The region in the vicinity of the Mouse, as seen by the Fermi LAT

L. Falletti[1], J. Cohen-Tanugi[1] and E. Nuss[1]
on behalf of the Fermi LAT Collaboration and the Pulsar Timing Consortium
[1]LUPM – Université Montpellier 2 / CNRS-IN2P3

Abstract

The Mouse region (PWN G359.23-0.82 and its pulsar PSR J1747-2958), located 1° away in projection from the Galactic Center, is detected from radio to gamma rays. Various sources are detected within less than one degree of the Mouse : pulsars, SNRs, PWNs, OH masers, molecular clouds... Located west of the pulsar and its bow-shock nebula, the TeV HESS source J1745-303 presents 3 emission regions identified as A, B and C in [2]. This is an extended and complex VHE γ-ray source, with a dominant emission in the region A. In our analysis, we look for a possible counterpart of this HESS source with the Fermi LAT data. At the same time, we also study the localization and spectrum of the LAT source coincident with PSR J1747-2958.

HESS J1745-303

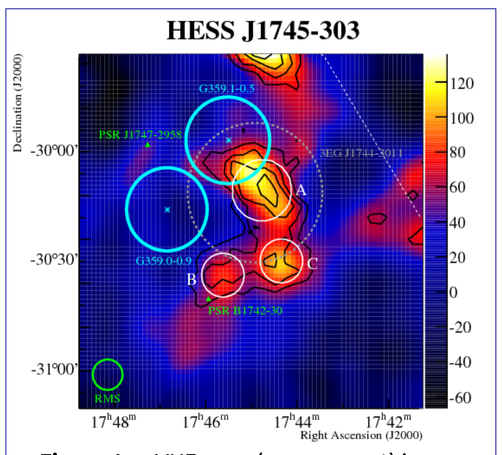

Figure 1 : a VHE γ-ray (excess count) map obtained with HESS data (1-10 TeV), with the positions of 3 identified emission regions (A, B and C) and possible counterparts (or counterpart candidates). The 4σ to 7σ statistical significance contours are shown in black.

Region A :
- OH masers + CO emission ⇒ interaction between SNR G359.1-0.5 and molecular cloud
- ~7.6 kpc, high magnetic field ⇒ hadronic model

Regions B and C :
- no CO ⇒ not the same scenario as for region A
- Possible explanation : PSR B1742-30 is energetic enough to power a PWN

⇒ Very complex source which presents 3 identified emission regions (see Figure 1 and [2]) within a area smaller than 1°. Not well understood yet.

The Mouse region

SNR G359.1-0.5 : d~7.6 kpc, τ≥10^4 yr, ^{12}CO emission lines : dense ring of matter surrounding the shell, OH masers (1720 MHz), m_{H2}~5 10^4 M⊙ [2]

SNR G359.0-0.9 : d~6 kpc, τ~1.8 10^4 yr, n~0.5 cm^{-3}, E~1.2 10^{51} erg [3]

PSR B1742-30 : d~2.1 kpc, T~5.45 10^5 yr, P~367.4 ms, $\dot{E}/D^2$~2 10^{33} $erg.s^{-1}.kpc^{-2}$ [2]

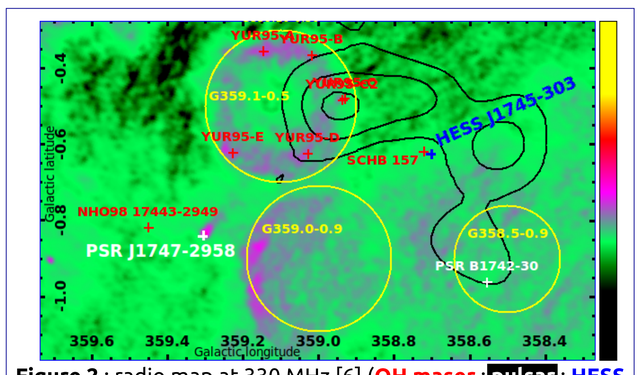

Figure 2 : radio map at 330 MHz [6] (**OH maser** ; **pulsar** ; **HESS source** ; **SNR** ; **4σ, 6σ and 8σ HESS significance contours**)

