The Galactic Transients KSP

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Core Program = ~40% of time in first 10 yrs = 9 (+1) Key Science Projects

Theme		Question	Dark Matter Programme	Galactic Centre Survey	Galactic Plane Survey	LMC Survey	Extra-galactic Survey	Transients	Cosmic Ray PeVatrons	Star-forming Systems	Active Galactic Nuclei	Galaxy Clusters
Understanding the Origin and Role of Relativistic Cosmic Particles	1.1	What are the sites of high-energy particle acceleration in the universe?		✔	✔✔	✔✔	✔✔	✔✔	✔	✔	✔	✔✔
	1.2	What are the mechanisms for cosmic particle acceleration?		✔	✔	✔		✔✔	✔✔	✔	✔✔	✔
	1.3	What role do accelerated particles play in feedback on star formation and galaxy evolution?		✔		✔				✔✔	✔	✔
Probing Extreme Environments	2.1	What physical processes are at work close to neutron stars and black holes?		✔	✔	✔			✔✔		✔✔	
	2.2	What are the characteristics of relativistic jets, winds and explosions?		✔	✔	✔	✔	✔✔	✔✔		✔✔	
	2.3	How intense are radiation fields and magnetic fields in cosmic voids, and how do these evolve over cosmic time?					✔	✔			✔✔	
Exploring Frontiers in Physics	3.1	What is the nature of Dark Matter? How is it distributed?	✔✔	✔✔		✔						✔
	3.2	Are there quantum gravitational effects on photon propagation?						✔✔	✔		✔✔	
	3.3	Do Axion-like particles exist?					✔	✔			✔✔	

Comparison with other KSP

Extragalactic Survey	—> 1000 hr, 25% of sky, 6mCrab
Gal Plane Survey	—> 1600 hr, ~2-4 mCrab,
Galactic Center Survey	—> 825 hr
LMC Survey	—> 500 hr (S),
Transients	—> 2700 hr

KSP on Transients in "Science with CTA"

A) Gamma-ray Bursts

B) Galactic Transients

C) X-ray, optical and radio transients

(= external alerts)

D) High-E neutrino transients

E) GW transients

F) Serendipitous VHE transients

(= internal CTA alerts during normal observations)

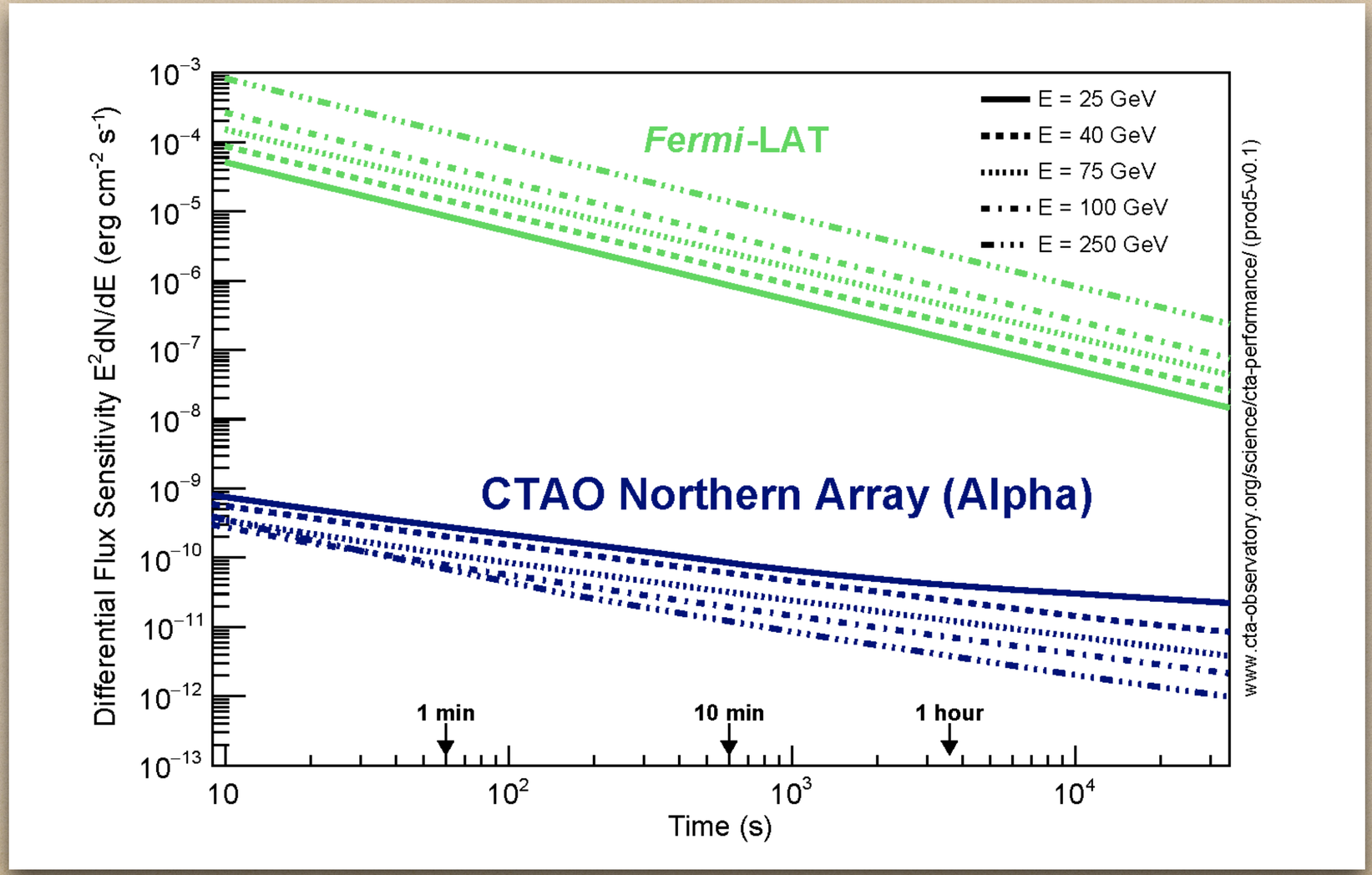
G) VHE transient survey

(= internal CTA alerts during dedicated surveys / divergent pointings

Planned observation time for transients KSP

	Hours / year / site		
	Early phase	Years 1-2	Years 2-10
GRB	50	50	50
Galactic	150	30	0 ?
X-ray, optical, radio	50	10	10
HE neutrinos	20	5	5
GW	20	5	5
Serendipitous VHE	100	25	25
TOTAL	390	125	95

Sensitivity on short timescales



OUTLINE

- Introduction
- Pulsar Wind Nebulae
- Gamma-ray Binaries
- Micro QSOs
- Novae
- Magnetars
- Remarks

Pulsar Wind Nebulae

- Gamma-ray variability discovered by AGILE and Fermi in 2011

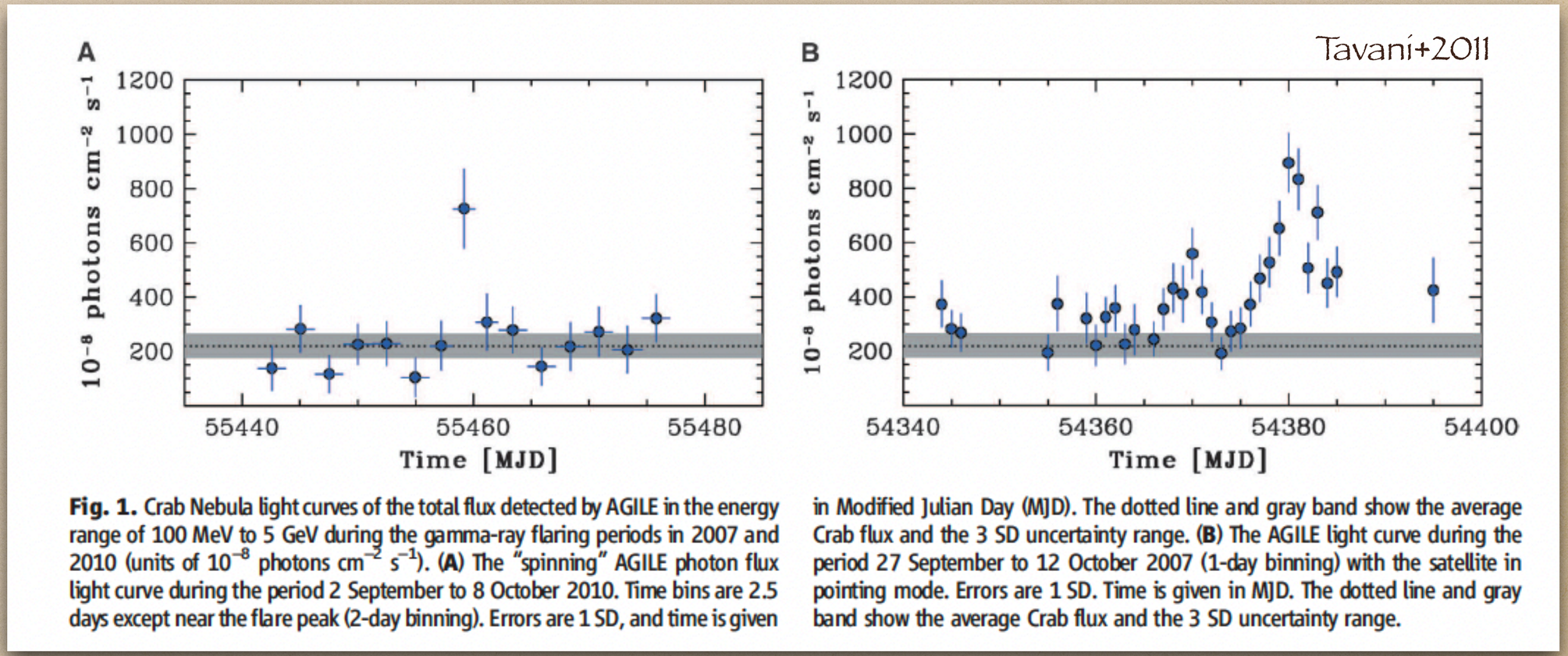


Fig. 1. Crab Nebula light curves of the total flux detected by AGILE in the energy range of 100 MeV to 5 GeV during the gamma-ray flaring periods in 2007 and 2010 (units of 10^{-8} photons cm^{-2} s^{-1}). (**A**) The "spinning" AGILE photon flux light curve during the period 2 September to 8 October 2010. Time bins are 2.5 days except near the flare peak (2-day binning). Errors are 1 SD, and time is given in Modified Julian Day (MJD). The dotted line and gray band show the average Crab flux and the 3 SD uncertainty range. (**B**) The AGILE light curve during the period 27 September to 12 October 2007 (1-day binning) with the satellite in pointing mode. Errors are 1 SD. Time is given in MJD. The dotted line and gray band show the average Crab flux and the 3 SD uncertainty range.

0.1-5 GeV 3x increase in ~day

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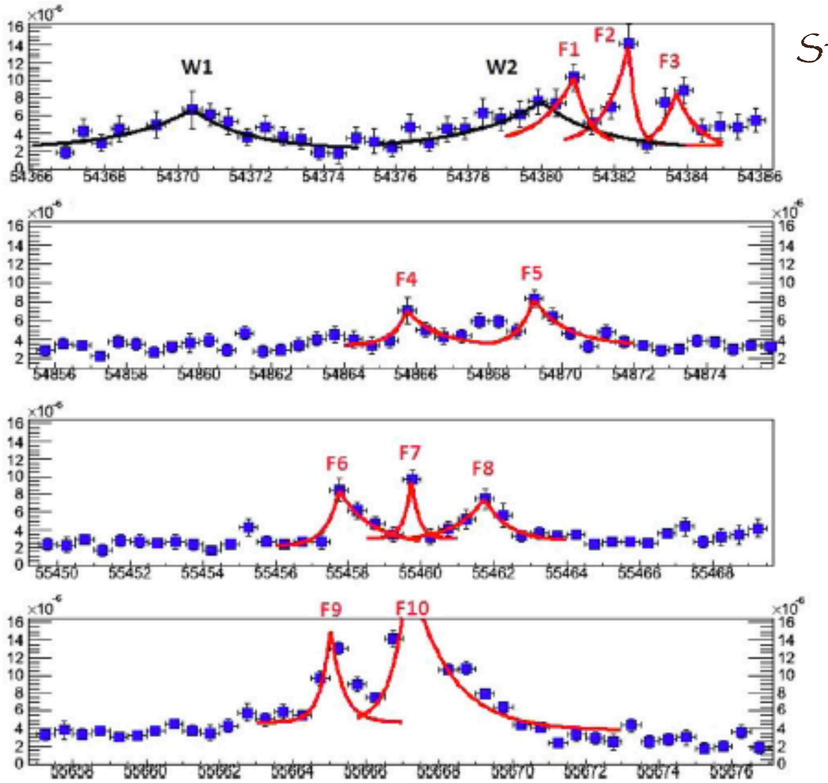
- Short bright flares (<day, up to x30) and longer "waves"



Striani+2013

Figure 1. Gamma-ray lightcurves above 100 MeV (12 hr time bins) from the Crab (pulsar plus Nebula) detected by *AGILE* and *Fermi*-LAT. From top to bottom: the 2007 September–October event (*AGILE* data), the 2009 February event (*Fermi*-LAT data), the 2010 September event (*Fermi*-LAT data), and the 2011 April event (*Fermi*-LAT data).

