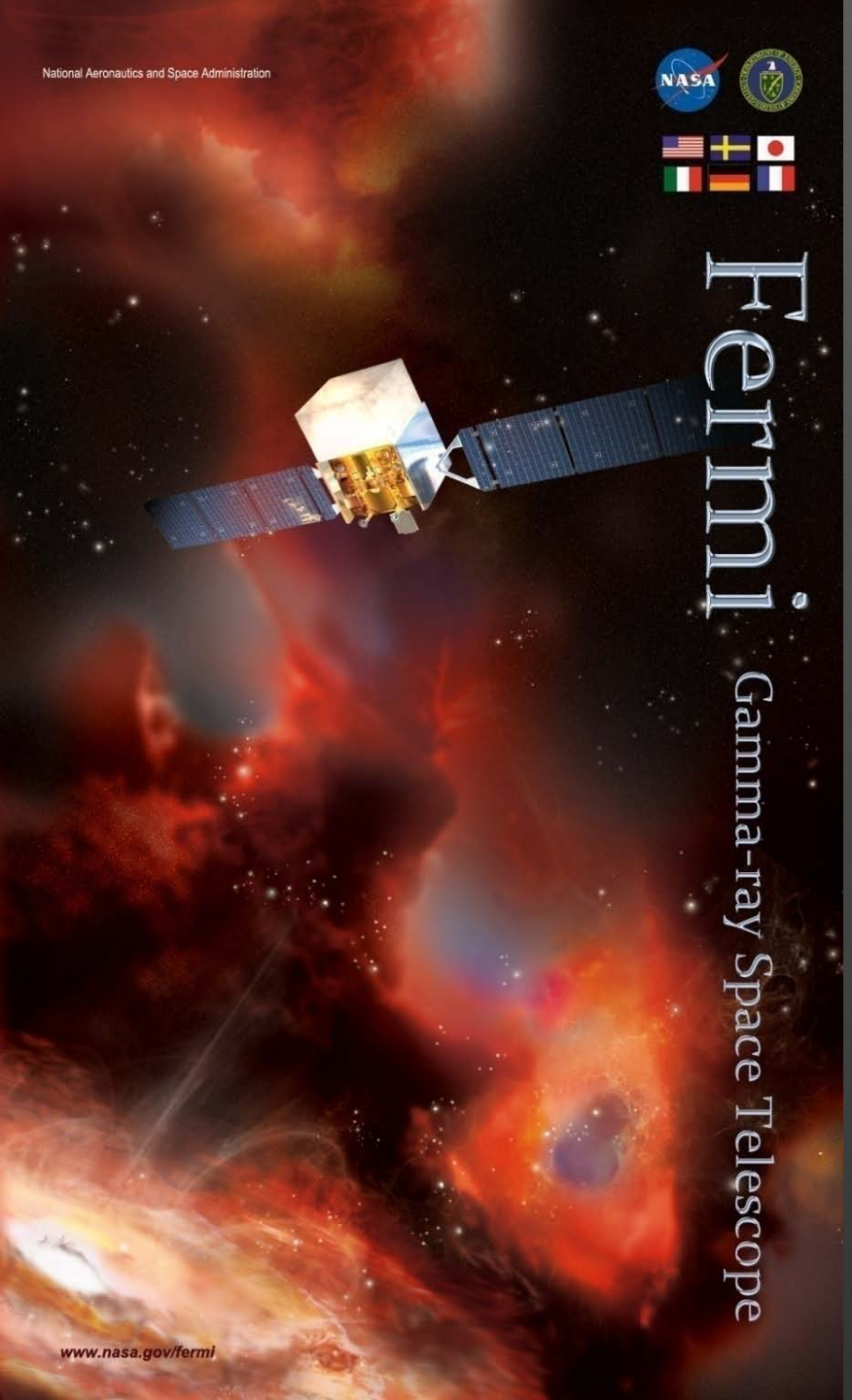

Gamma-ray flare activity from PSR B1259-63 during 2014 periastron passage and comparison to its 2010 passage

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outline

- 1. Introduction
- 2. Observations and data analysis
- 3. Fermi monitoring of 2014 periastron and comparison to 2010 periastron passage
  - 3.1 Light curve— GeV flare and Multiwavelength view of both periastra
  - 3.2 Spectral analysis
- 4. Conclusion and discussion

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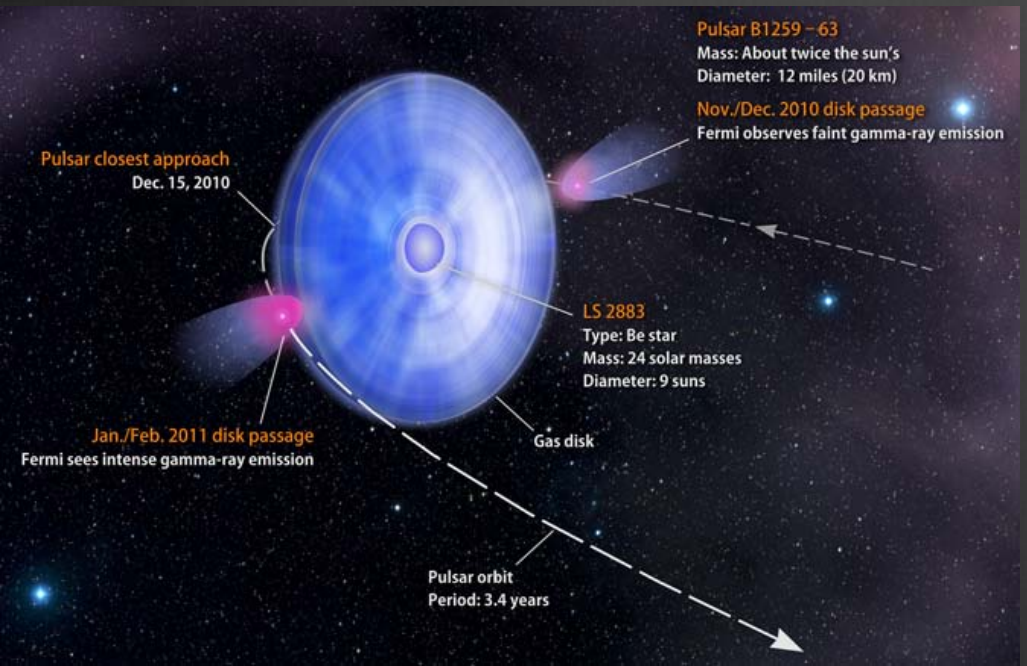
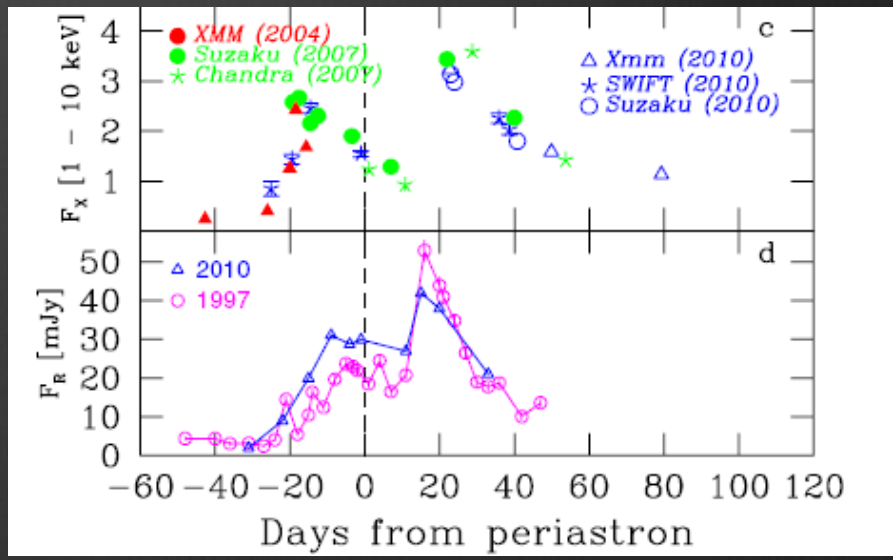
Introduction

