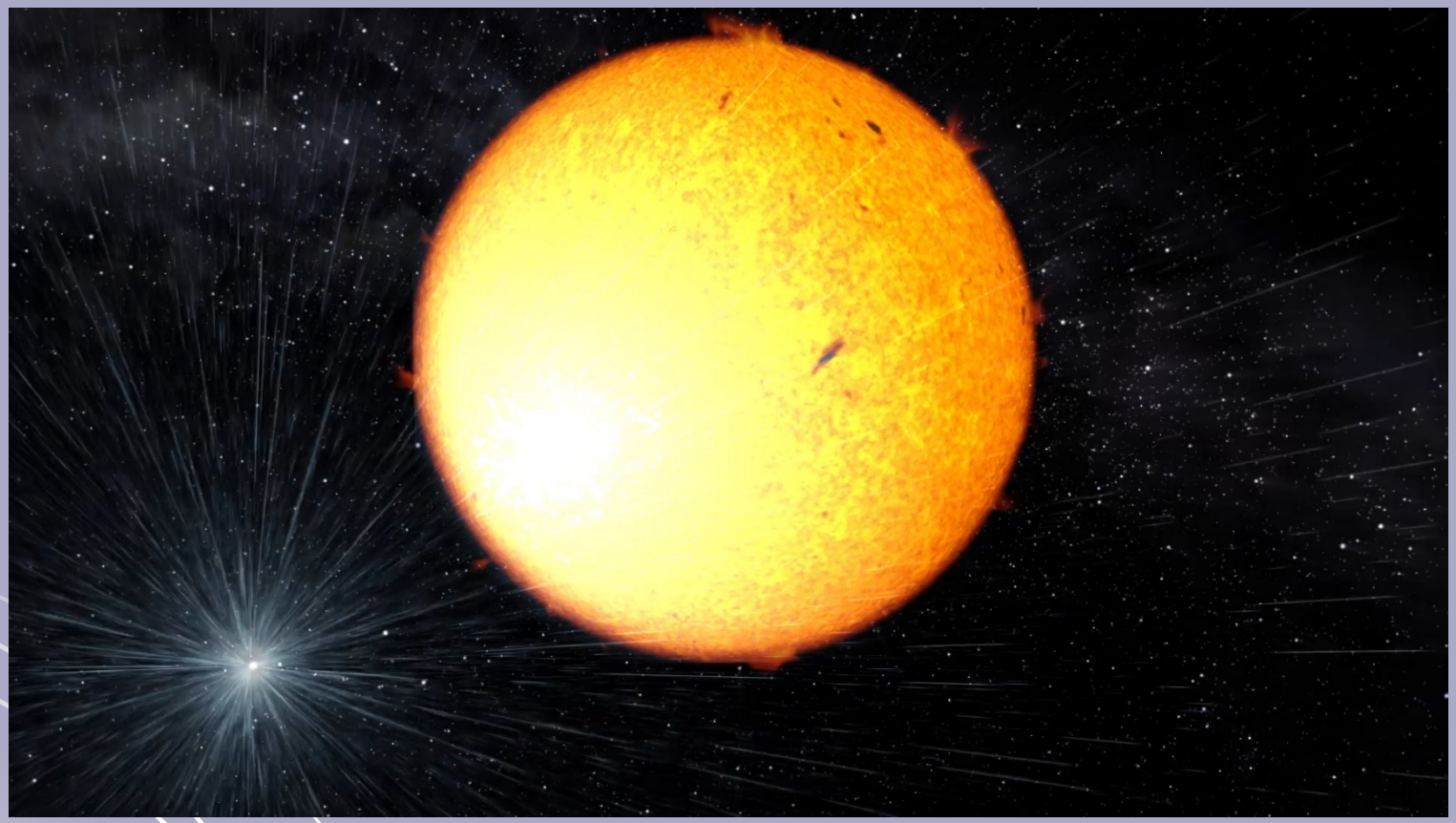
The hunt for the most Massive Neutron Stars



Manu Linares – GAA@UPC, Barcelona

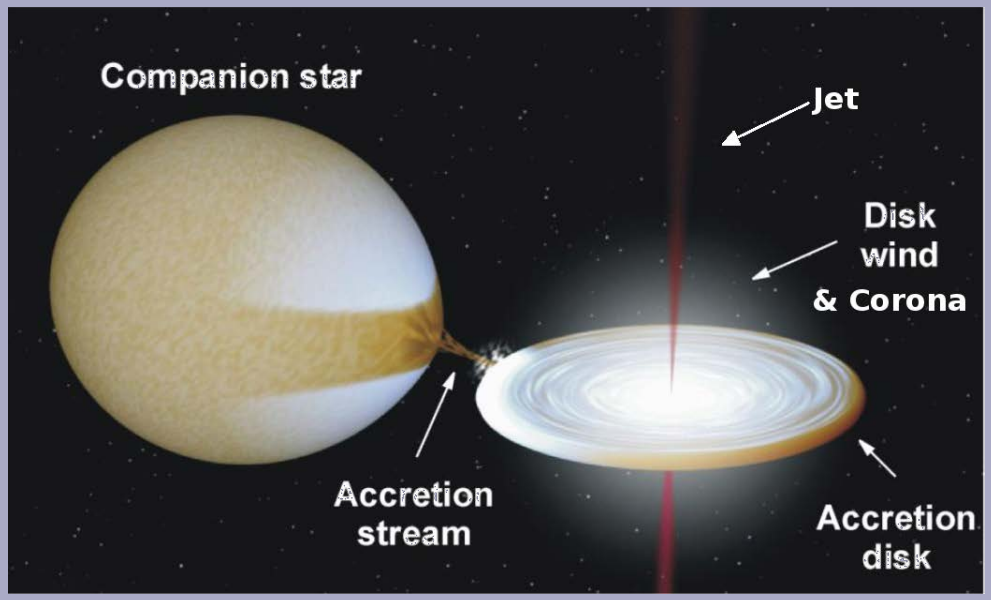
Bahramian, Bogdanov, Breton, Casares, Heinke, Homan, Kachelriess, Miles-Paez, Palomo, Patruno, Rodriguez-Gil, Shahbaz, Wijnands, …