(A color version of this figure is available in the online journal.)

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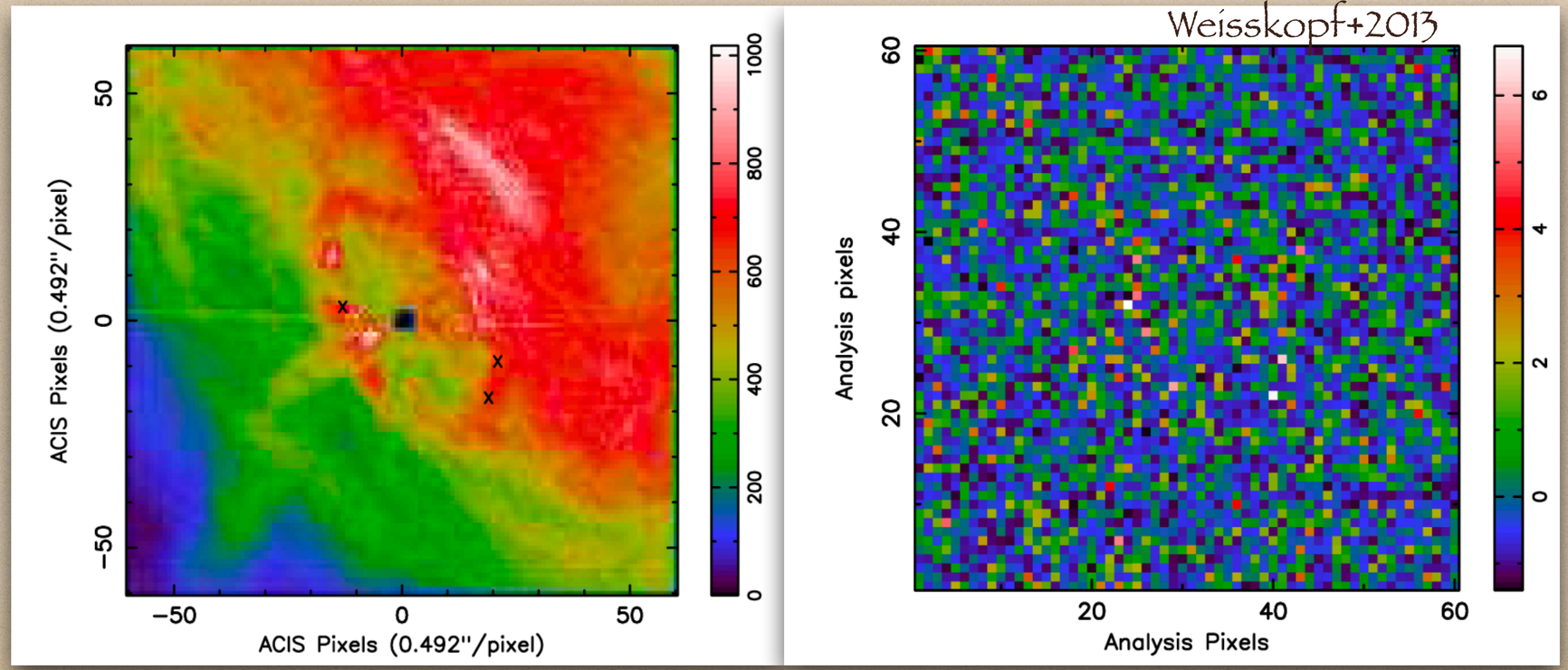

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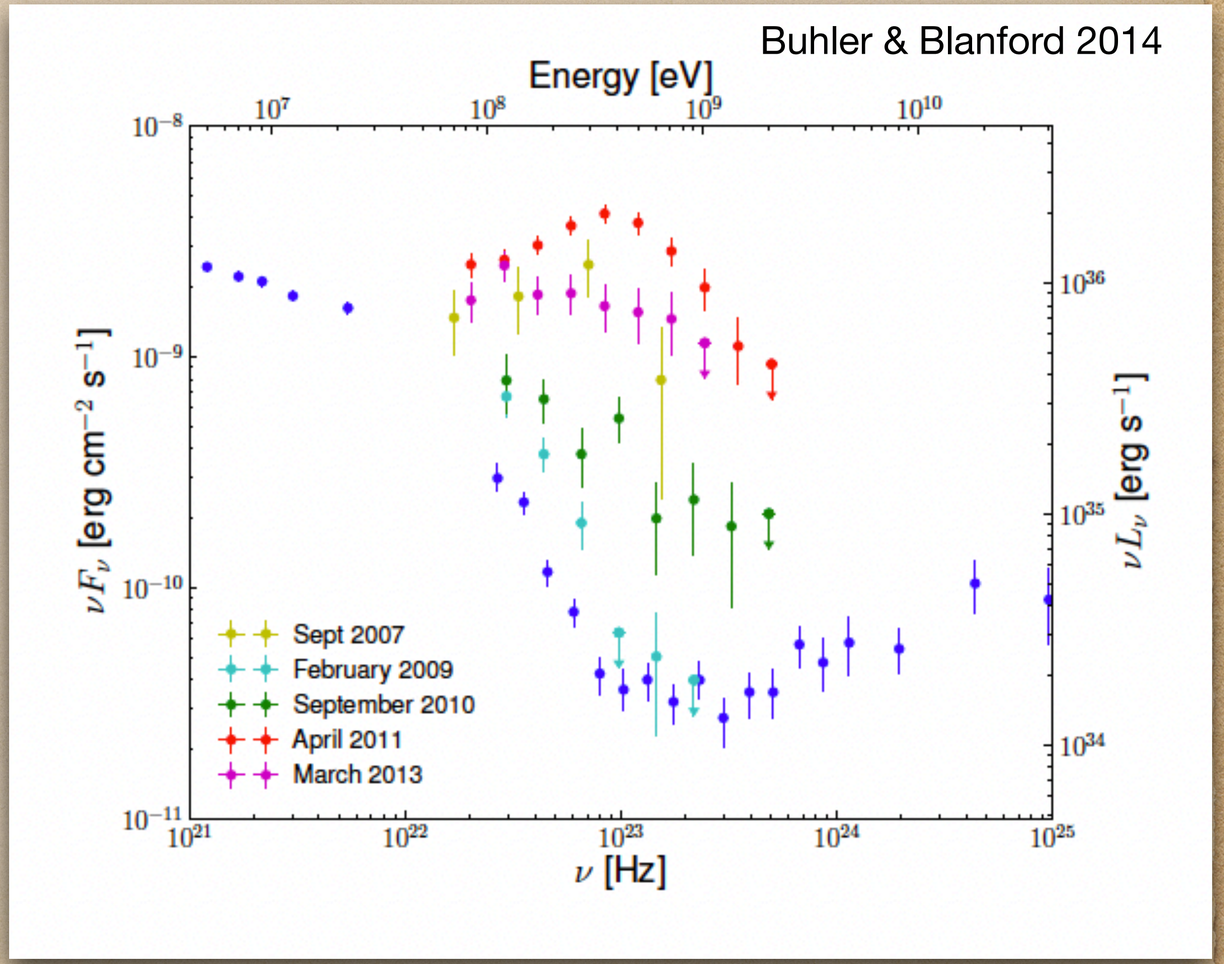
- magnetic reconnection / relativistic boosting ?
- Synchrotron + IC, pair production



Pulsar Wind Nebulae

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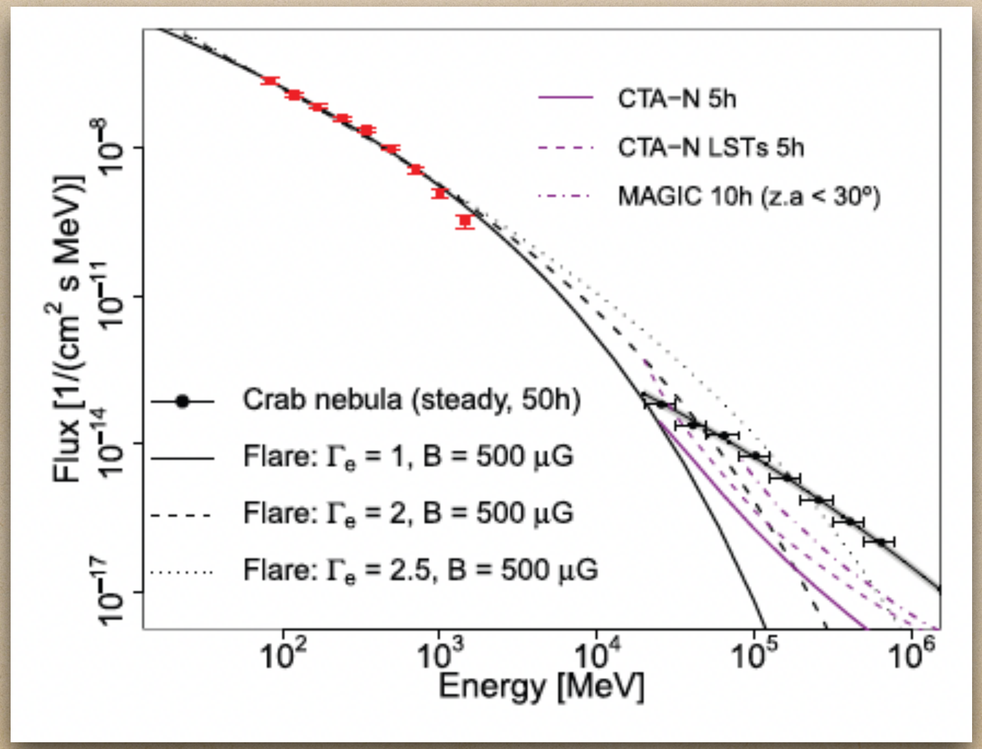