PSR B1259-63:

- Gamma-ray binary with a 47.76 ms radio pulsar and a Be star companion.
- Long orbital period of 1236.7 days (3.4 years) and a highly elliptical (e~0.87) orbit.
- PSR B1259-63 shows high orbital variability in all wavelengths, which is consistent with its two crossings of the circumstellar disk near periastron.

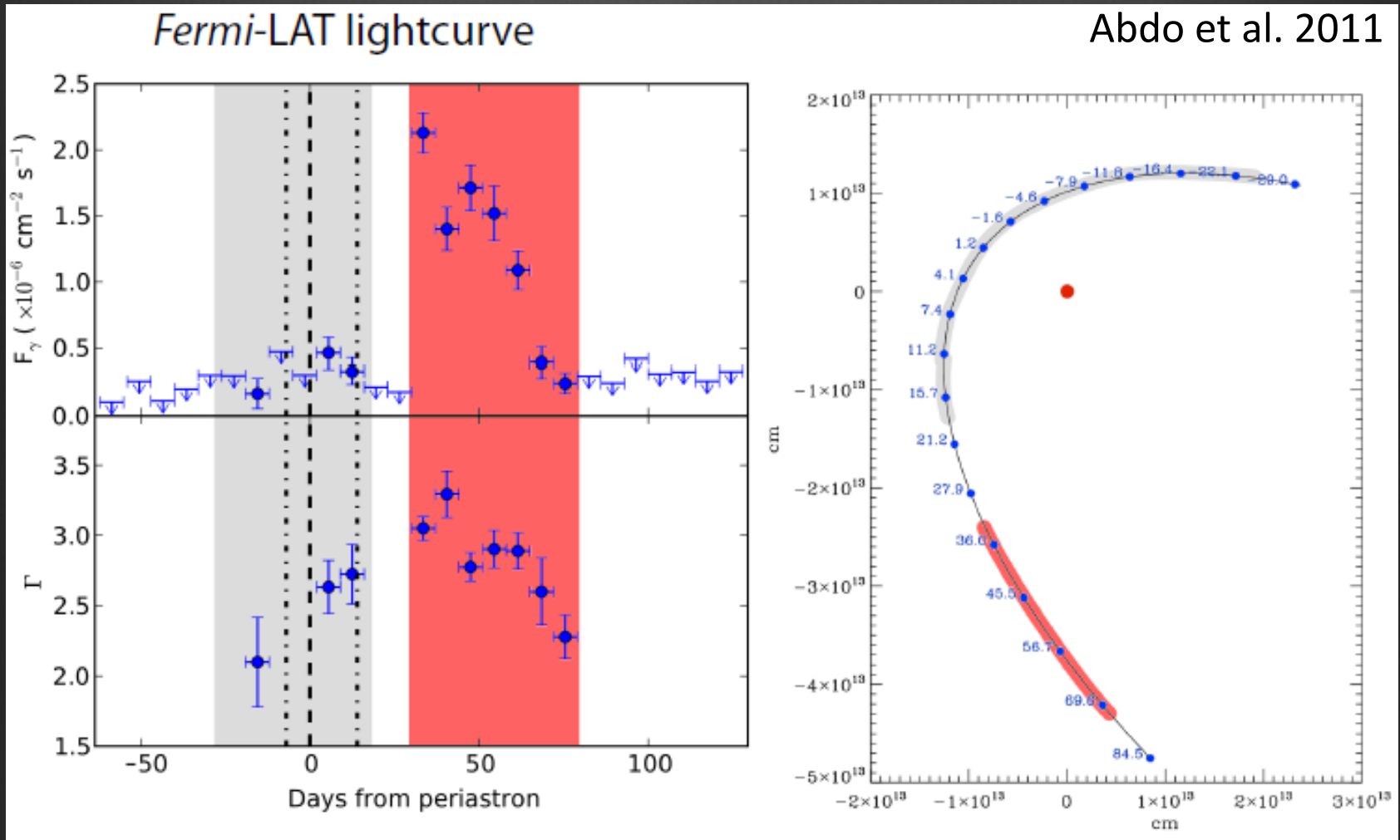
Abdo et al. 2011

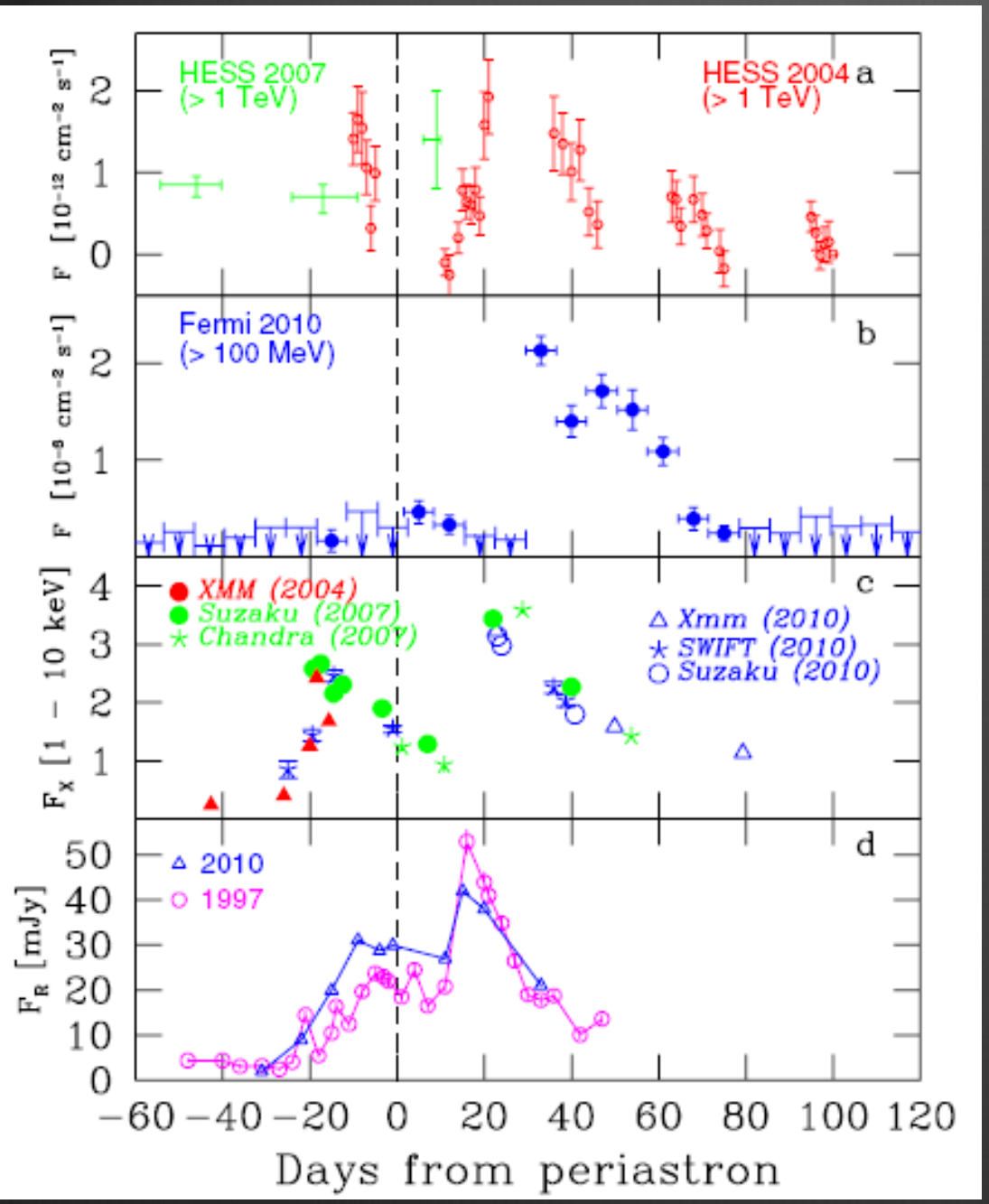




- In the 2010 periastron passage (2010-12-14), non-thermal HE emission was observed by Fermi/LAT ~30 days after periastron.