Co-funded by the Horizon 2020 programme of the European Union

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

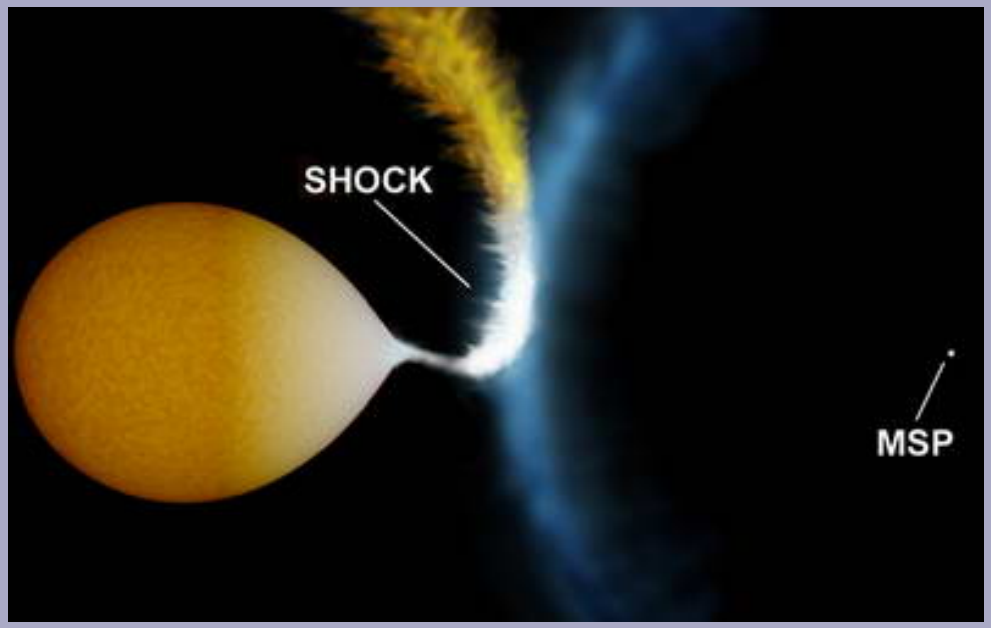
Neutron stars in binaries

- Low-mass X-ray binaries (LMXBs): accretion power, nuclear power.

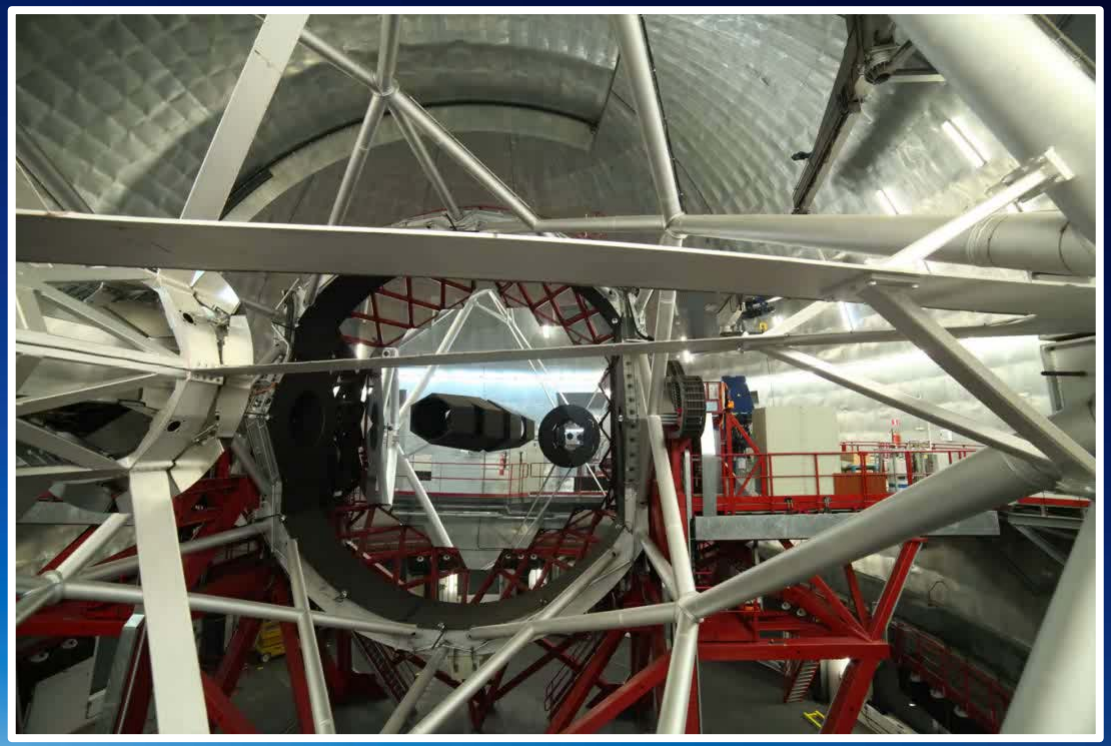


- Compact binary ms pulsars: rotation power, companion star (Porb <~ 1 day).

Maximum NS mass.