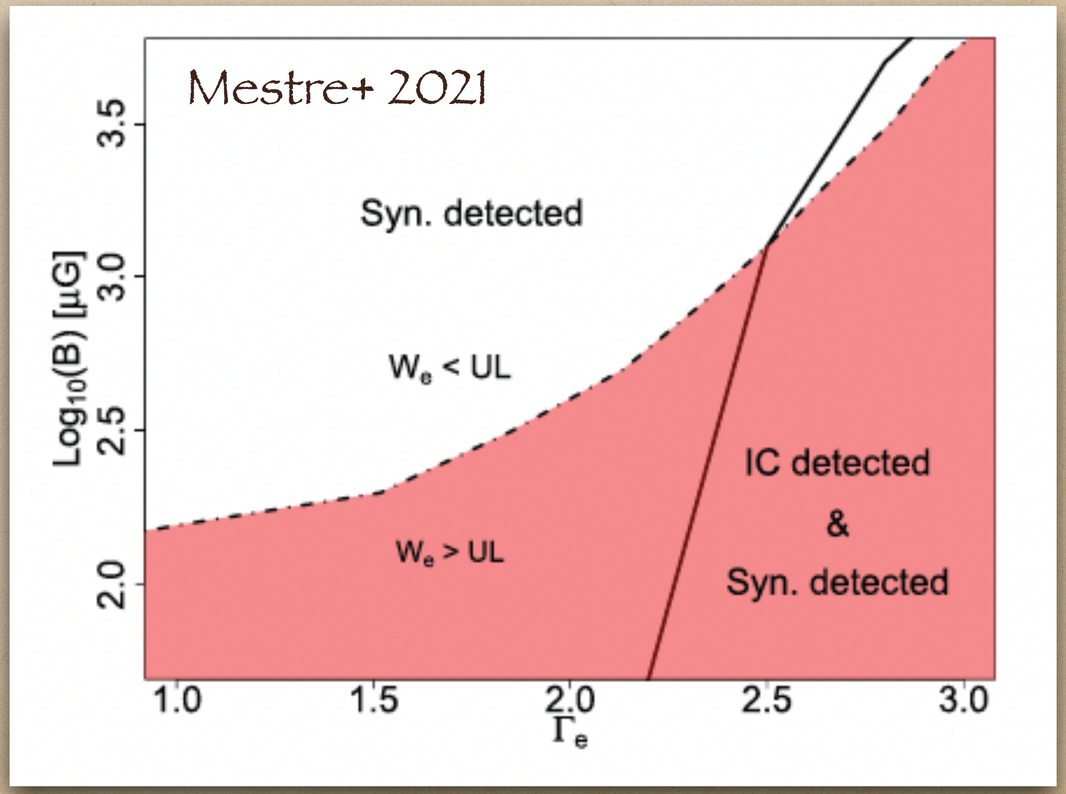

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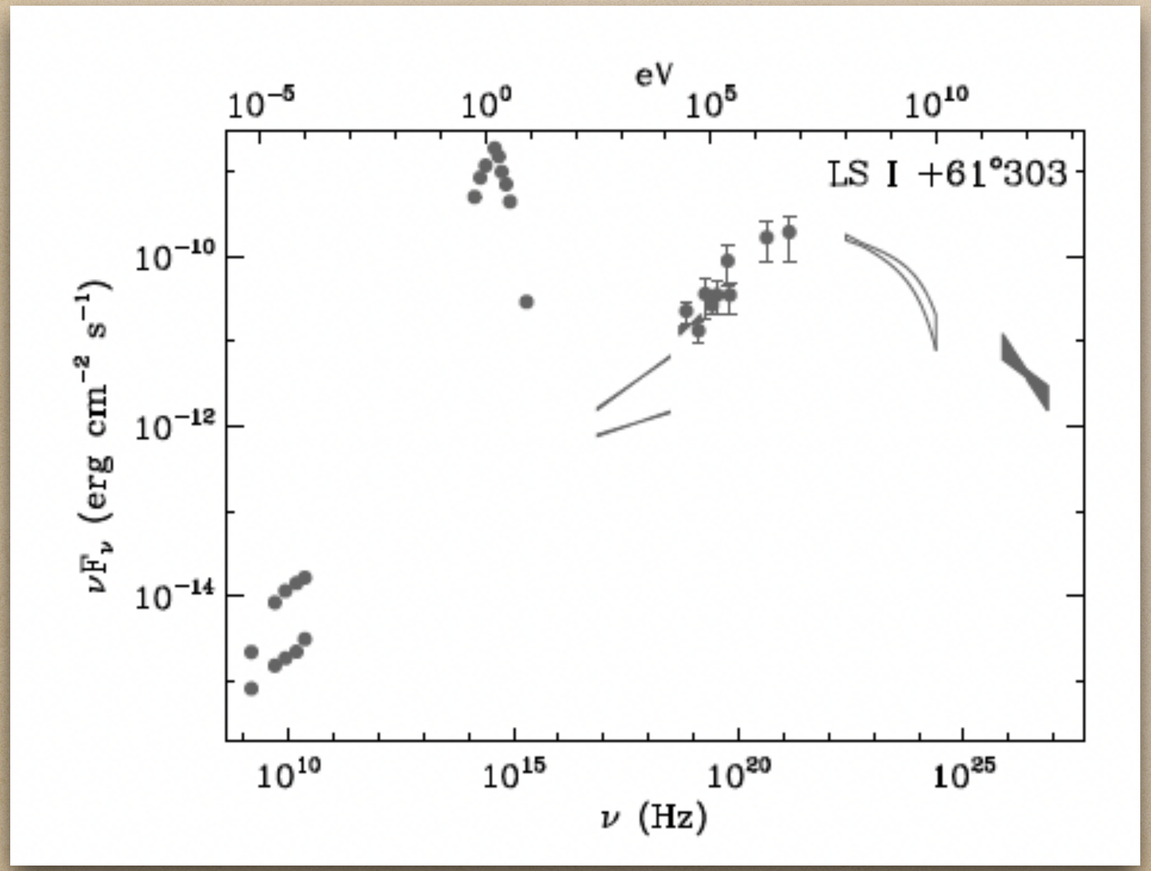
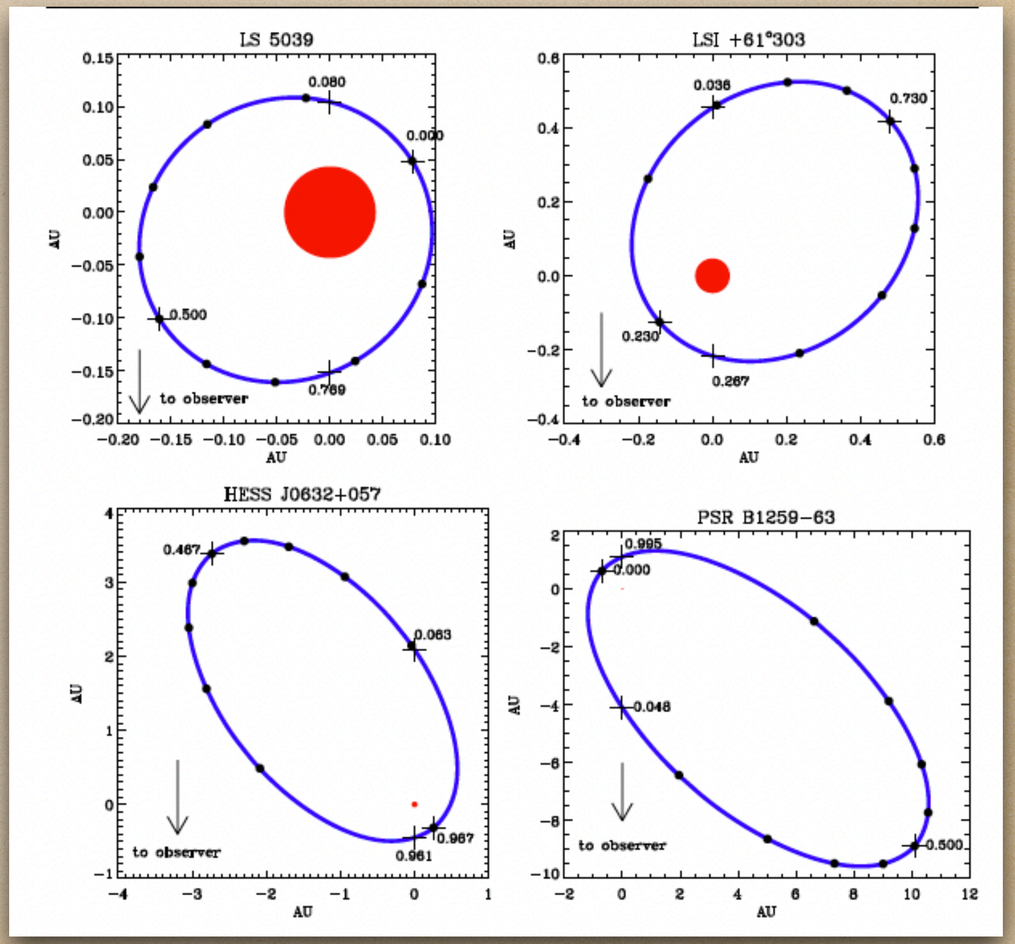
- Massive star (O/Be) + Neutron Star (or BH ?)
- HE and/or VHE emission dominates SED





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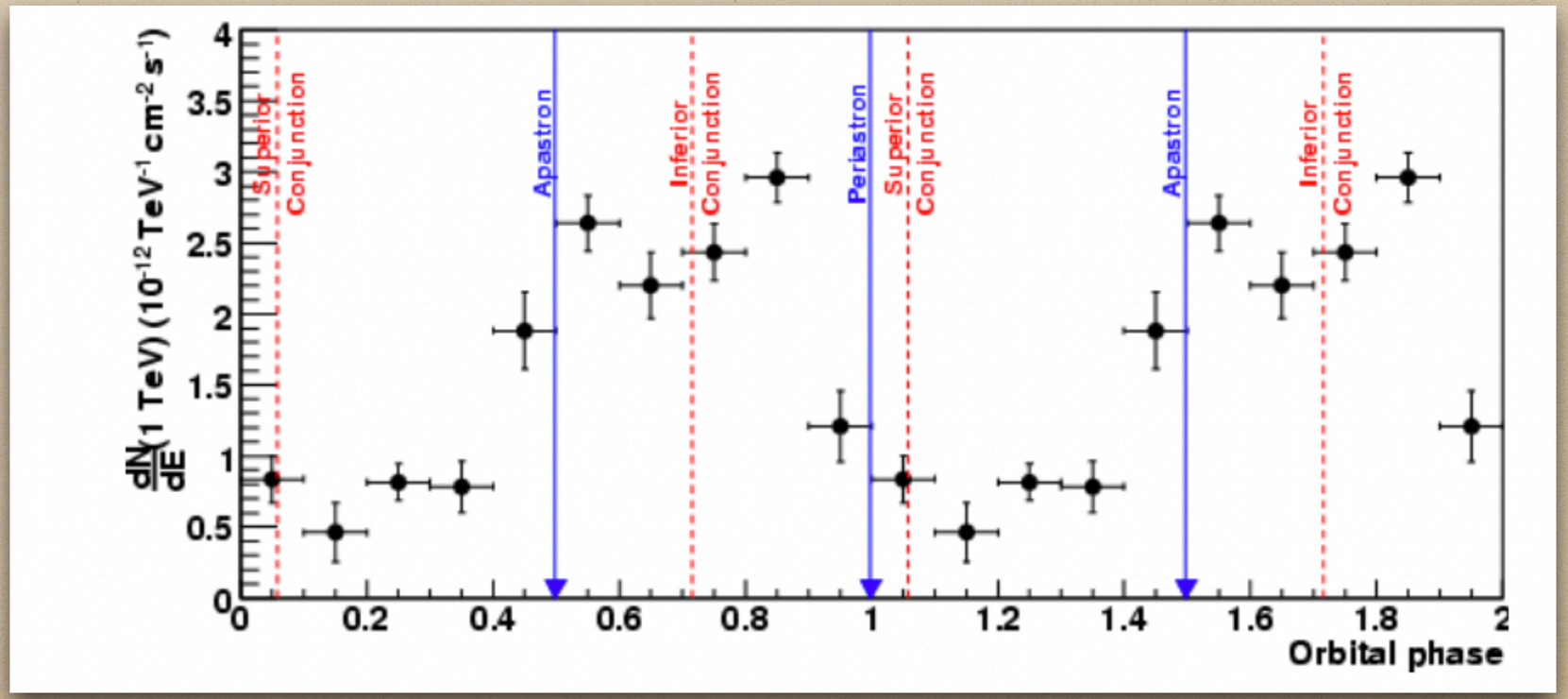
LS5039 - Aharonian+ 2006



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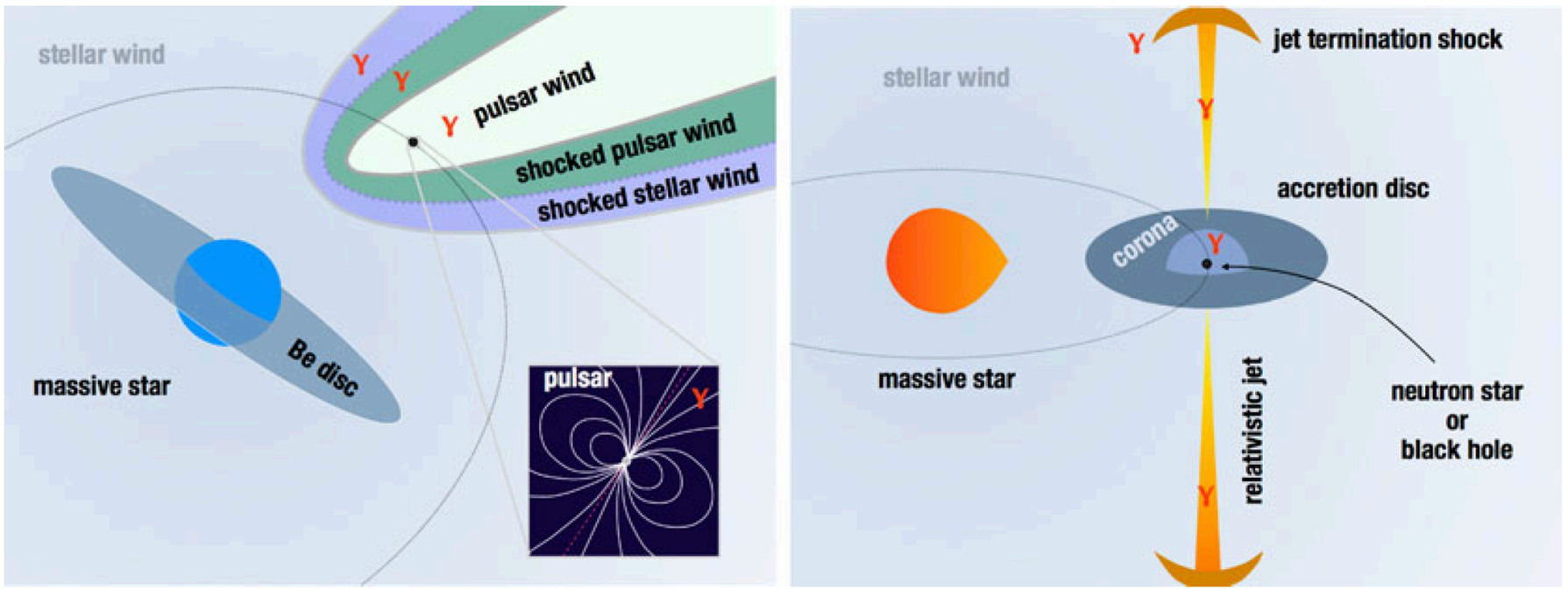