- Fermi-LAT detected a rapid brightening of PSR B1259-63 at >100 MeV, reaching a flux about 10 times higher than the first disk passage.





Light curves of PSR B1259−63 around periastron.

(a) HESS 2004 and 2007 periastron passages

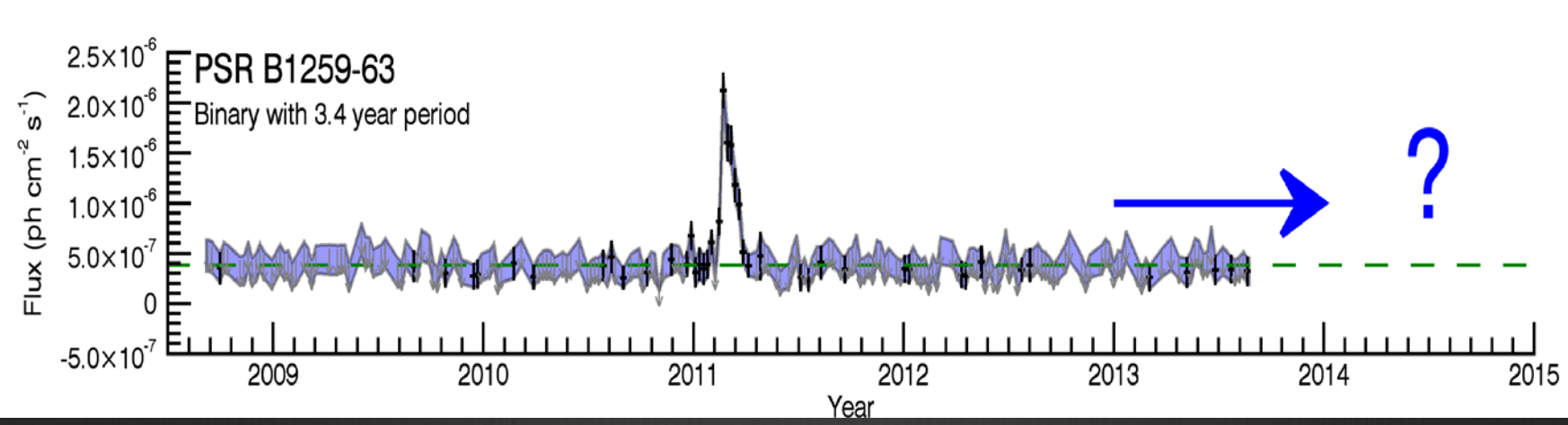
(b) Fermi-LAT 2010 periastron passage.

(c) X-ray fluxes

(d) Radio (2.4 GHz) flux densities

Abdo et al. 2011

- Is this flare event intrinsic to PSR B1259-63?
- Would it happen again in 2014 periastron?
- What's the physical origin?