•INCREASED MASS (AND SPIN)
•CLEAN VIEW OF (IRRADIATED) COMPANION



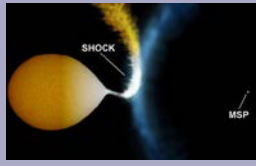
IAC/Rosenberg

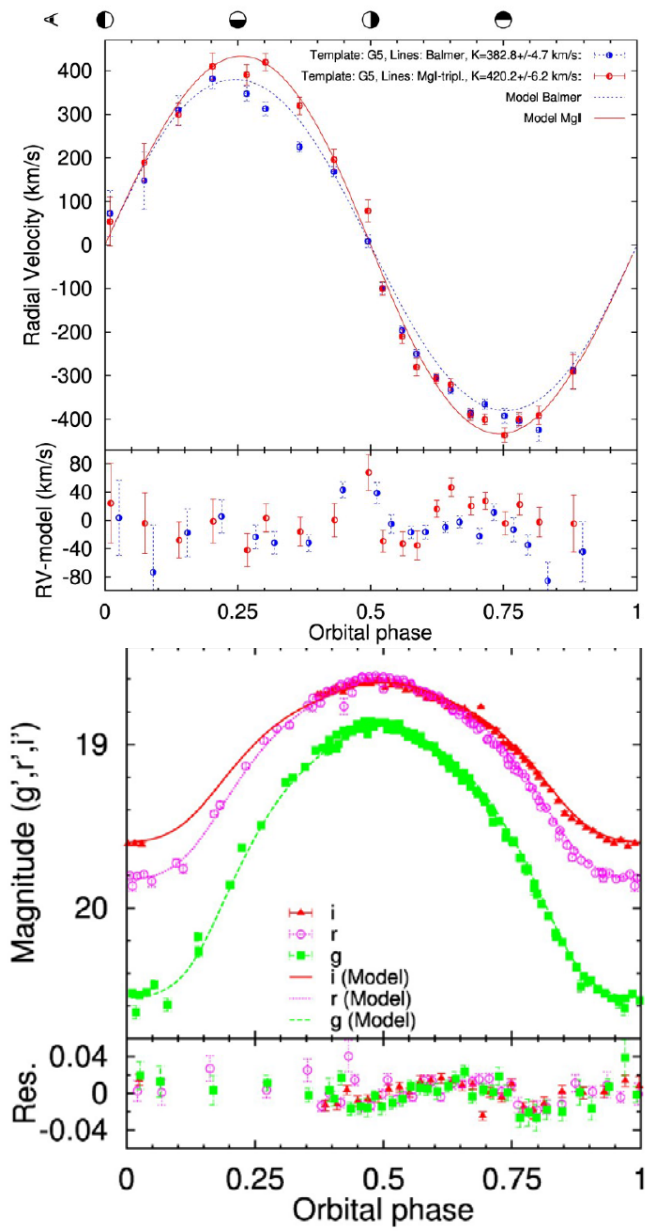
Gran Telescopio CANARIAS (10.4 m)

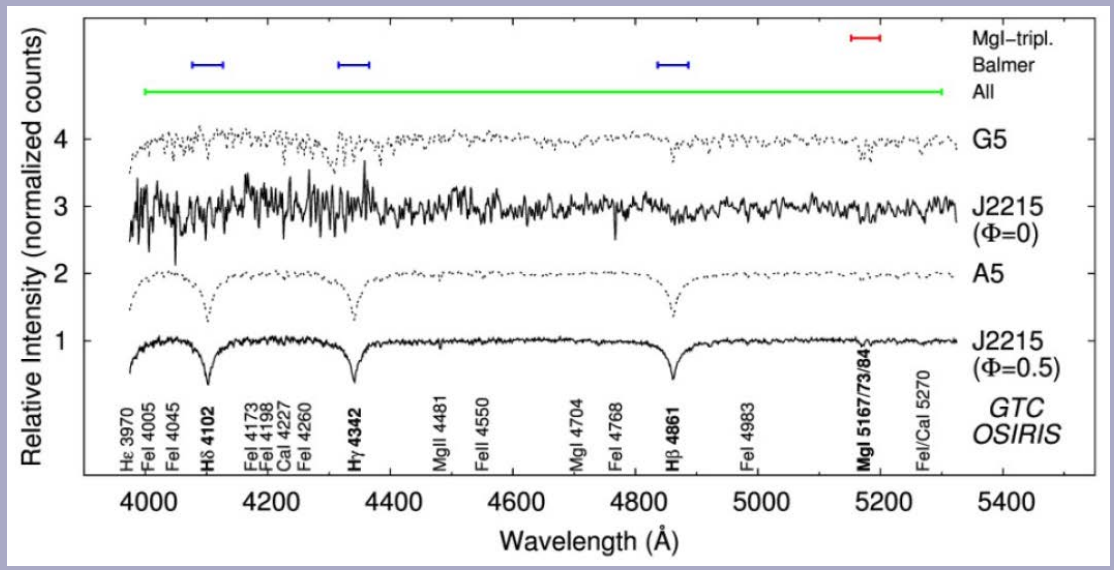
Radio | Microondas | Infrarrojo | Visible | Ultravioleta | Rayos X | Rayos γ

A Massive Neutron Star

Dynamical Studies with Irradiation: PSR J2215+5135







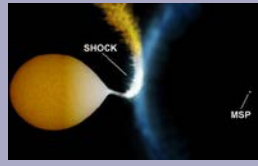
- **Extreme heating: from 5660 K (cold side) to 8080 K (heated/inner side)**
- **We trace the velocity of both sides by using different absorption lines (H vs Mg)**
- **Physical model to find inclination and masses:**

→ A 2.27 [+0.17-0.15] M_{sun} Neutron Star!