Dubus 2013

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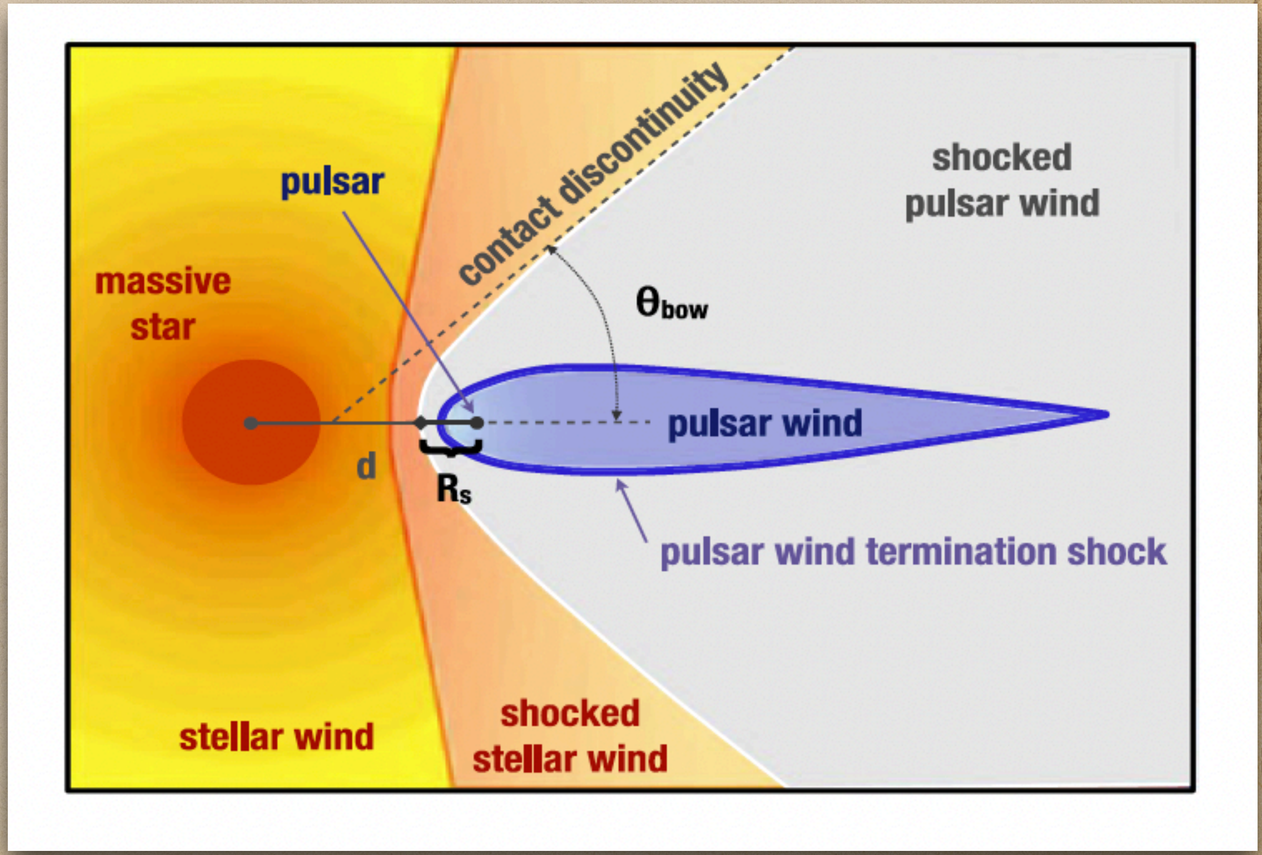

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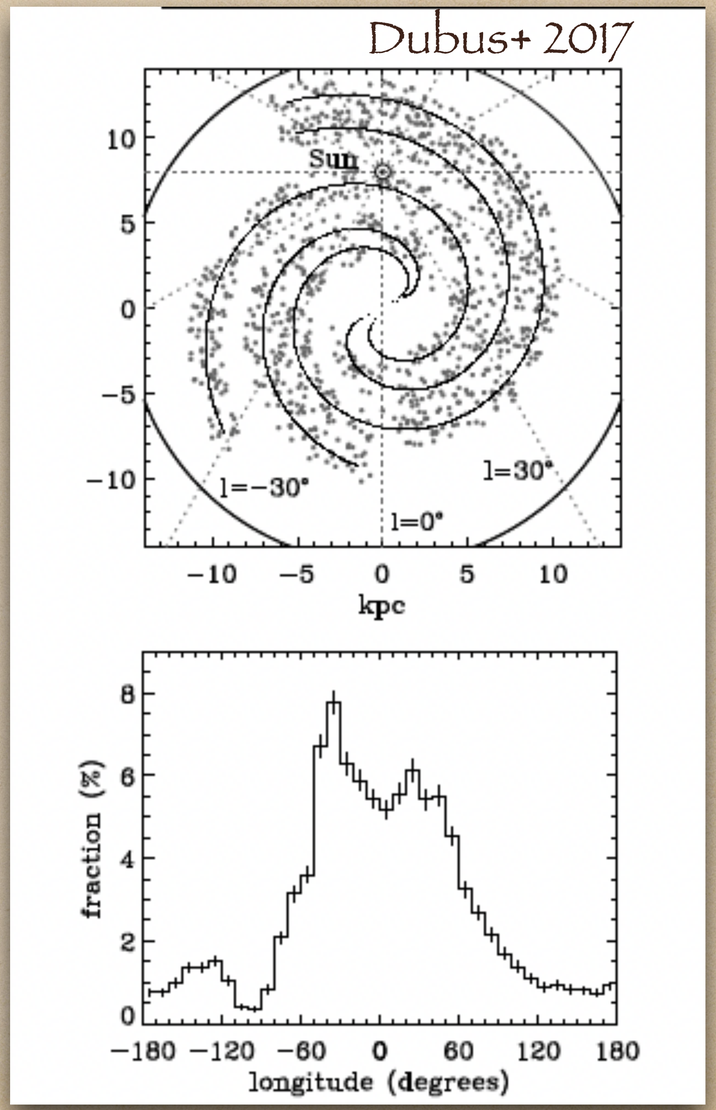
- 50-200 expected in the Galaxy (Dubus+2017) Many low-duty cycle to be discovered (long Porb)



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Micro QSOs

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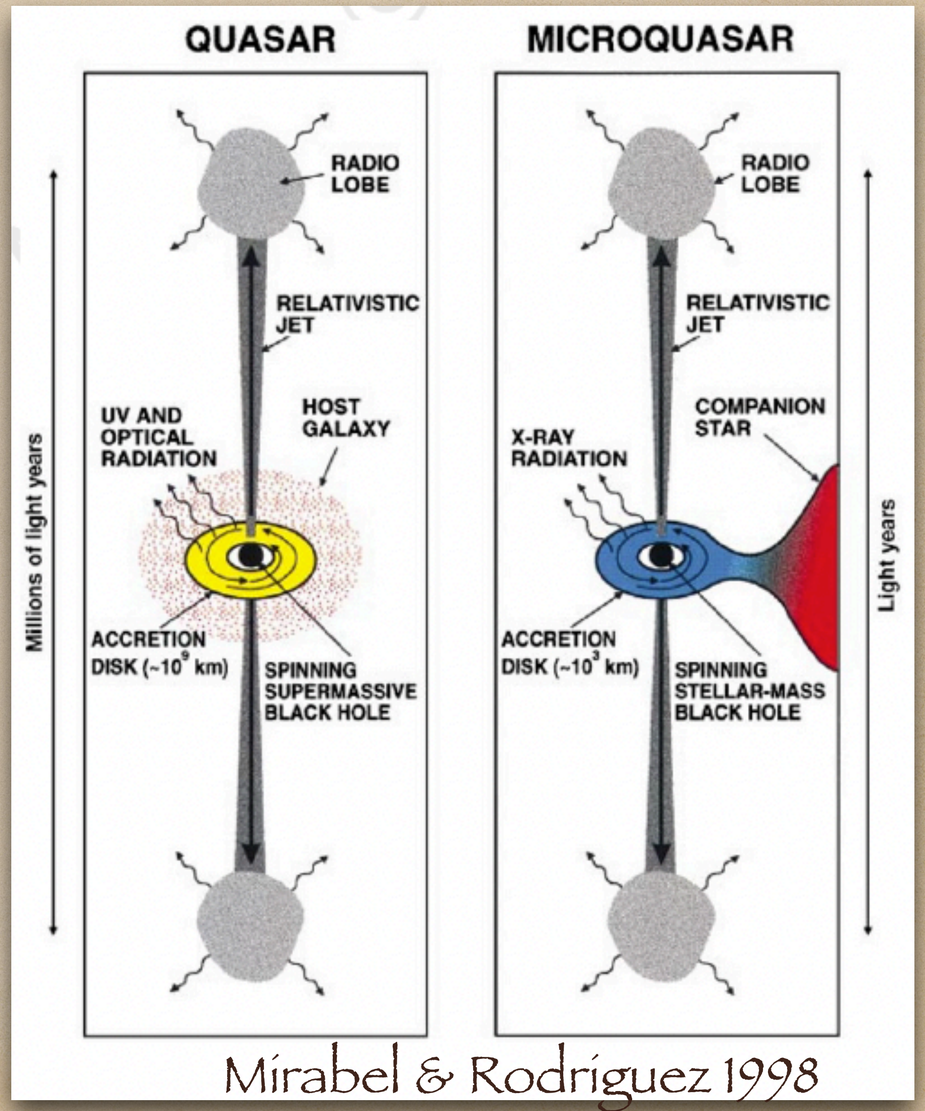

Mirabel & Rodriguez 1998

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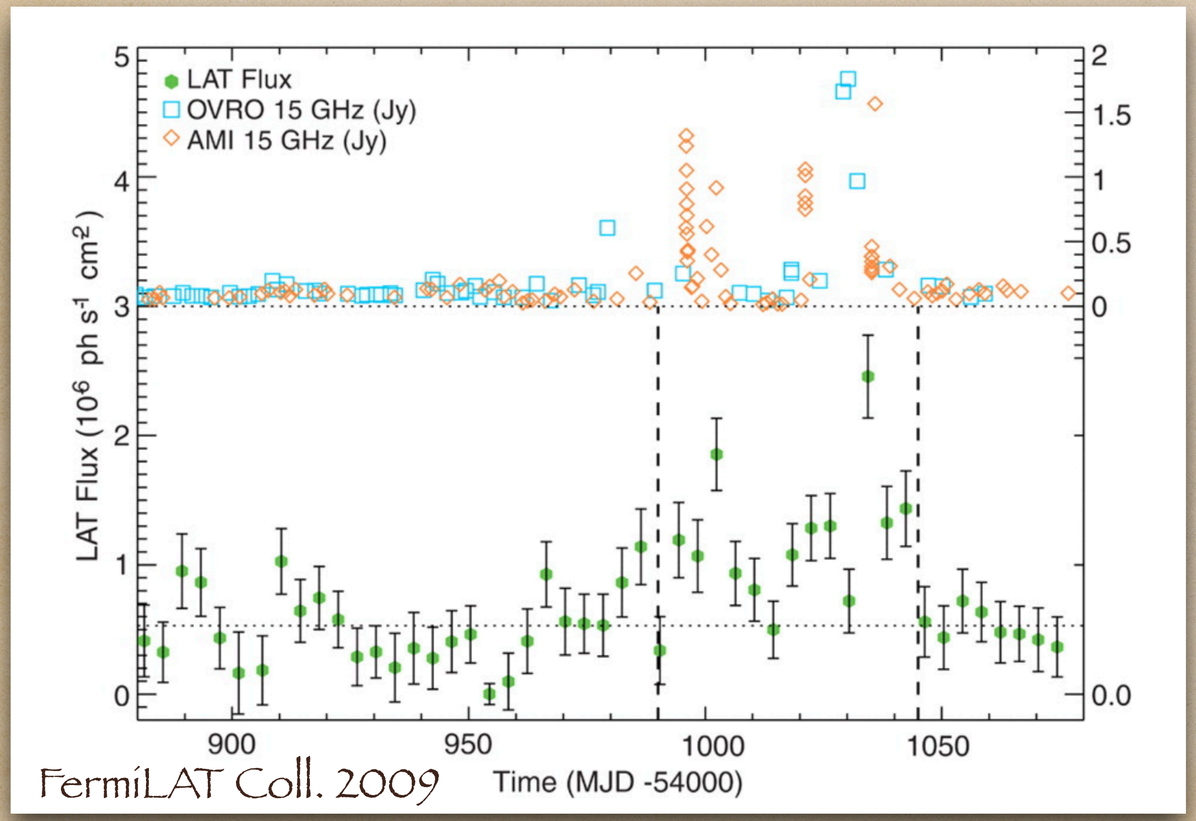
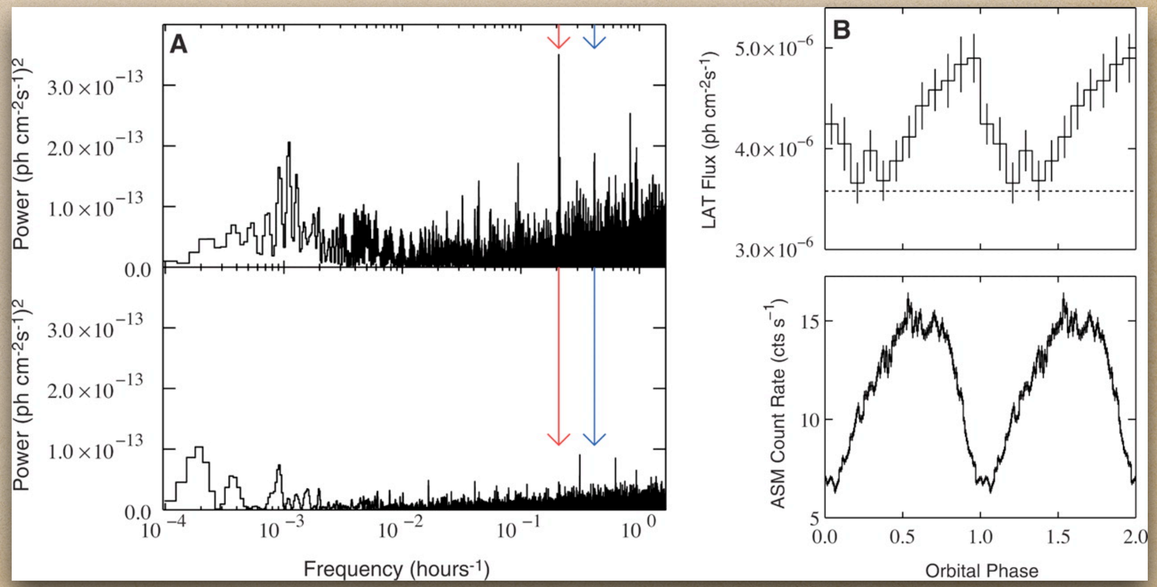


