.E.S.S., suggesting a hadronic origin. This is not the case for the overall spectral energy distribution of HESS J1641-463 whose origin remains enigmatic. A detailed analysis of this region with the Fermi-LAT is presented as well as different scenarios to explain the gamma-ray emission observed from both sources.

The field of view

**Gamma-rays:** HESS J1640-465 is located about 0.05° away from HESS J1640-465 and only shows up at very high energy (above 450 GeV) on the excess maps due to its hard spectrum [2]. HESS J1640-465 has a softer spectrum [2] and therefore constitutes the neighboring weak source at lower energies (<1 TeV). 

**X-rays:** pulsar and pulsar wind nebulae (PWN) counterparts to HESS J1640-463 [43], no clear counterpart to HESS J1641-463 [2]. Radio: Each TeV source is in spatial coincidence with a supernova remnant (SNR) [10], 13. Presence of dense molecular clouds traced by the CO line [11, 12].

Analysis details:
- 5 years of data in a survey mode: from 2008 August 04 to 2013 December 04
- Region of 30° around the position of HESS J1640-465
- PIPER PREF_S, V1959A and Source class gamma-ray events selected
- Events coming from a zenith angle >100° excluded
- Galactic diffuse model (galactic.v05.f8) and isotropic diffuse model (iso_source.v05.f8)
- Source model from Internal 4-year 3FGL catalog list
- Spectral parameters from sources within a 5° FOV are left free

Spectral results:
- **HESS J1640-465:**
  - Energy range: 0.1-300 GeV
  - Spectral index: $\gamma = 1.65 \pm 0.07$ (stat) $^{+0.04}_{-0.06}$ (syst) $\times 10^{-2}$ MeV$^{-1}$ cm$^2$(stat) $^{+3}_{-2}$ cm$^2$(syst)

- **HESS J1641-463:**
  - Energy range: 0.01-30 GeV
  - Spectral index: $\gamma = 2.0 \pm 0.3$ (stat) $^{+0.1}_{-0.2}$ (syst), $\gamma = 2.4 \pm 0.3$ (stat) $^{+0.1}_{-0.2}$ (syst)

- 2 sources with position and morphology compatible with the Fermi LAT sources HESS J1640-465 and HESS J1641-463 found in this new analysis

**References**