(Linares, Shahbaz & Casares, ApJ, today)

A Massive Neutron Star

Dynamical Studies with Irradiation: PSR J2215+5135



IAC/Perez-Diaz

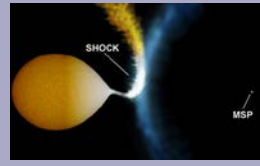
Hynes

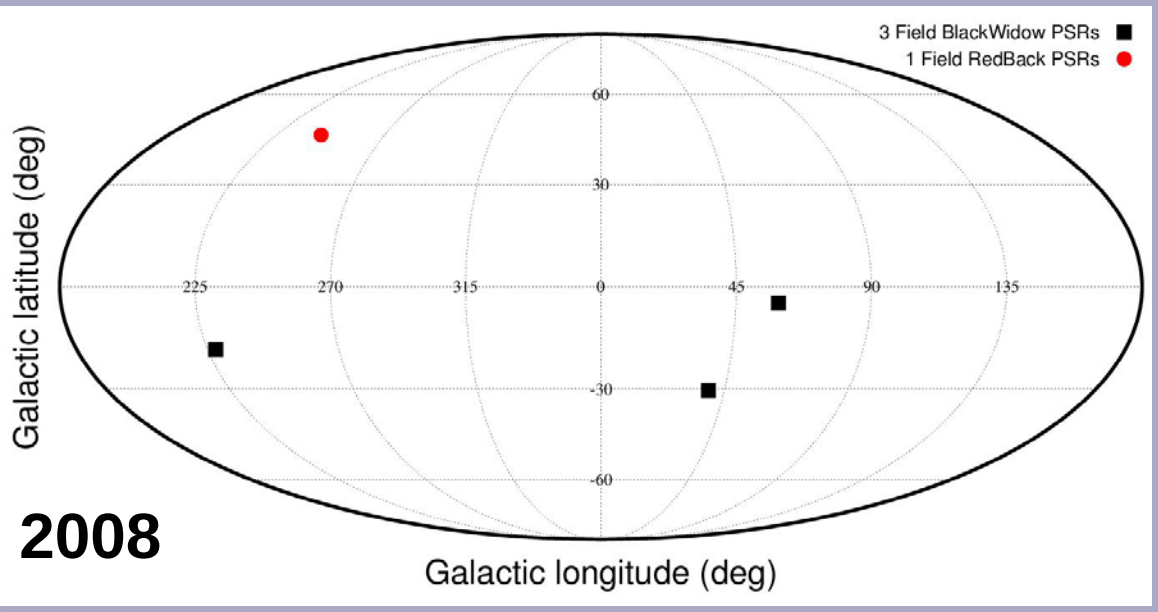
A 2.3 Solar-mass NS (Linares, Shahbaz & Casares, ApJ, today)

https://doi.org/10.3847/1538-4357/aabde6

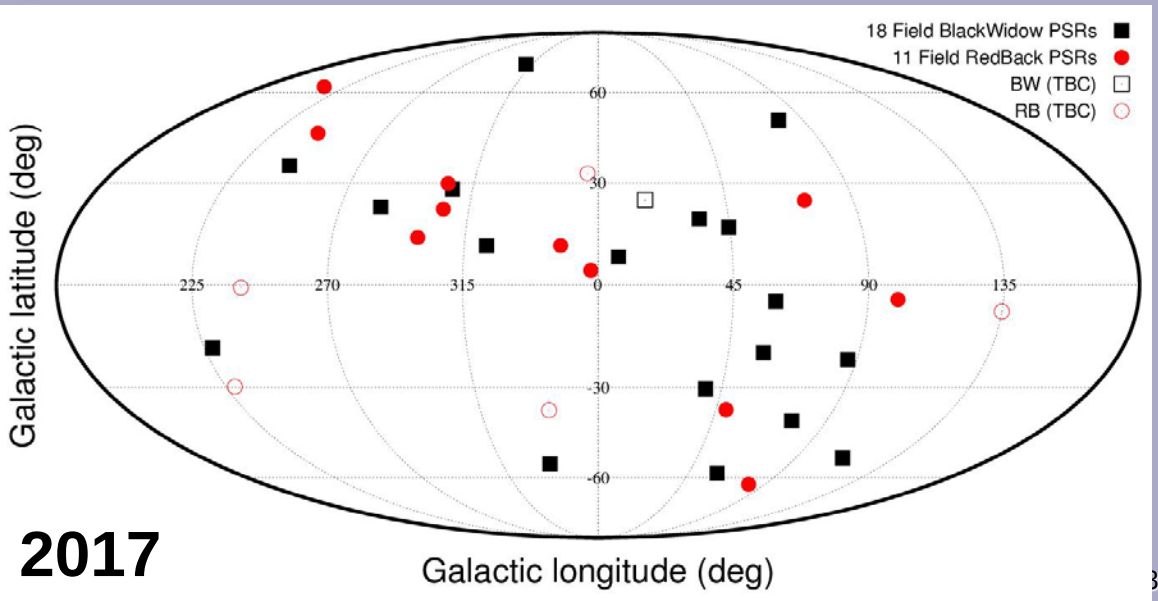
A Spider Revolution

A booming field thanks to Fermi-LAT driven discoveries





2008



2017

Compact binary MSPs:

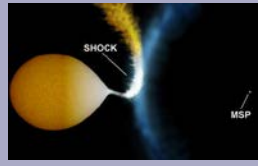
A growing, nearby pulsar population!