Cyg X-3



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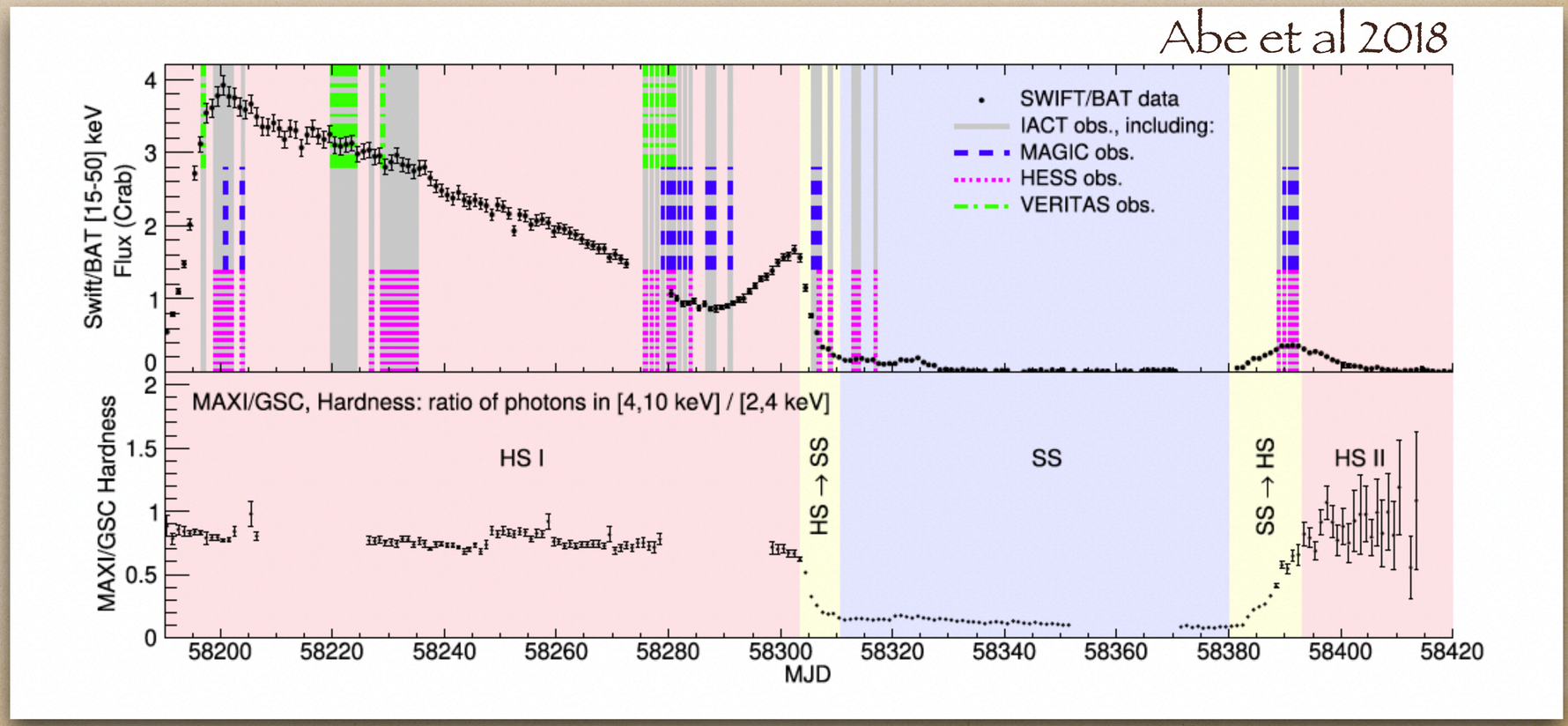
Abe et al 2018



MAXI J1820+070

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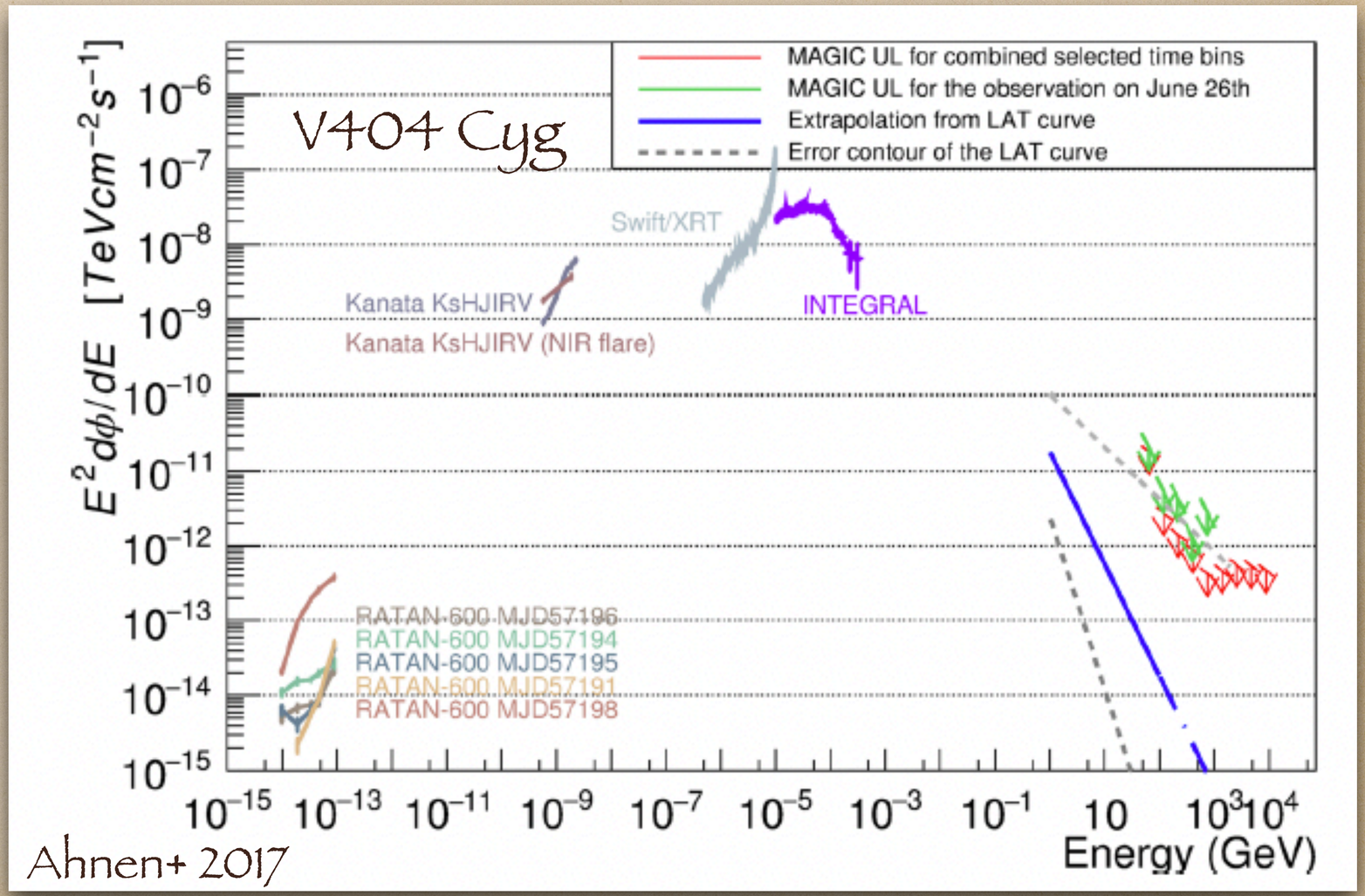

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Novae

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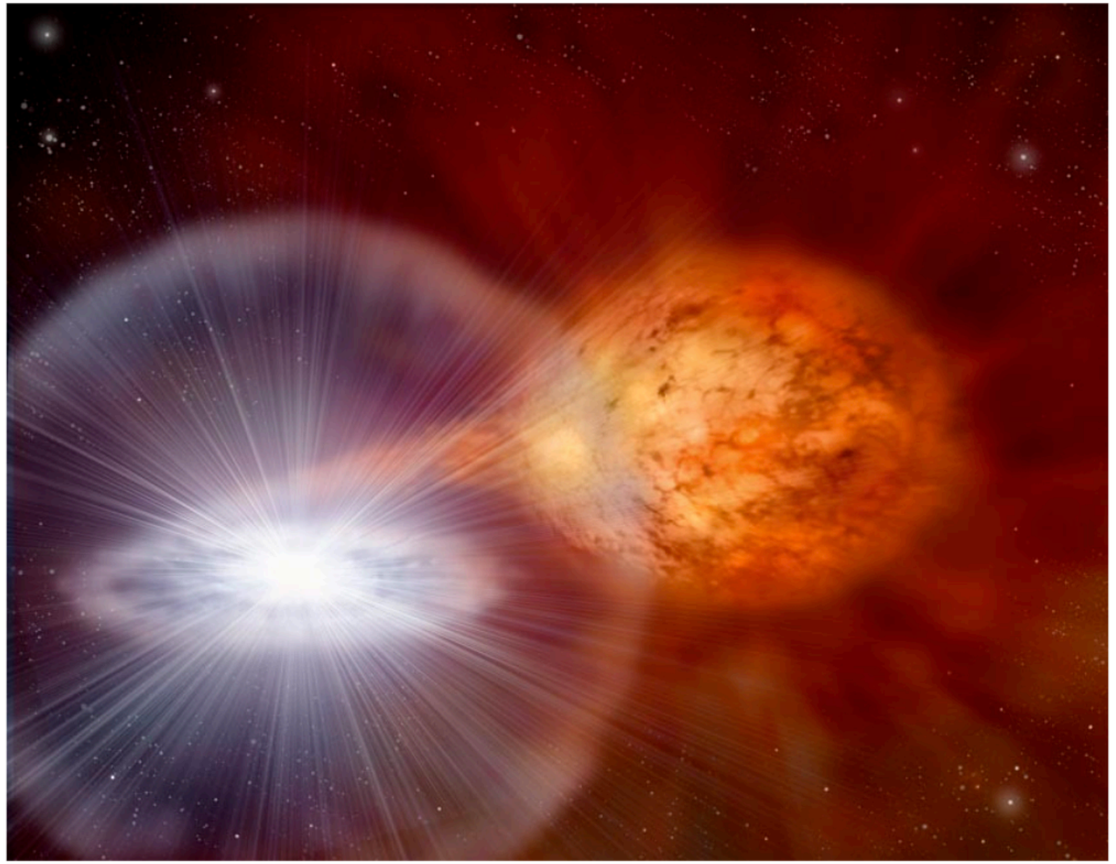

Credit: David A.Hardy/ www.astroart.org & PPARC.