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Fermi observations and data analysis

- Data: P7 reprocessed data, source class, 100 MeV—100 GeV
- Catalog: 3FGL
- ROI: 10 degree
- Xml Model:

  all sources within the radius of 15 degree are included and flux normalizations are set to free if they are within the radius of 3 degree from PSR B1259-63. We also test the free normalization radius of 5 degree. Results are all consistent

  PSR B1259-63 is fitted with Power Law and cutoff Power Law respectively. Spectral index, cutoff energy and normalization of PSR B1259-63 are set to free

Periastron time

- The most recent determination of orbital period and periastrons is from Shannon et al. 2013, which are used in this paper.
- From 23 years of radio observations (1990 January 18 to 2013 February3), orbital period is determined at 1236.724526(6) days, which is shorter than previous measurement: 1236. 79 (1) days (Johnston et al. 1994)
- Periastron(s) are at:

MJD	MET	UTC
53071.2447290(7)	100331544.586	2004-03-07 05:52:24.586
54307.969255	207184544.632	2007-07-26 23:15:43.632
55544.693781	314037544.678	2010-12-14 16:39:02.678
56781.418307	420890544.725	2014-05-04 10:02:21.725

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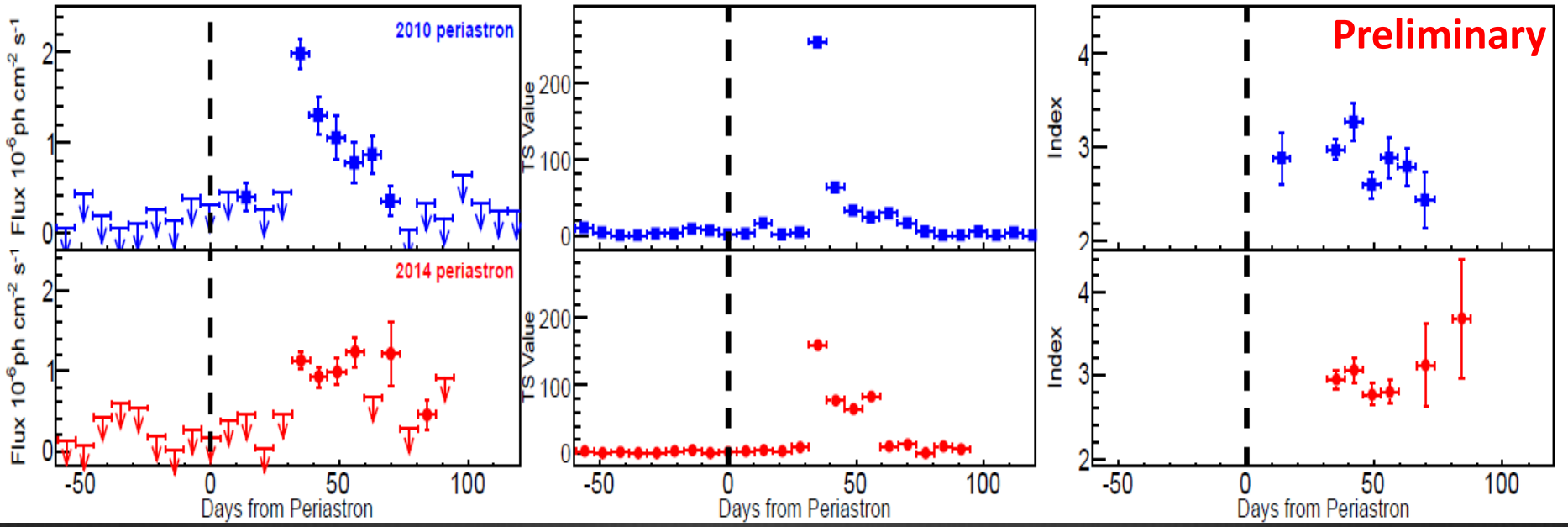
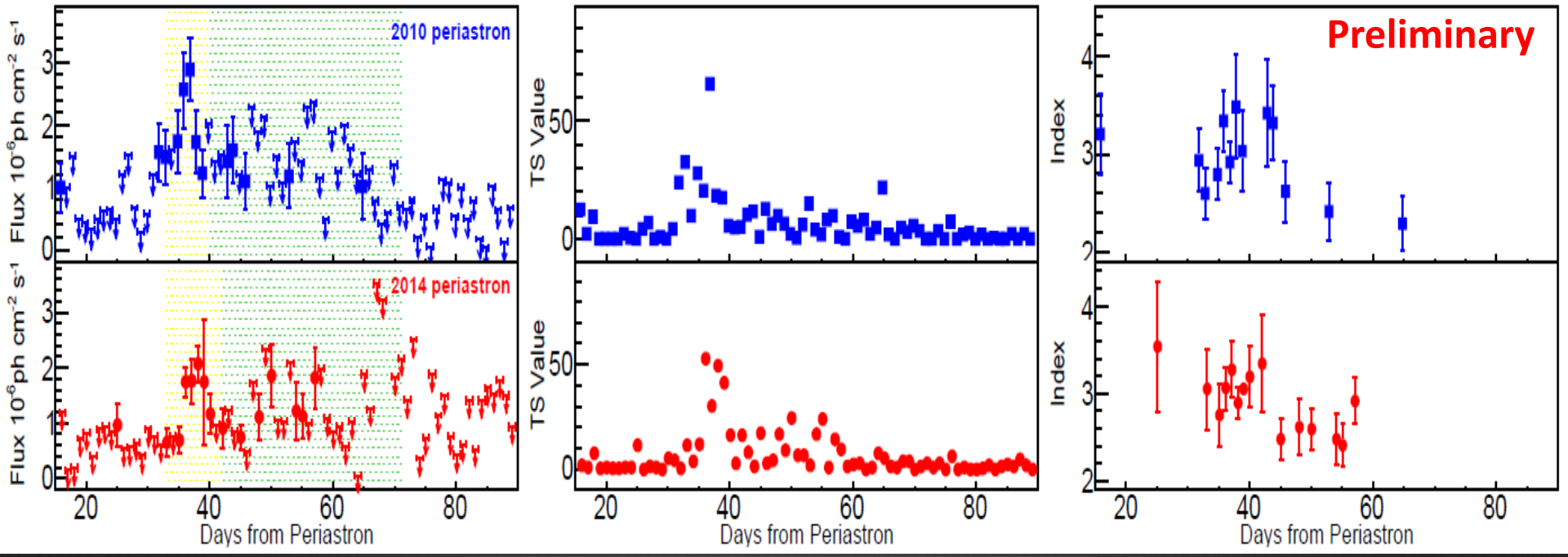
Light curve—GeV flare