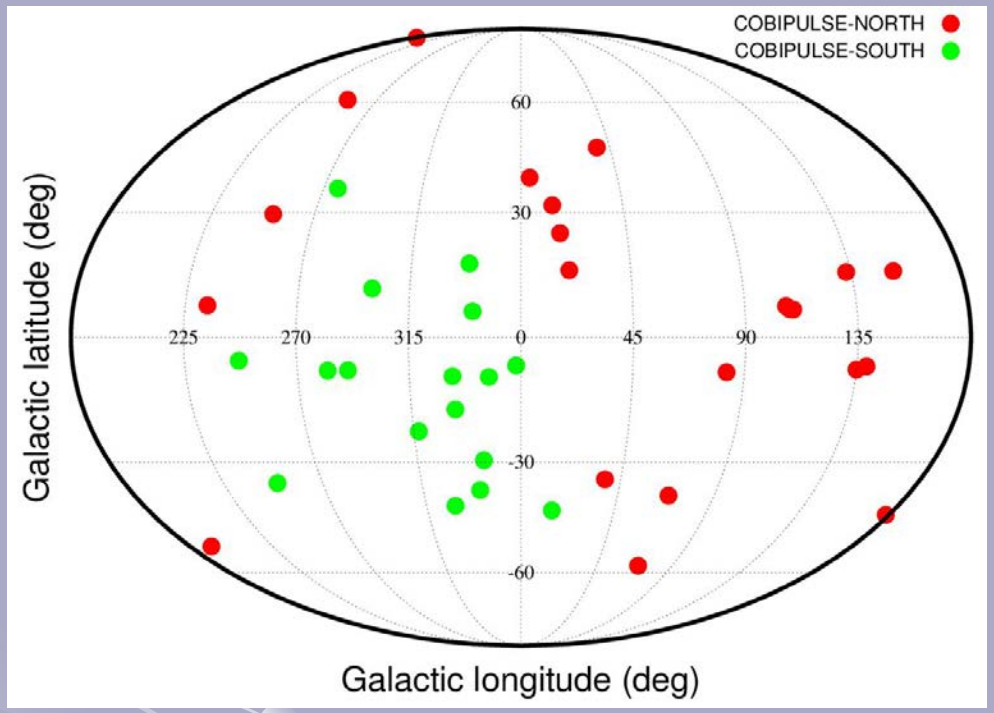
(0.5-4 kpc; Hessels, Roberts, Ray et al PSC; Kong, Romani;

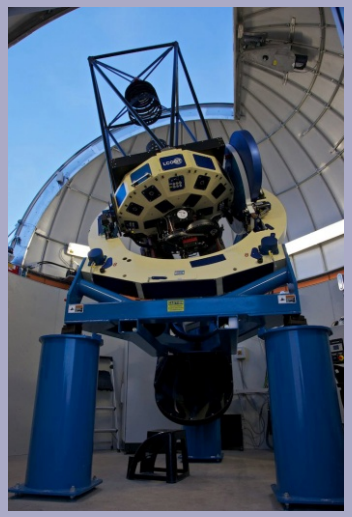
This talk: COBIPULSE)

Finding New Spiders

COBIPULSE: COmpact BInary PULsar SEarch







Let's find more (massive) PSRs!

Multi-band, wide-field, well-sampled optical photometry (robotic):

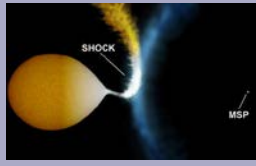
- COBIPULSE-N: Stella-1.2m Large Program, observed (220 hrs)

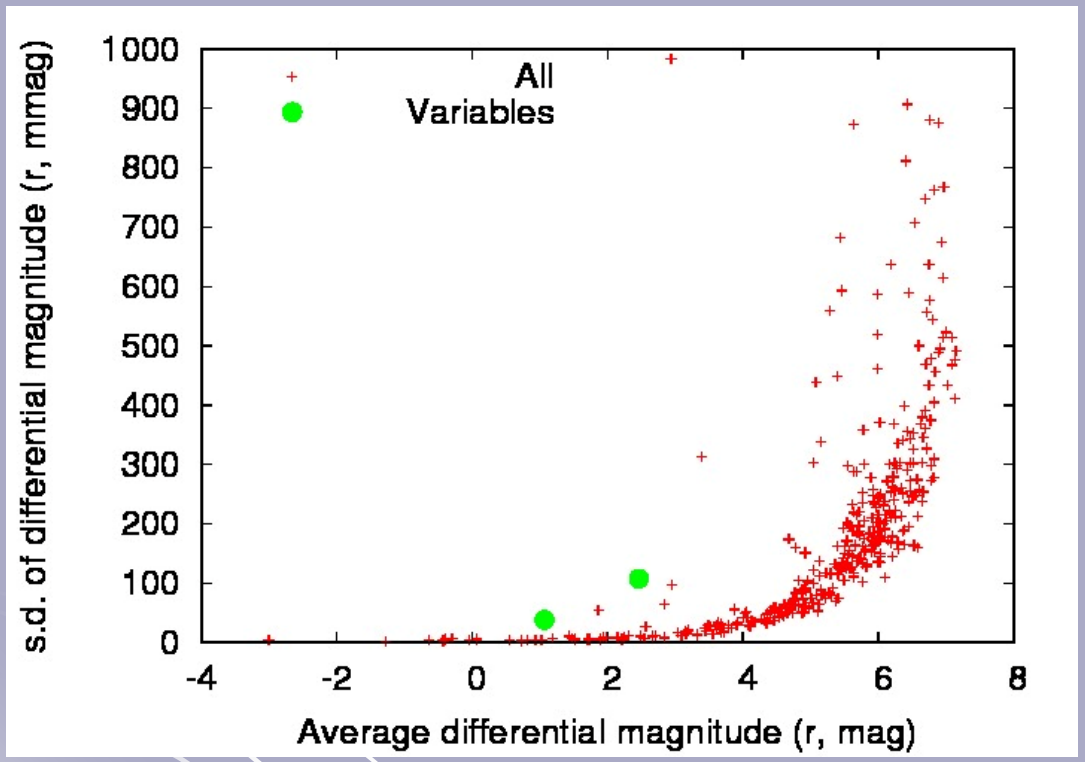
24x3FGL FIELDS: 19 WITH DETECTED OPT. VARS; 13 CONTAIN CAT. X-ray SRCS