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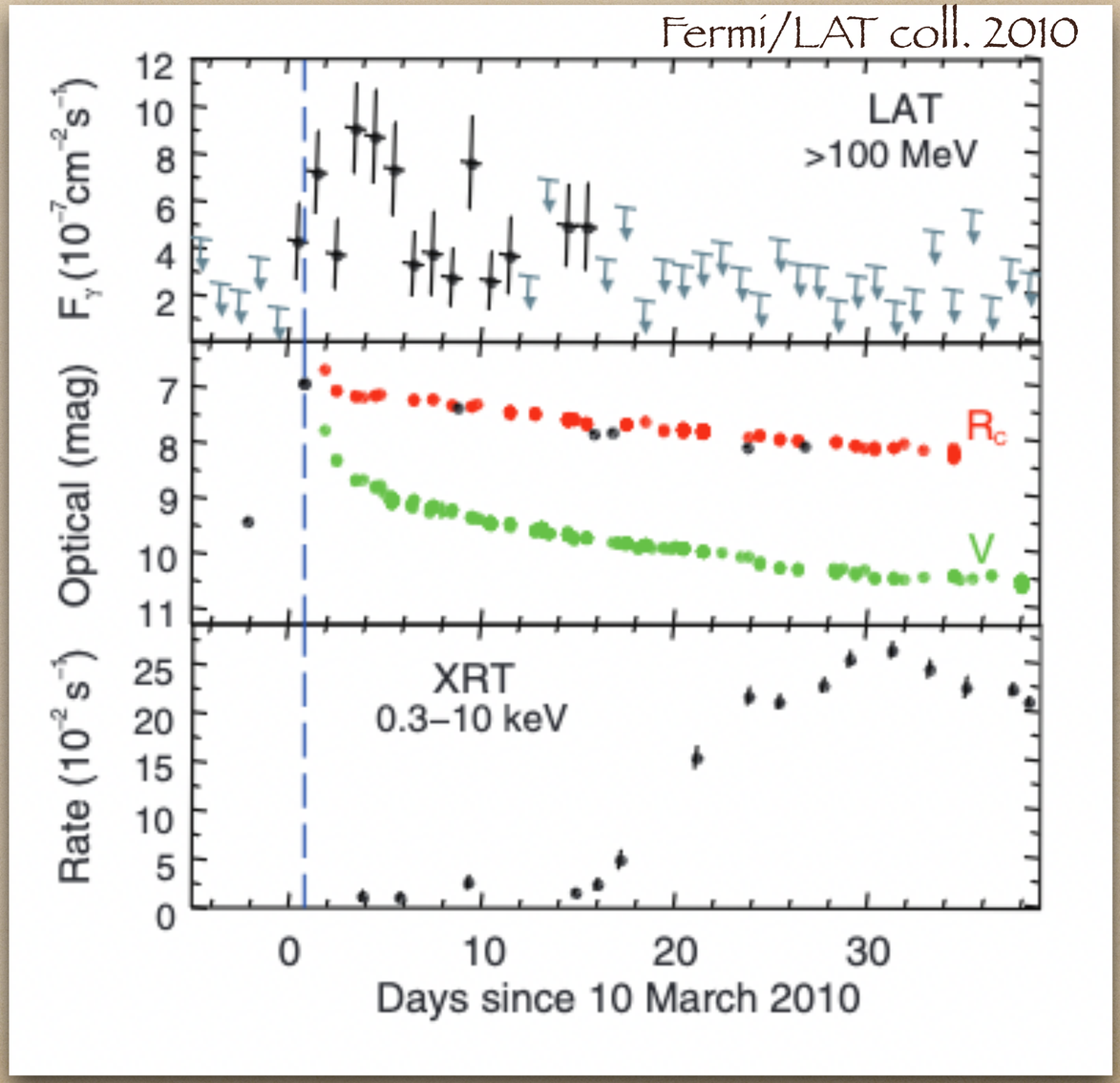
V407 Cyg



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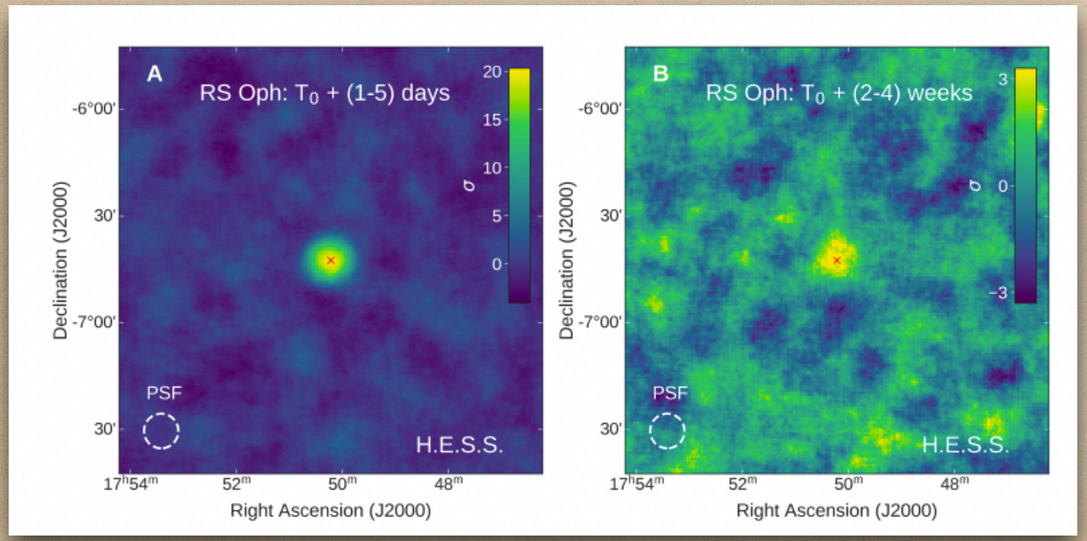

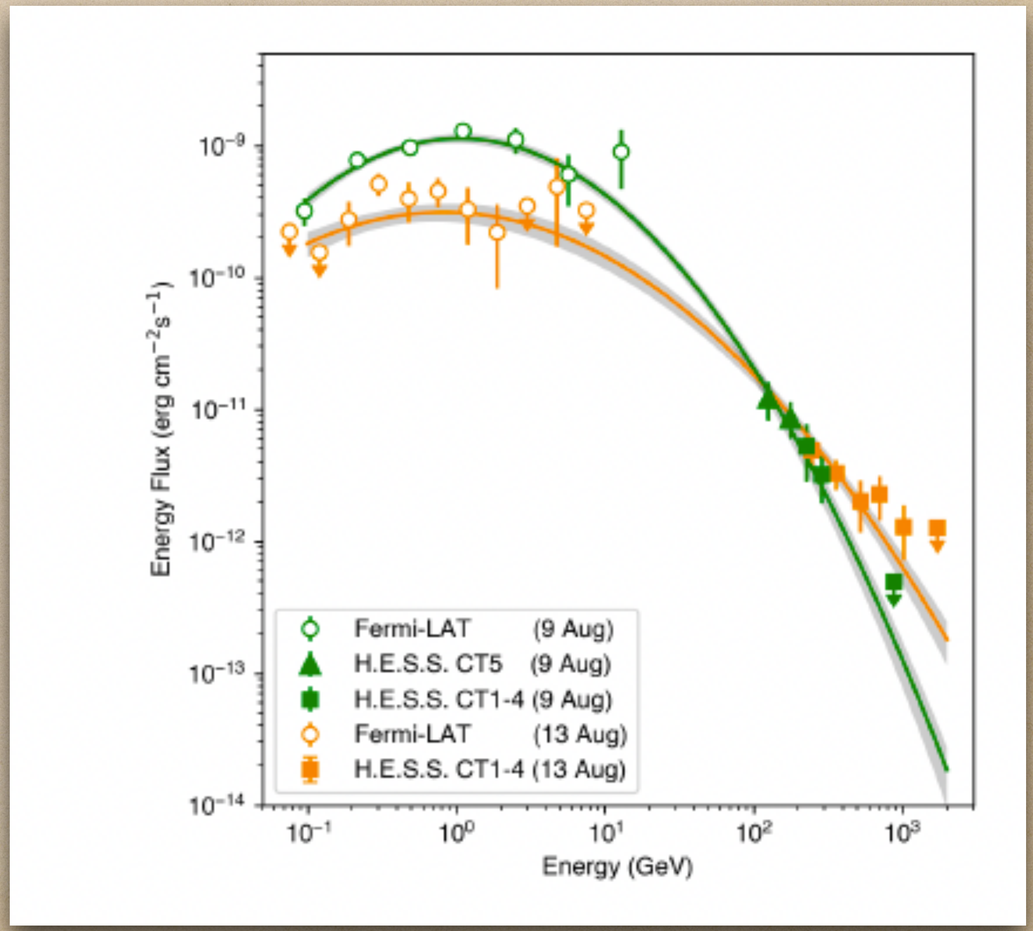

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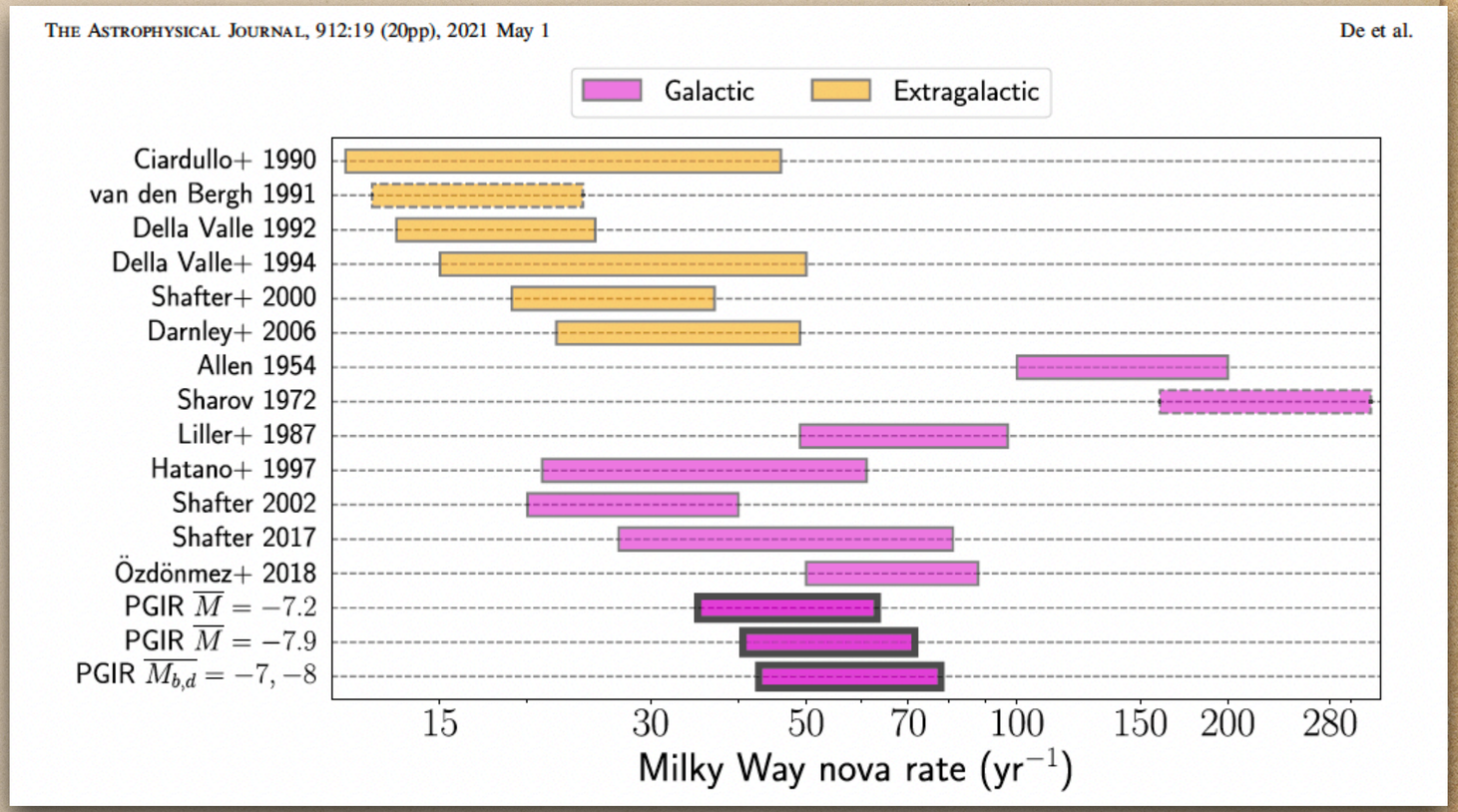