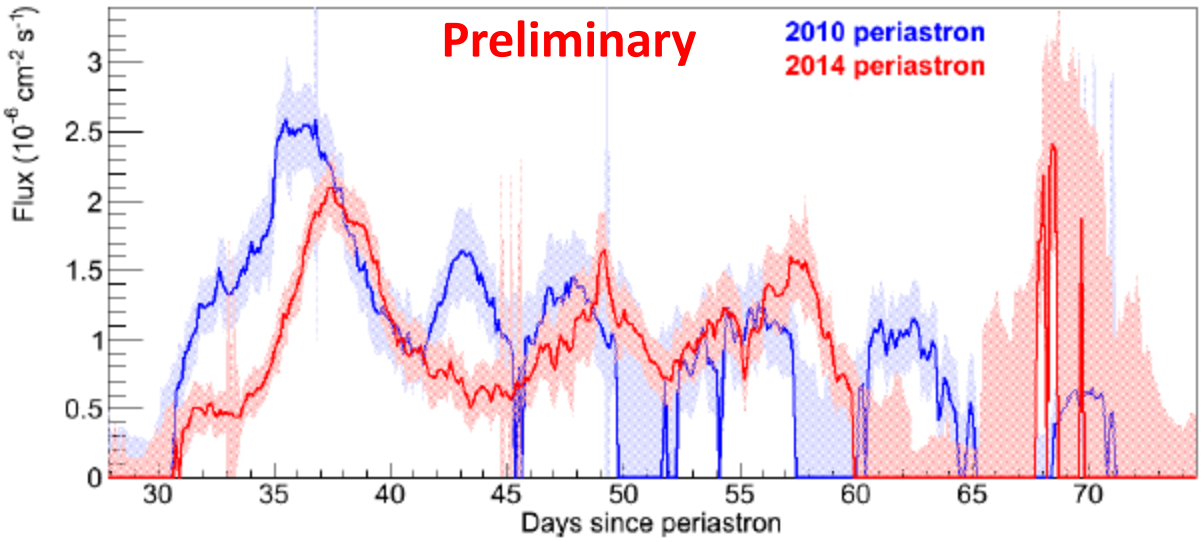
- Weekly flux (left), TS value (middle) and Spectral index (right) of PSR B1259-63 in the 2010 (blue) and 2014 (red) periastron

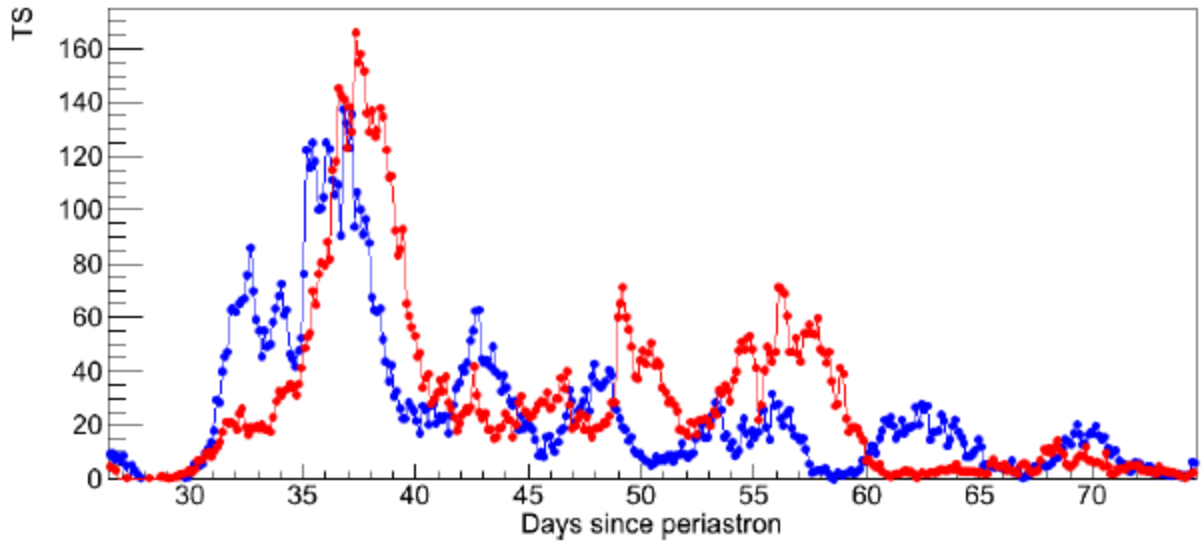
Light curve—GeV flare



- Daily flux (left), TS value (middle) and Spectral index (right) of PSR B1259-63 in the 2010 (blue) and 2014 (red) periastron
- The GeV activity in 2014 is 2.4 +/- 0.6 days delayed from 2010 calculated by cross-correlation

- To better visualize similarities and differences, a smoothed light curves was produced using a sliding window technique. We chose a time window of 3 days moving forward in time with steps of 3 hours

