GeV gamma-ray emission from the binary PSR B1259-63/SS2883 during the 2010 periastron passage

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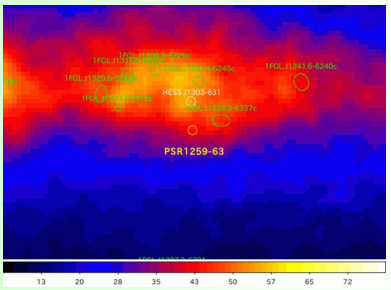
Introduction

- The PSR B1259-63/SS2883 system is one of a few binary systems detected in TeV gamma-ray energies.
- Gamma-rays should be emitted via interaction of high-speed wind from the 48-ms pulsar with the Be star wind and disk.
- The elliptic orbit with long (3.4-yr) period offers a unique experimental field of wind interaction with varying distance between the pulsar and the Be star (Kawachi et al. 2004, Okazaki et al. 2011).
- In 2004 and 2007, H.E.S.S. detected TeV gamma-rays as a marginal pre-periastron peak and a clear post-periastron peak (Aharonian et al. 2005, Acero et al. 2009).
- We studied the 2010 periastron (Dec. 14) passage in GeV gamma-rays using the Fermi-LAT data and compared the result with SPH simulation (Okazaki et al. 2011).

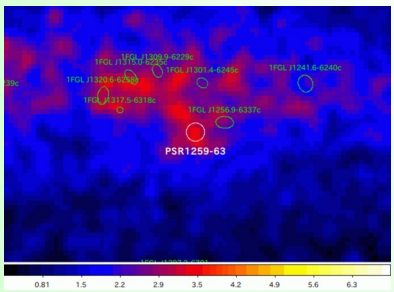
Fermi-LAT observation

Fermi-LAT data were obtained via Fermi Science Support Center and analyzed using the *Fermi Science Tools* (v9r17p0) with `P6_V3_DIFFUSE` instrument response function. Examples of countmaps are shown below.



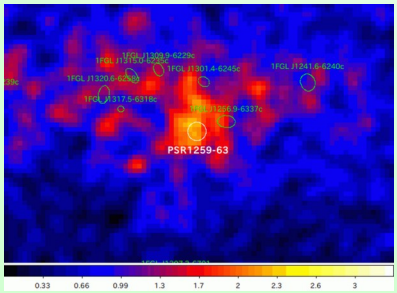
Not significant

Countmap (200MeV—10 GeV, 04-AUG-2008 – 09-FEB-2011)



Marginal (TS=5)

Countmap (200MeV—10 GeV, 22-DEC-2010 – 21-JAN-2011)



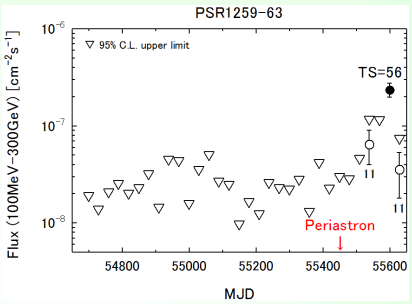
Significant (TS=58)

Countmap (200MeV—10 GeV, 21-JAN-2011 – 09-FEB-2011)

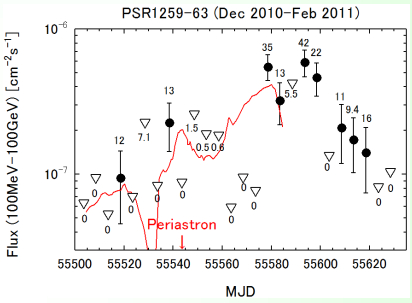
[TS (test statistic) is a measure of statistical significance of gamma-ray signal and behaves approximately as √(TS)~excess/σ.]

Light curves

Light curves in 30-day bins and 5-day bins (assuming E^{-2} spectrum) are calculated with the help of *Tools* as shown below. We detected gamma-ray signal between 30 days and 65 days after the periastron. Spectral study is in progress.



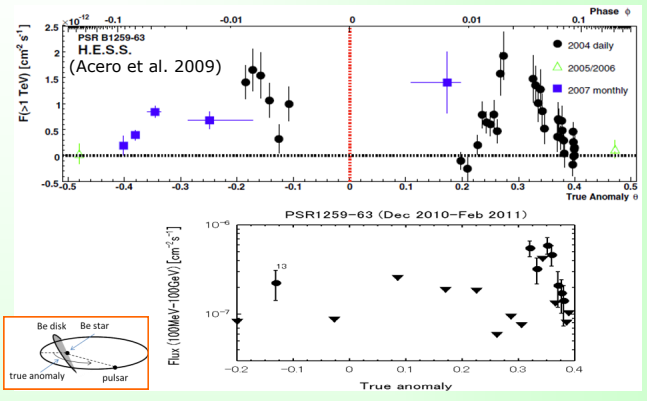
30-day-bin light curve. Positive detection is observed only after the periastron. Open circles are fluxes with marginal significance (~3σ).



Close-up of light curve in 5-day bins around periastron. Points are plotted including marginal detections (9< TS<25). TS values of each point is shown by numbers. Also shown by red lines are the preliminary light curves calculated by SPH simulation of interaction between the pulsar and the Be star assuming realistic parameters of the system (Takata et al, in preparation) scaled arbitrary by 300%.

Light curves in terms of true anomaly

Light curves are plotted as a function of true anomaly below and compared with TeV light curves in the past.



Discussion

We found a significant GeV gamma-ray signal from this system between 30 days and 65 days after the periastron. Emission in this epoch should be related to the time-varying geometry of this system. We will compare the gamma-ray light curves and spectra with simulation to understand the emission from this binary system.
After the analysis presented here, we found similar results from Fermi-LAT data have been reported (Tam et al. 2011, Abdo et al. 2011).

References

[1] Kawachi, A., Naito, T., Patterson, J.R. et al., ApJ, 607, 949 (2004)
[2] Okazaki, A.T., Nagataki, S., Naito, T., Kawachi, A., Hayasaki K., Owocki, S.P. and Takata, J., submitted for publication (2011)
[3] Aharonian, F. et al., A&A, 442, 1 (2005)
[4] Acero, F. et al., A&A, 507, 389 (2009)
[5] Takata, J. et al., in preparation
[6] Tam,P.H. et al., arXiv:1103.3129v1 (2011)
[7] Abdo, A.A. et al., arXiv:1103.4108v1 (2011)