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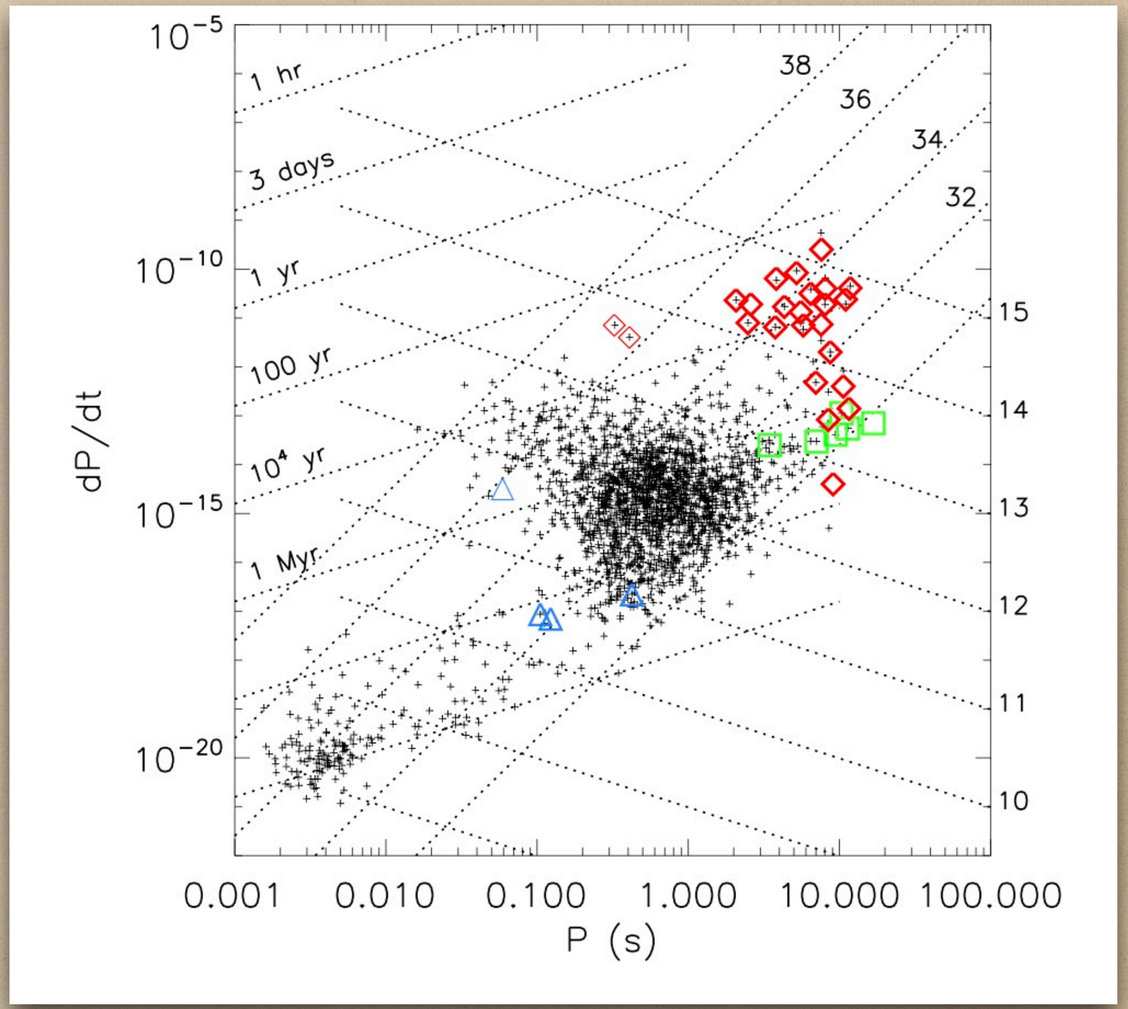
Magnetars

- (Isolated) neutron stars powered by magnetic energy



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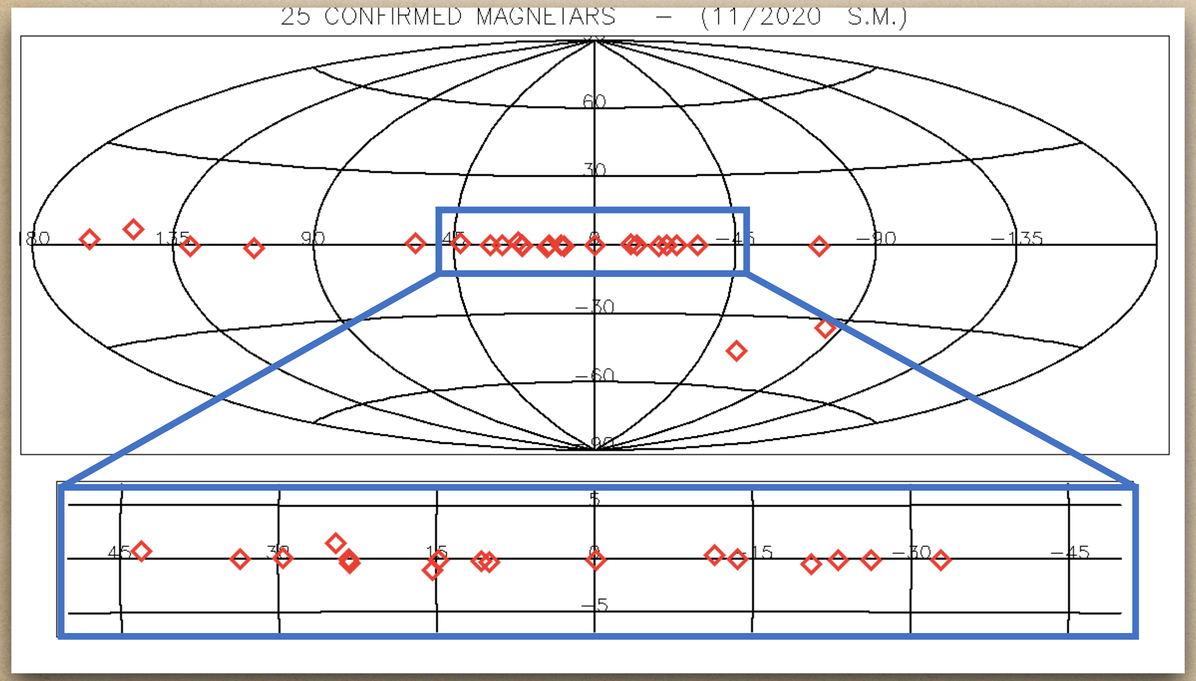

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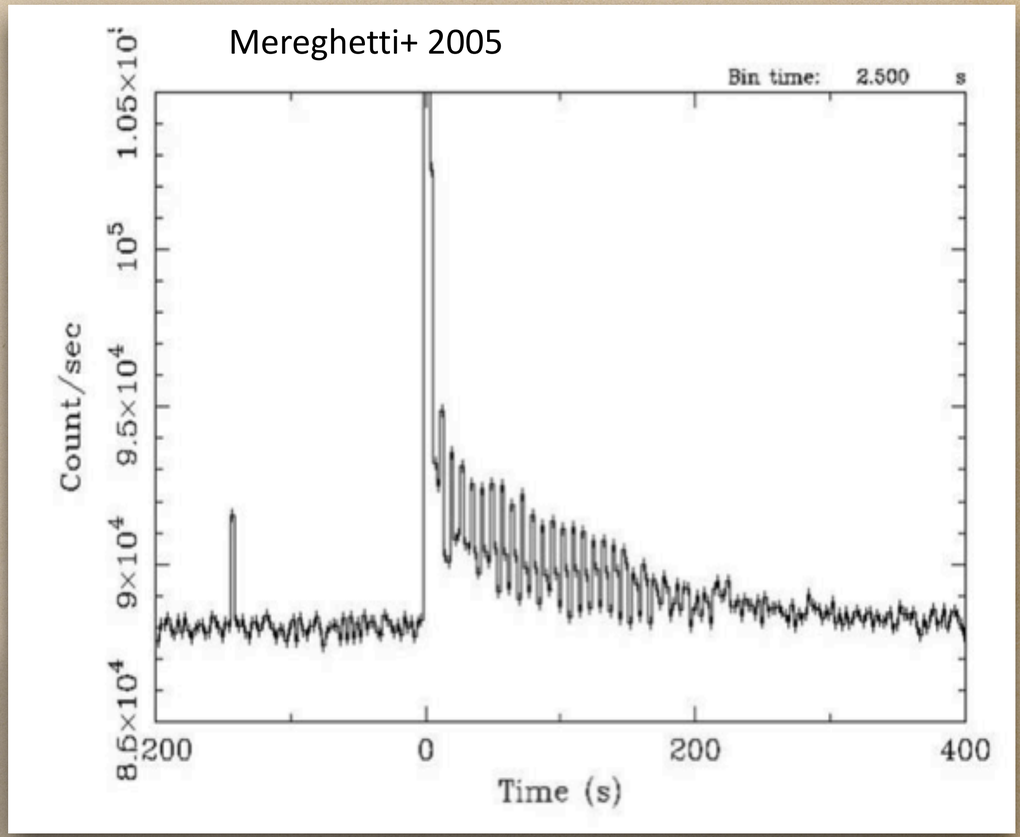

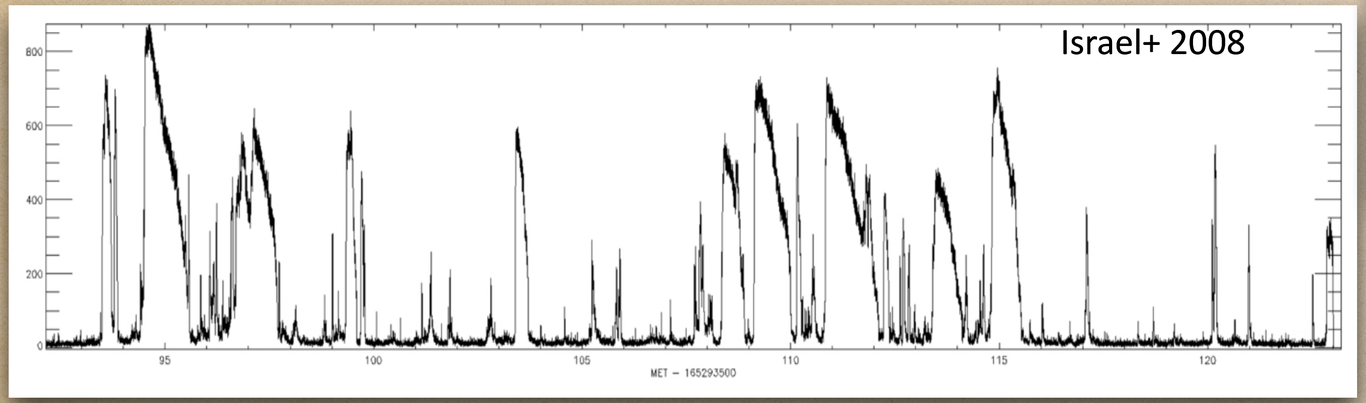

30 sec

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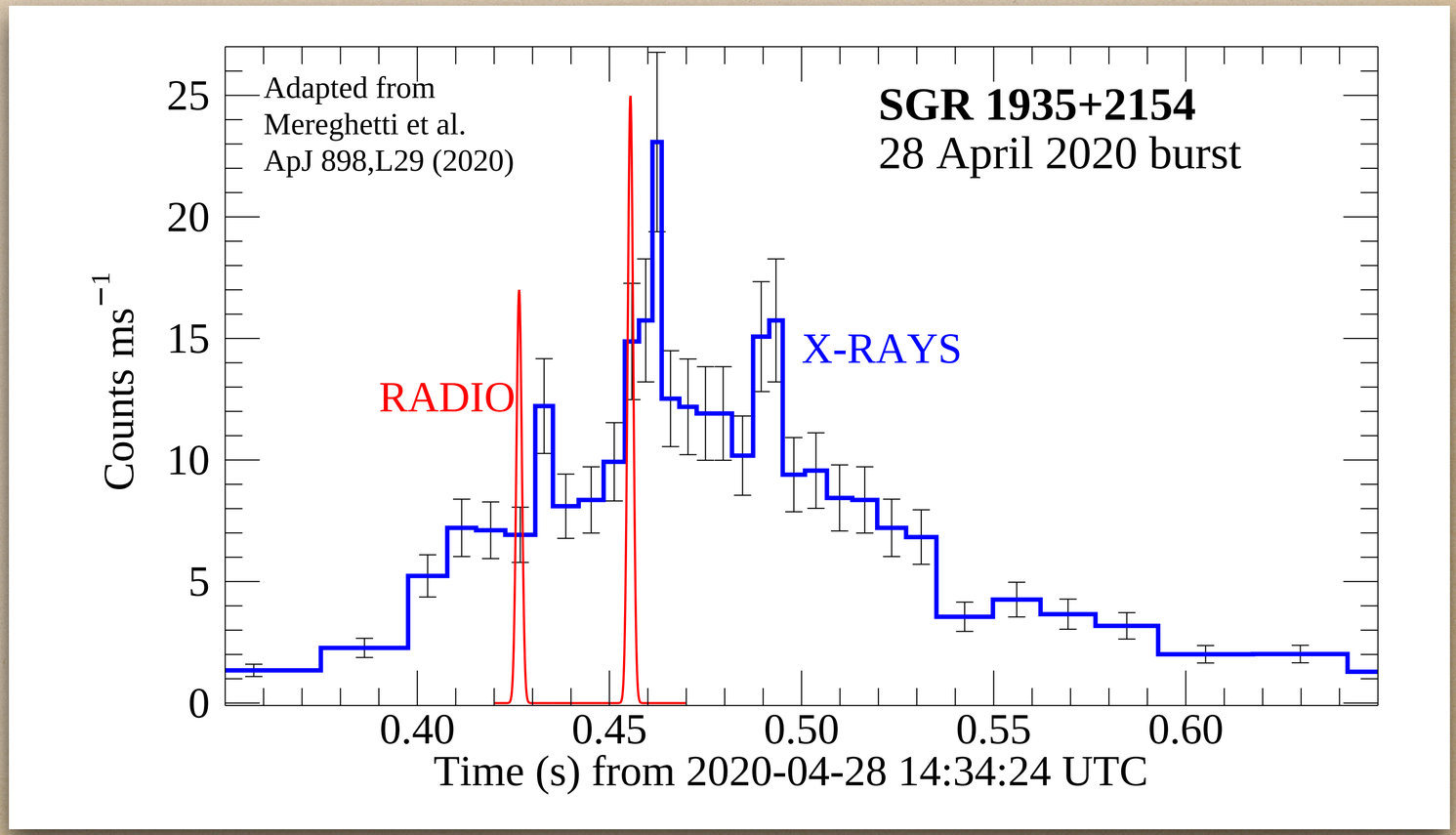