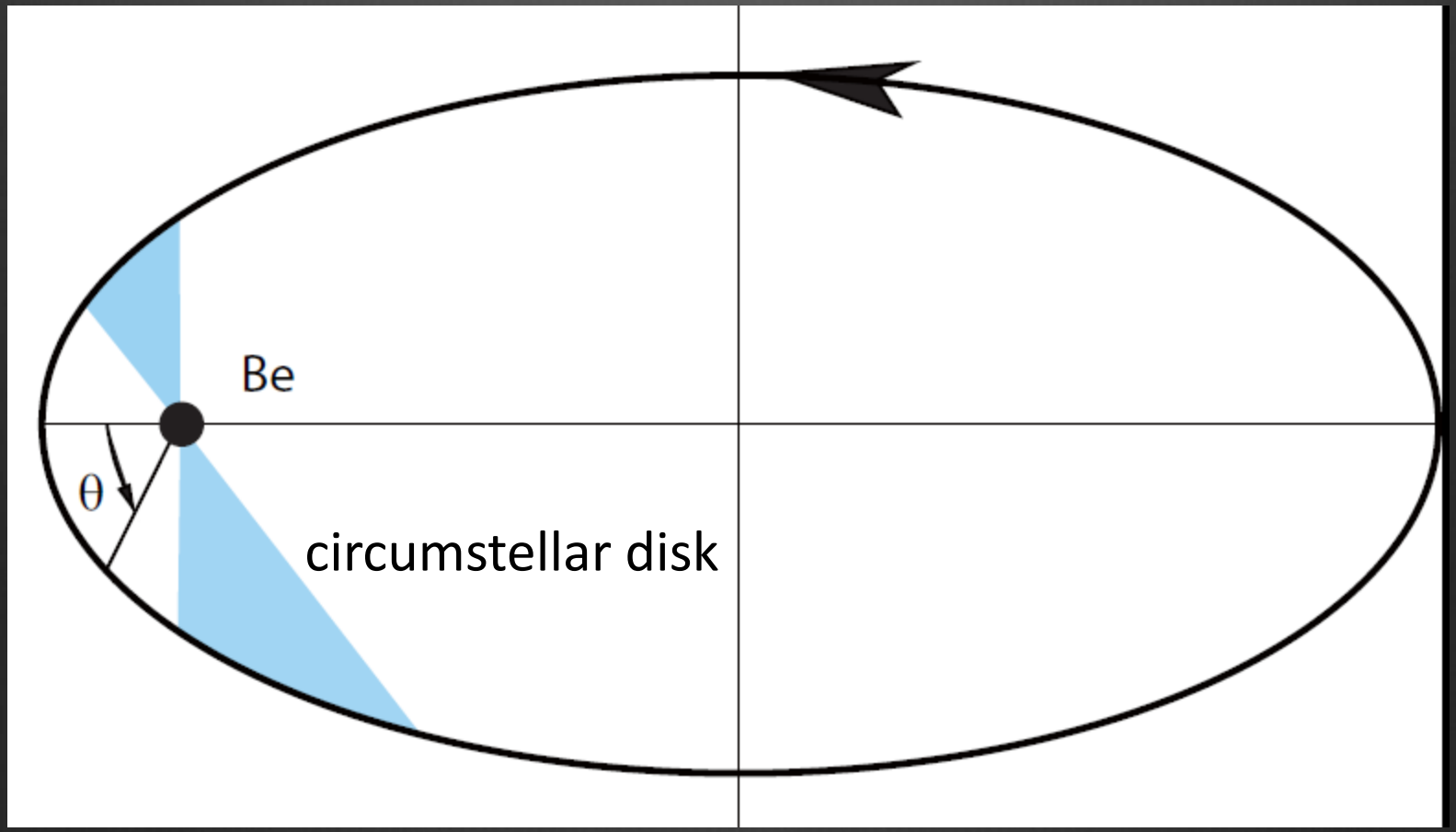




The flaring activity in 2010 and 2014 periastron start approximately at 30 days after periastron

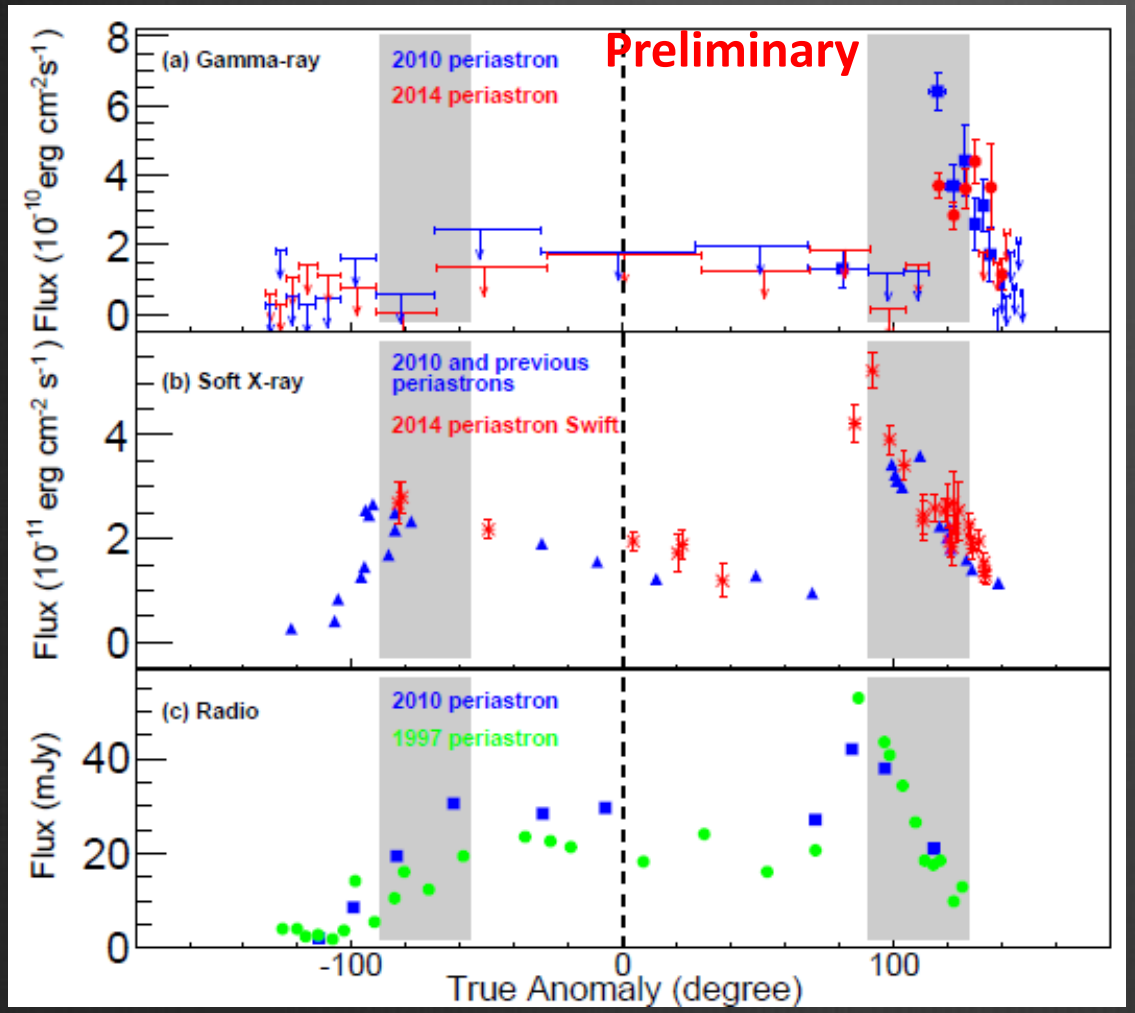
The peak at 2010 periastron is at ~36 days while 2014 periastron is at ~38 days after periastron. The 2 days delay is consistent with the cross-correlation result.

Light curve—Multiwavelength view of both periastra



Schematic representation of the PSR B1259−63 binary system. Shaded area shows the geometry of the disc inferred from the X-ray data (Chernyakova et al. 2006).