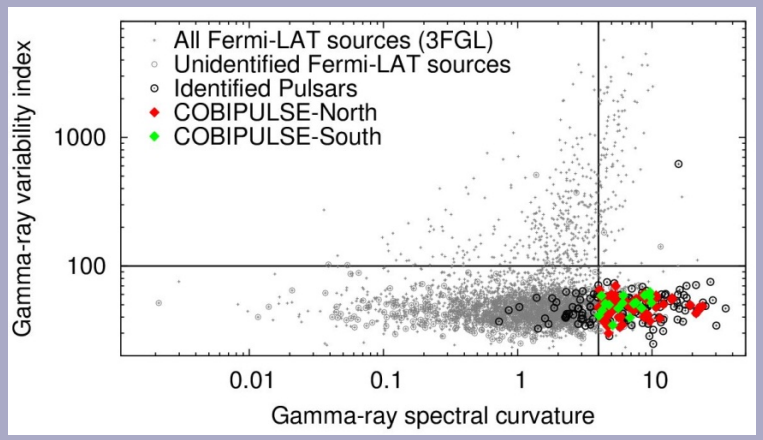
- COBIPULSE-S: LCOGT-1m Program, observed (80+100 hrs): 17x3FGL fields

Finding New Spiders

COBIPULSE: COmpact BInary PULsar SEarch







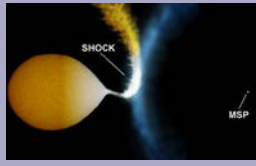
Strategy in a nutshell:

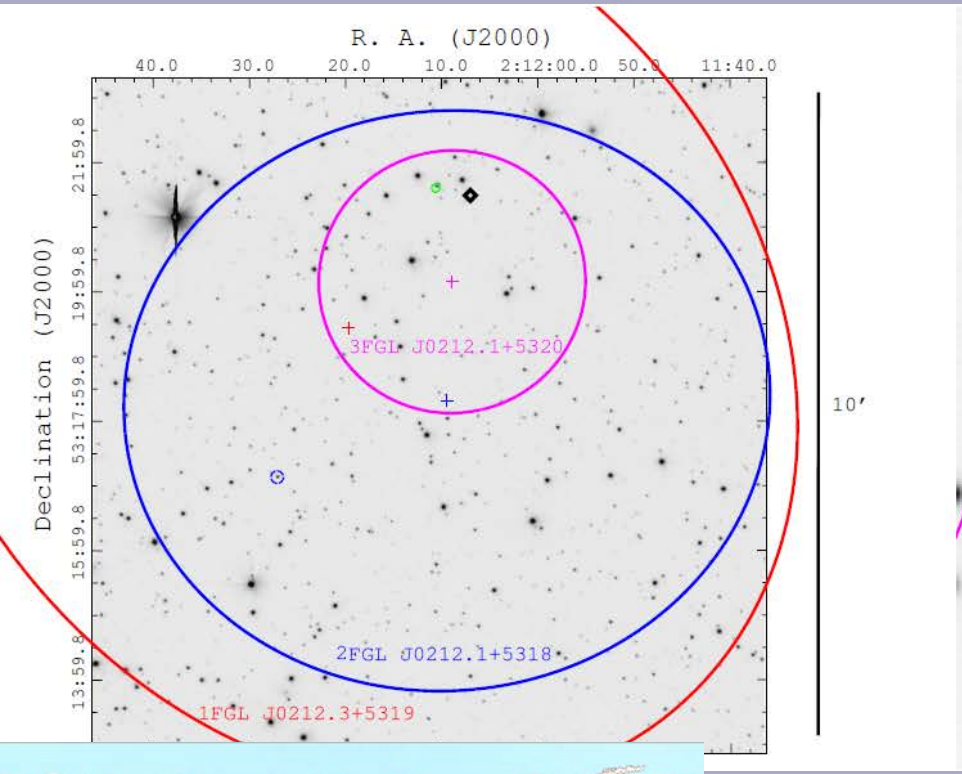
GeV SELECTION + OPTICAL VARIABILITY + X-RAY CATALOGS + IR/radio