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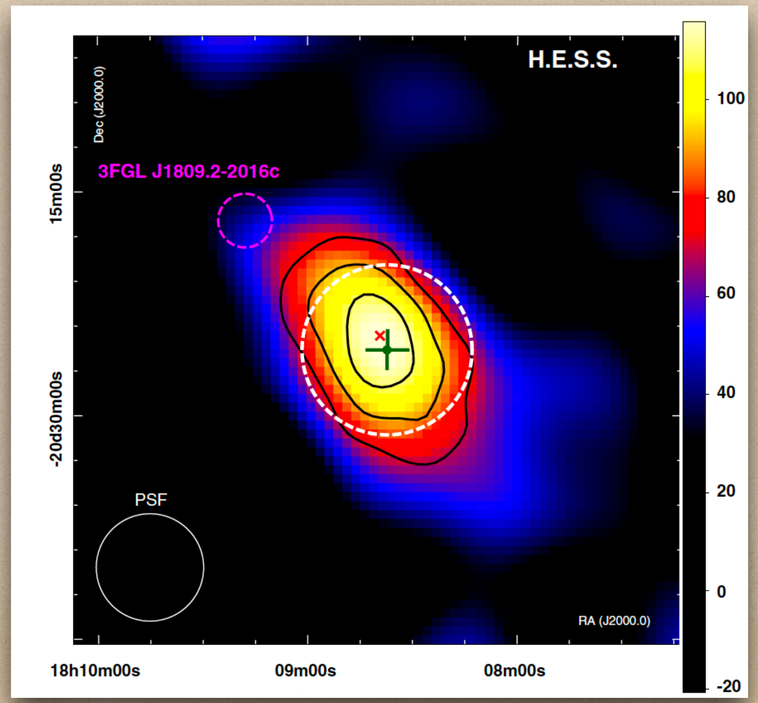
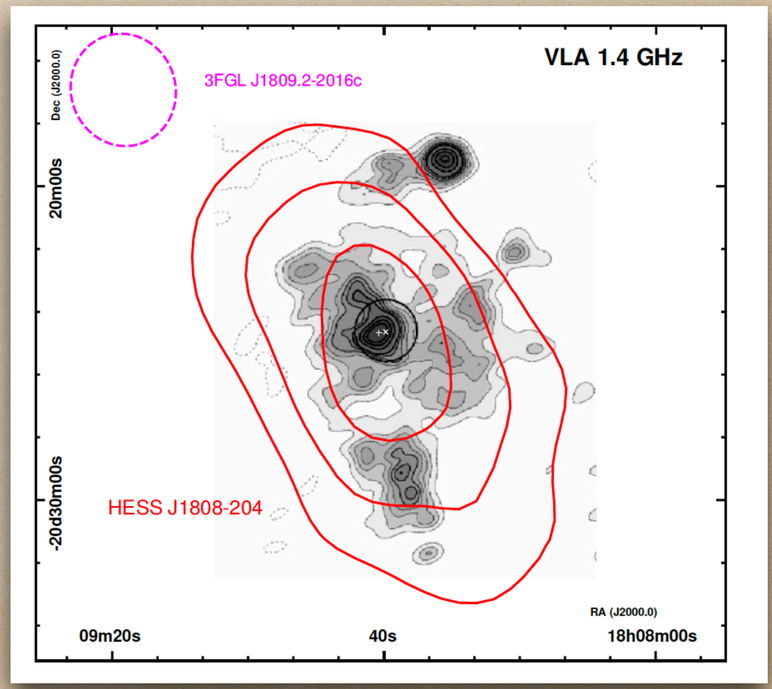
SGR 1806-20

HESS Coll. 2018





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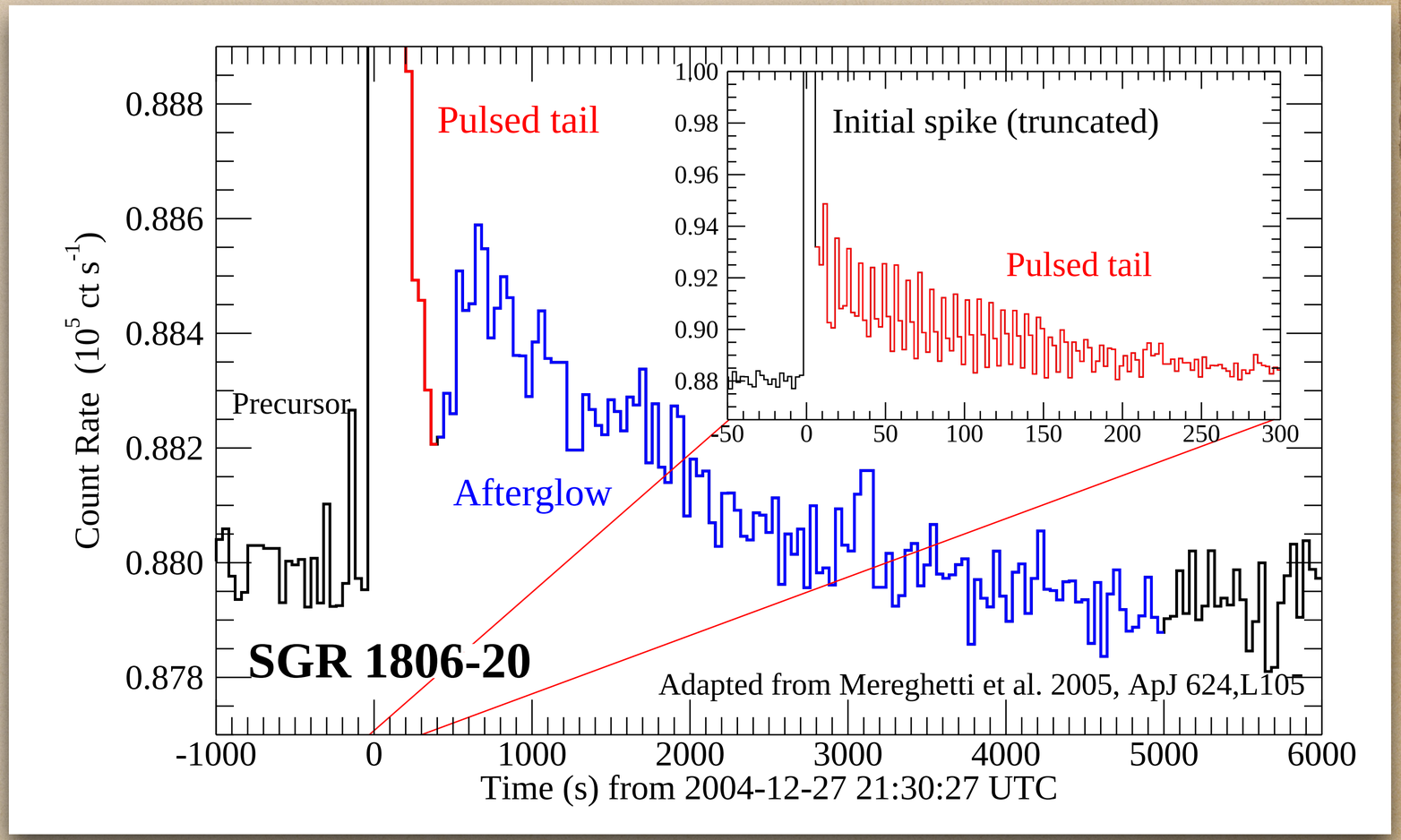

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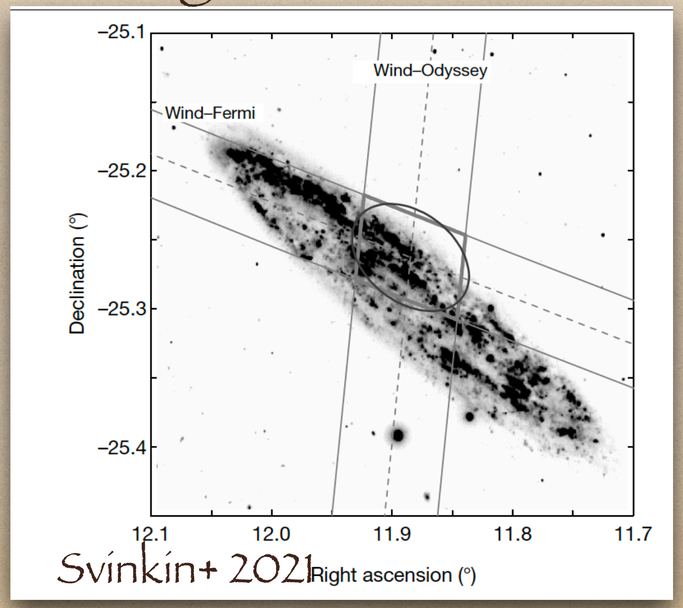
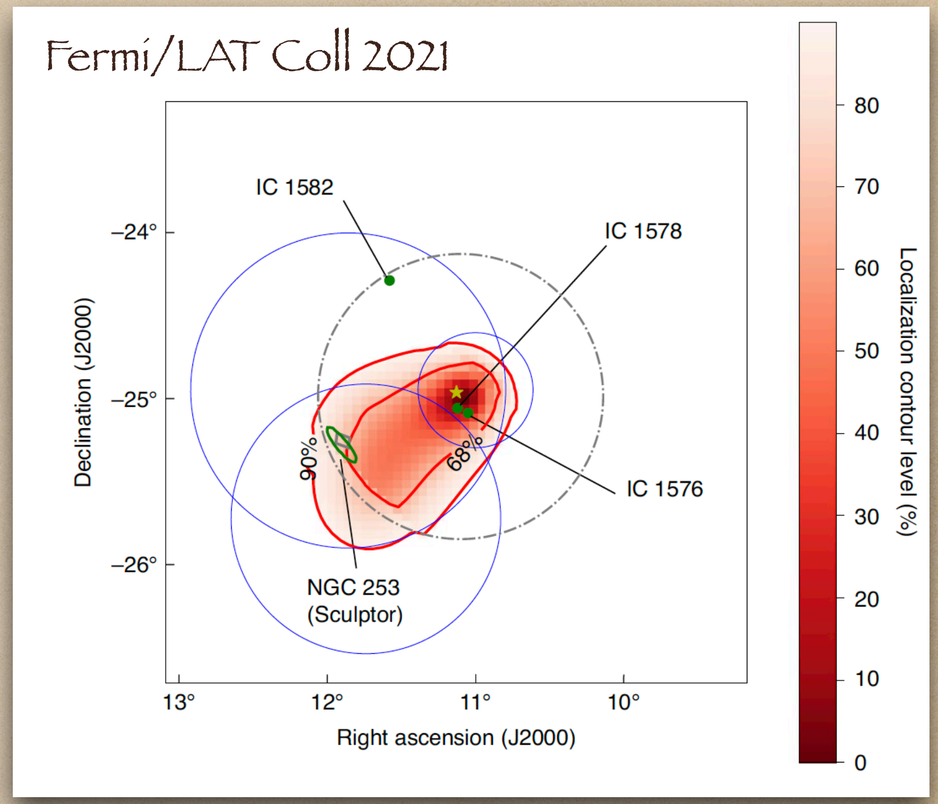


Svinkin+ 2021



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Final remarks

Many overlaps with other KSPs (both in targets and sci. themes)

Most HE and VHE sources are variable.... what defines a "transient" ?

Very different time-scales and requirements on response times

"Transients KSP" really needed ? Redefine KSP based on source classes ?

How do we measure "scientific return" to Italian community ?