Light curve—Multiwavelength view of both periastra



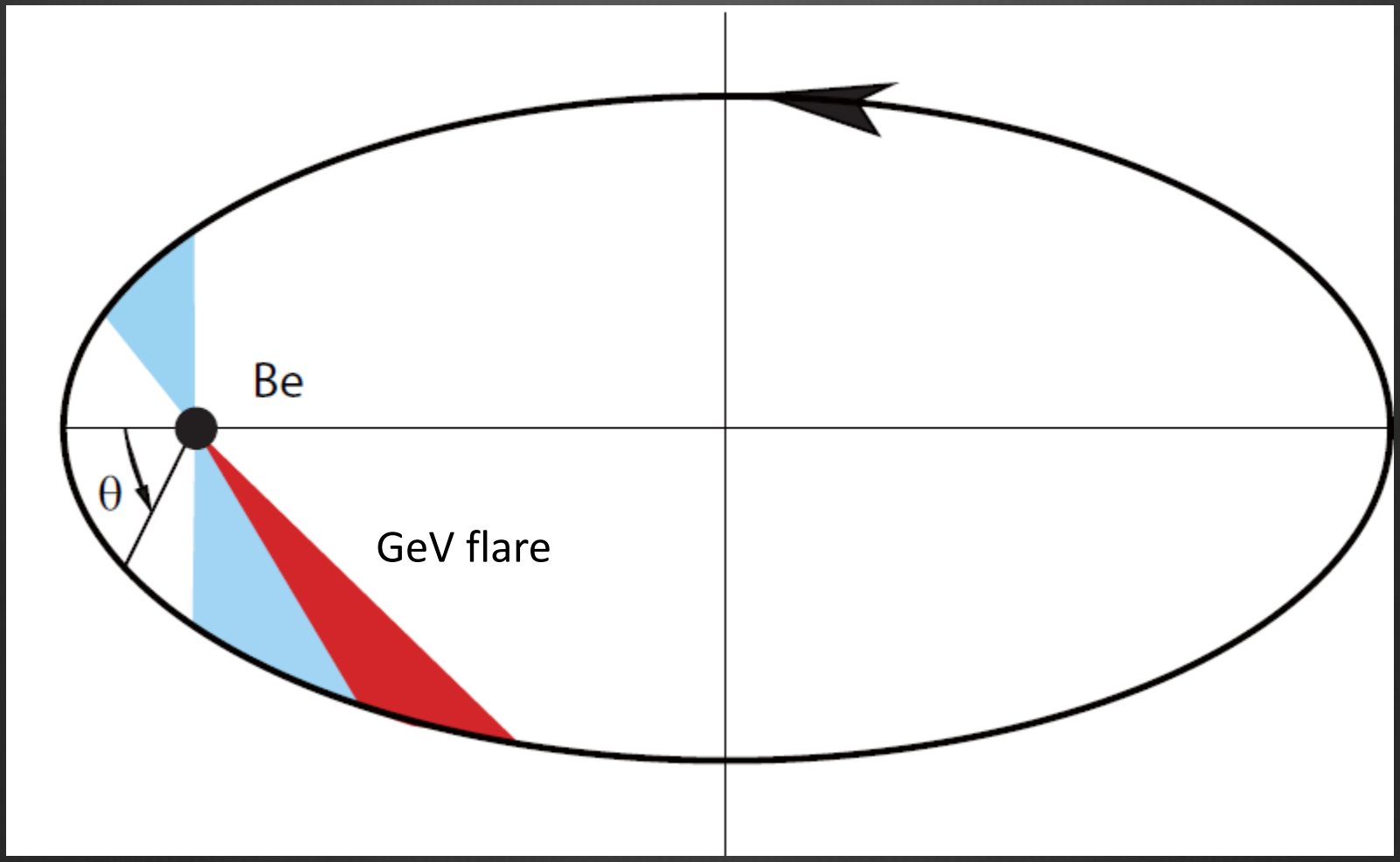
1: weekly gamma-ray flux of 2010 (blue) and 2014 (red) periastron passage

2: X-ray fluxes from 2014 Swift (red) and previous periastron

3: radio (2.4 GHz) flux densities for the 2010 (blue) and 1997 periastron passages (purple).

Shaded area corresponds to the Be circumstellar disk position proposed in Chernyakova et al. (2006).

Light curve—Multiwavelength view of both periastra



Schematic representation of the PSR B1259−63 binary system. Shaded area shows the geometry of the disc inferred from the X-ray data (Chernyakova et al. 2006).

- We searched for gamma-ray pulsations from PSR B1259-63 with all LAT observations available excluding periastron passages (from 60 days before periastron till 120 days after periastron)

  Neither a statistically significant detection of a pulsation, nor a detection of the source was found.

- We also searched for gamma-ray pulsation around 2009 and 2012 apastron passages (from 1, 2 and 3 month before apastron till after apastron, respectively).

  No pulsation nor PSR B1259-63 itself was significantly detected in these periods.

Spectral analysis

- Based on the smoothed Light curve, we define two intervals during the flare period (31-79 days after periastron) , Peak (yellow) and Tail (blue) interval
- 2010 periastron,