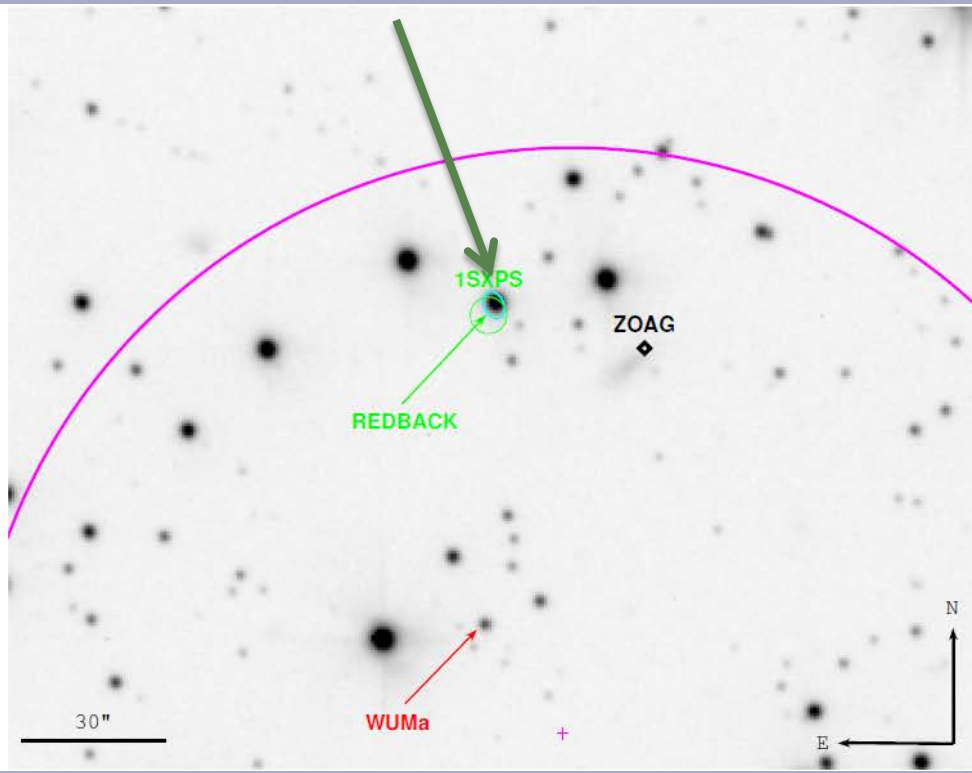
FERMI-LAT OWN DATA RXS/1SXPS/CSC/3XMM 2MASS/FIRST

Found New Spiders (I)

J0212: the brightest companion, in a 21hr orbit







A millisecond pulsar candidate in a 21-h orbit: 3FGL J0212.1+5320

Manuel Linares ✉, Paulo Miles-Páez, Pablo Rodríguez-Gil, Tariq Shahbaz, Jorge Casares, Cecilia Fariña, Raine Karjalainen

Mon Not R Astron Soc (2017) 465 (4): 4602-4610.

DOI: https://doi.org/10.1093/mnras/stw3057

Published: 29 November 2016 **Article history**

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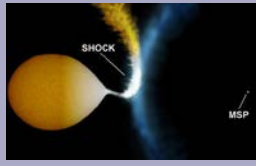
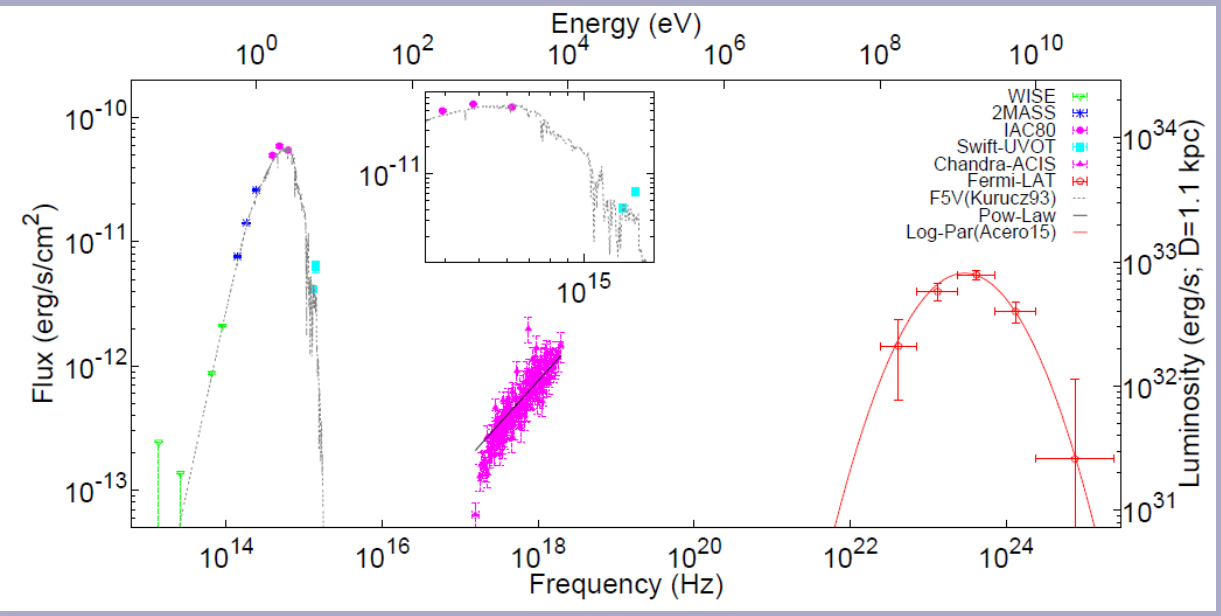
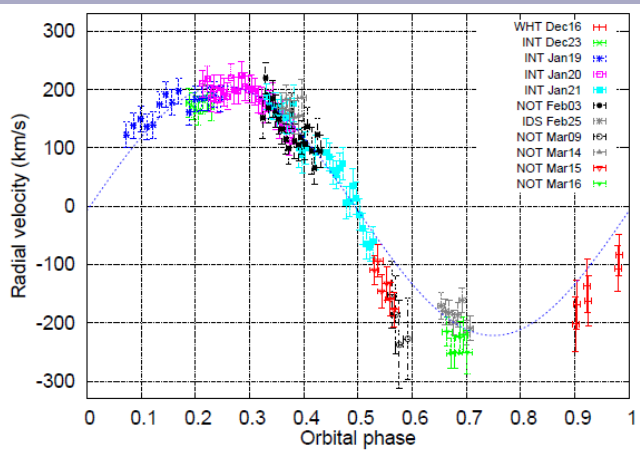
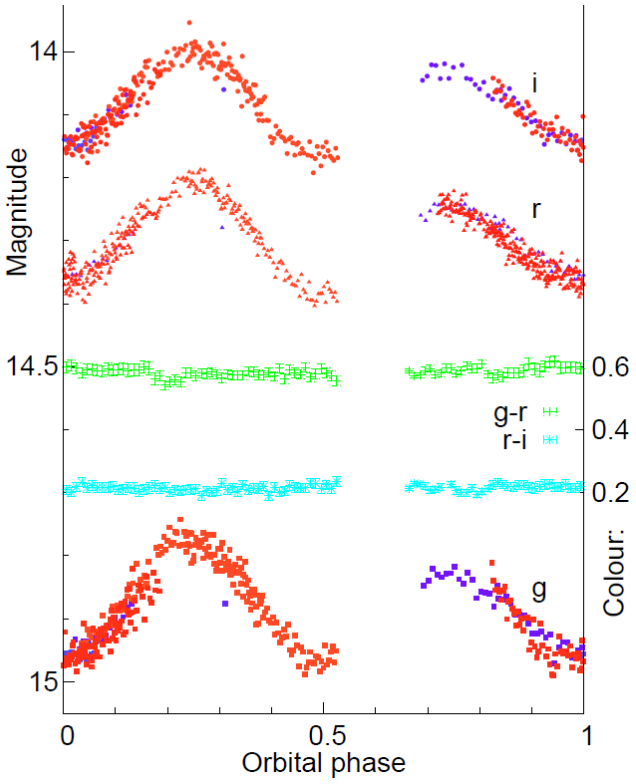
J0212: the brightest companion, in a 21hr orbit