PSR J1747-2958 :

d~2.08 kpc,
T~2.55 10^4 yr,
$\dot{E}$~2.5 10^{36} $erg.s^{-1}$,
B~1.5 10^{12} G,
P~98.8 ms,
$\dot{P}$~6.136 10^{-14},
$\dot{E}/D^2$~4 10^{35} $erg.s^{-1}.kpc^{-2}$

This pulsar powers the non-thermal radio PWN G359.23-0.82 (known as the "Mouse") [4] & [5]

Pulsations detected by the LAT :

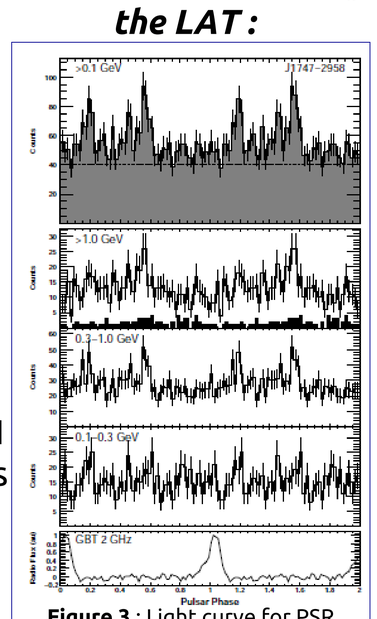

Figure 3 : Light curve for PSR J1747-2958 [1]

Fermi LAT analysis

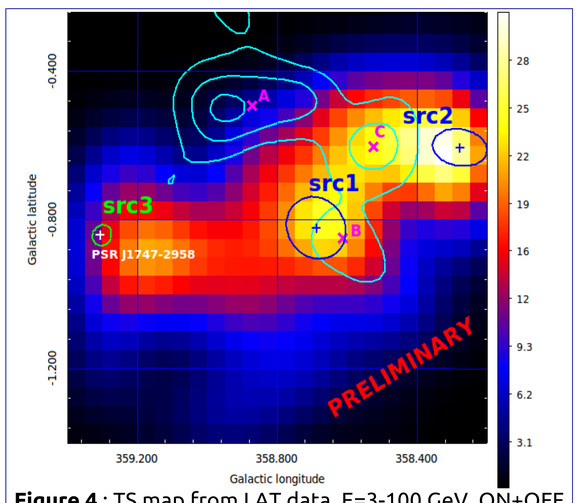

Figure 4 : TS map from LAT data, E=3-100 GeV, ON+OFF events. The 4σ, 6σ and 8σ HESS significance contours excess are shown in cyan. The magenta crosses show the localization of the HESS J1745-303 regions A, B and C. The white cross is the radio position of PSR J1747-2958. The other sources (detected by Fermi-LAT) are shown with ellipses of 95% C.L. (statistical) error radius.

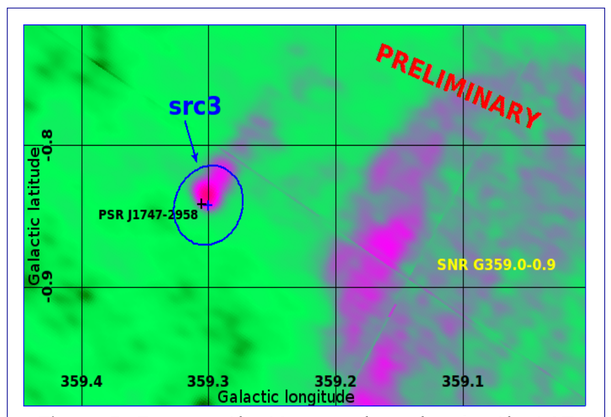

Figure 5 : Zoom on the Mouse pulsar, showing the LAT source (src3) overlaid on a VLA radio image at 330 MHz [6].