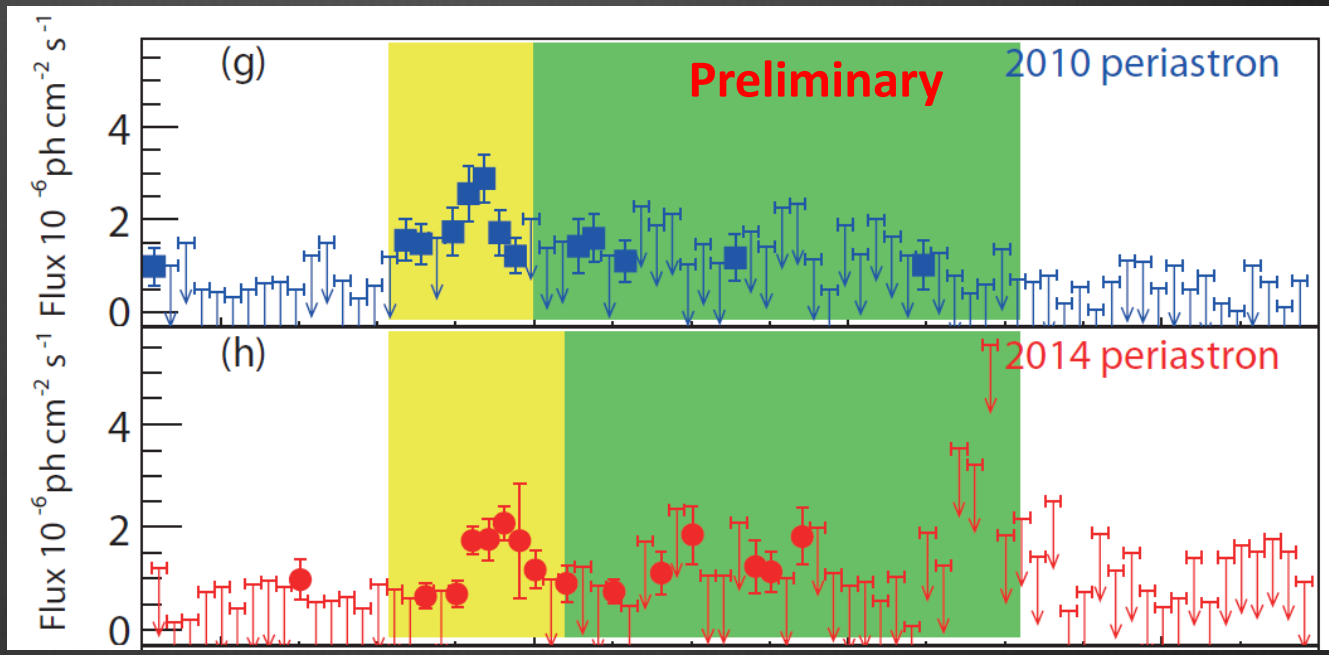
  Peak 31 to 40 days

  Tail 40 to 79 days
- 2014 periastron,

  Peak 31 to 42 days

  Tail 42 to 79 days

  (after periastron)

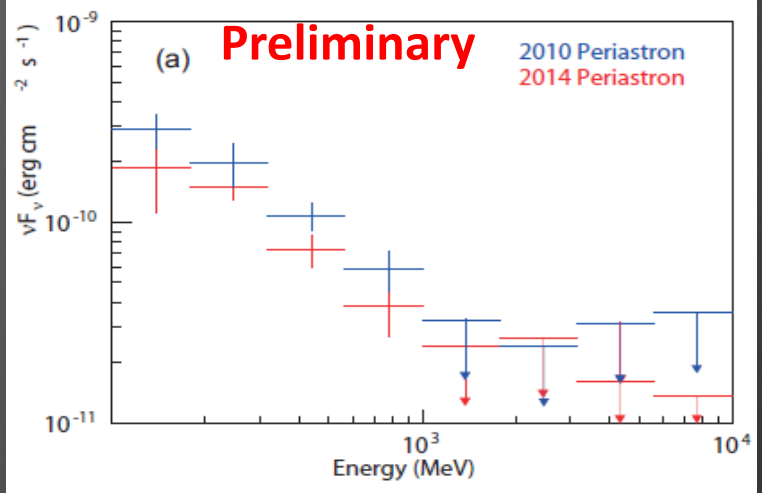


Spectral analysis

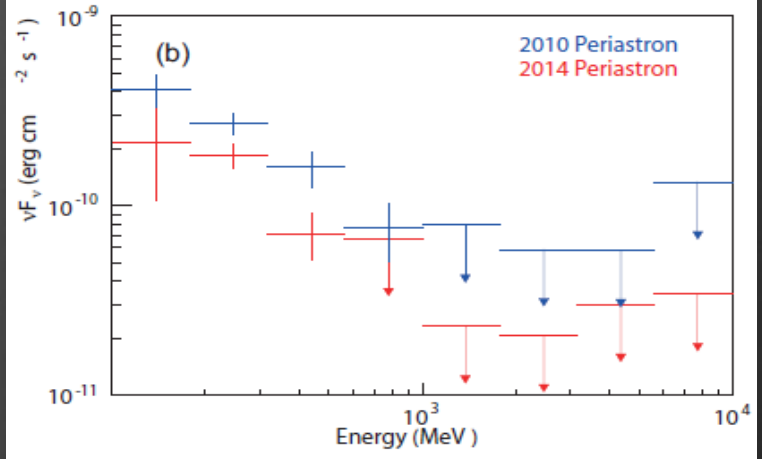
- The spectra of 2010 and 2014 flare (top, average spectra; bottom, Peak and Tail interval) and fitted results with single power law model.

		Photon index Γ	Flux(>100 MeV) 10^{-7} ph cm^{-2} s^{-1}
2014 flare	Average	2.94 ± 0.07	10.4 ± 0.7
	Peak interval	3.01 ± 0.10	12.7 ± 1.1
	Tail interval	2.87 ± 0.09	8.6 ± 0.9
2010 flare	Average	2.91 ± 0.07	11.5 ± 0.9
	Peak interval	3.04 ± 0.12	20.0 ± 1.7
	Tail interval	2.83 ± 0.09	8.8 ± 1.1

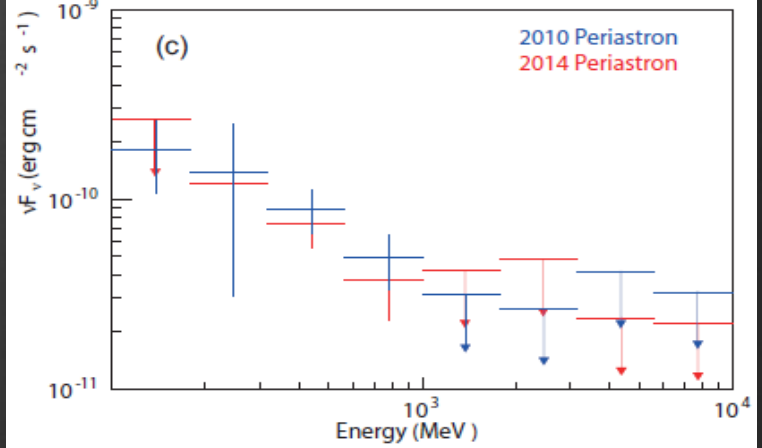
The significance of spectral cutoffs for 2010 and 2014 flares are less than 3 sigma.



Averaged



Peak



Tail

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Conclusion and Discussion

- We discover a recurrent flaring behavior in gamma-rays, a phenomenology that is associated with periastron passages.
- The 2014 GeV flare exhibits a similar flux level and spectral shape with the 2010 flare.
- The two GeV flares showed different flux evolution.
- The 2014 GeV flare peak is about 2 days delayed from the 2010 one.
- No GeV pulsations from PSR B1259-63 have been detected in any part of its orbit.
- The nature of the GeV flare is under debate.

Thanks for your attention