* *ON+OFF pulse analysis 3 GeV<E<100 GeV*
This first part of the analysis concerns the HESS region as seen by Fermi. We detect two new sources not included in the 1FGL catalog, which appear to be coincident with regions B and C of ***HESS J1745-303***.

Figure 4 shows the two excess which are present west of the pulsar : src1 (close to region B) and src2 (near region C).

Src1 : TS~43, integrated flux=(5.91±2.72) 10^{-8} $cm^{-2}.s^{-1}$
Src2 : TS~70, integrated flux=(7.74±3.37) 10^{-8} $cm^{-2}.s^{-1}$

Taking into account the morphology of these emission regions, the region A is not dominant at E>3 GeV, contrary to the HESS emission. With a lower energy threshold, the LAT PSF becomes wider and the region appears as a single excess spatially coincident with the HESS source. Thus region A is not detected yet with high significance, if the two higher energy excesses are modeled as point sources with a **power law spectrum**.

* *ON+OFF pulse analysis 100 MeV<E<100 GeV*
In this second part of the analysis, we focus on ***PSR J1747-2958*** as seen by Fermi (**src3**) taking into account src1 and src2. We localize this source 0.34' away from the radio position, with a 95% C.L. (statistical) error ellipse with semi-major (semi-minor) axis of 1.74' (1.56').

Dataset

- 29 months of data
- IRF : P7_V6
- ROI of 10° centered on the Galactic Center (RA=266.405° Dec=-28.936°)
- ON pulse : 0.1-0.64 (see Figure 3)

Preliminary results for src3

ON+OFF analysis
TS~930
Power law spectrum with exponential cutoff :
Normalization=(3.22±0.44) 10^{-10} $cm^{-2}.s^{-1}.MeV^{-1}$ at E_0=334 MeV
Index=-1.48±0.17
Cutoff=1630±316 MeV
Energy Flux=(1.66±0.58) 10^{-10} $erg.cm^{-2}.s^{-1}$

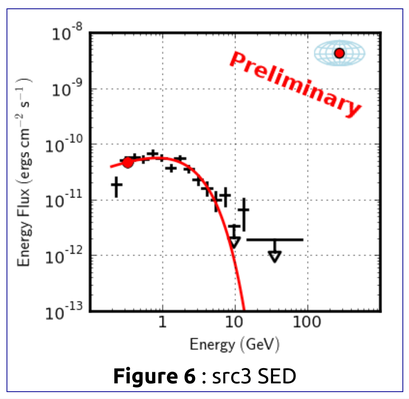

Figure 6 : src3 SED

Conclusions

The emission seen by Fermi-LAT seems to correspond to the HESS J1745-303 emission regions B and C, and there is no significant emission at the location of region A (which is, however, dominant in the HESS analysis). Further in-depth analyses are on-going within the Fermi LAT collaboration to fully characterize the Fermi emission spatially coincident with HESS J1745-303, especially with respect to region A. Taking into account these sources, we improve with this dedicated analysis the localization of the pulsating LAT source scr3 : GeV and radio positions of PSR J1747-2958 are compatible. Spectral results are very preliminary, and the detailed spectral analysis will be treated in a forthcoming publication.

Acknowledgment

The LAT collaboration gratefully acknowledges the members of the Pulsar Timing Consortium who provide updated radio ephemerides for a large number of radio pulsars [7]. The ephemeris for PSR J1747-2958 was provided by Fernando Camilo using data taken at the Green Bank Telescope funded by the Fermi Guest Investigator Program.

References

[1] Abdo *et al.*, ApJ Suppl., 187:460–494, 2010
[2] Aharonian *et al.*, A&A, 483:509, 2008
[3] Bamba *et al.*, PASJ, 52, 2000
[4] Camilo *et al.*, ApJ, 579:L25–L28, 2002
[5] Gaensler *et al.*, ApJ, 616:383–402, 2004
[6] LaRosa *et al.*, AJ, 119:207-240, 2000
[7] Smith *et al.*, A&A, 492:923-931, 2008

2011 Fermi Symposium
Rome, Italy