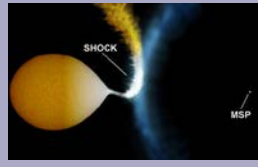


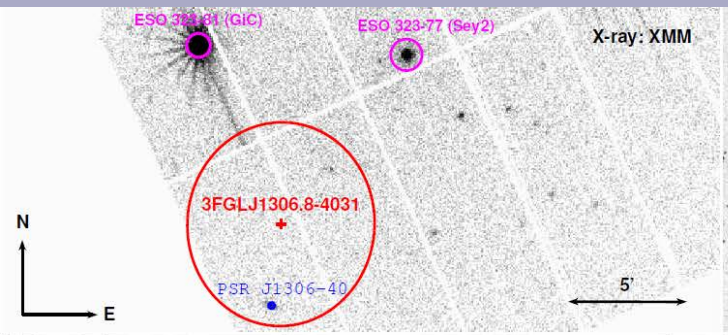
Modelling jointly light and radial velocity curves:

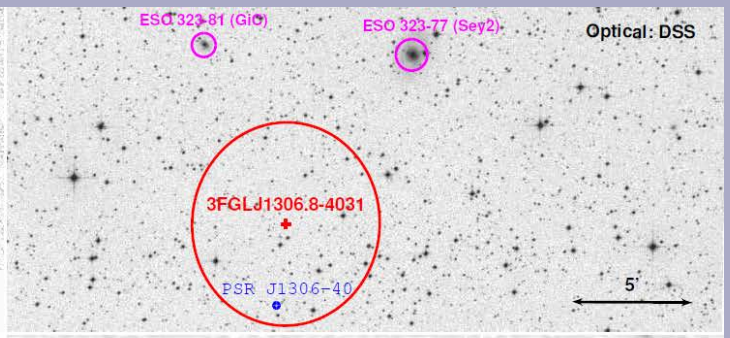
- M_1 = 1.85 +/- 0.29 Msun
- M_2 = 0.50 +/- 0.20 Msun
- i ≈ 69°
- (Shahbaz, Linares & Breton, 2017)

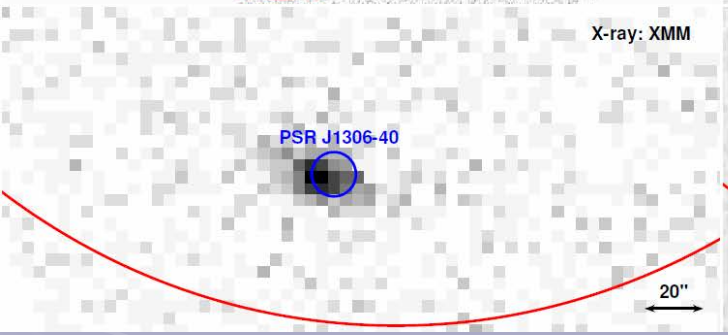
Found New Spiders (II)

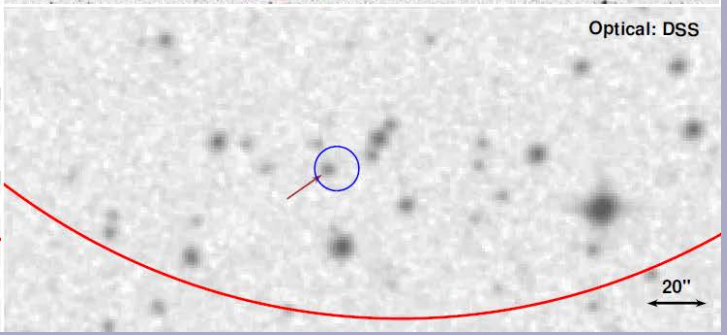
PSR J1306-40: 26.3-hr orbit; irradiation and shock still prominent

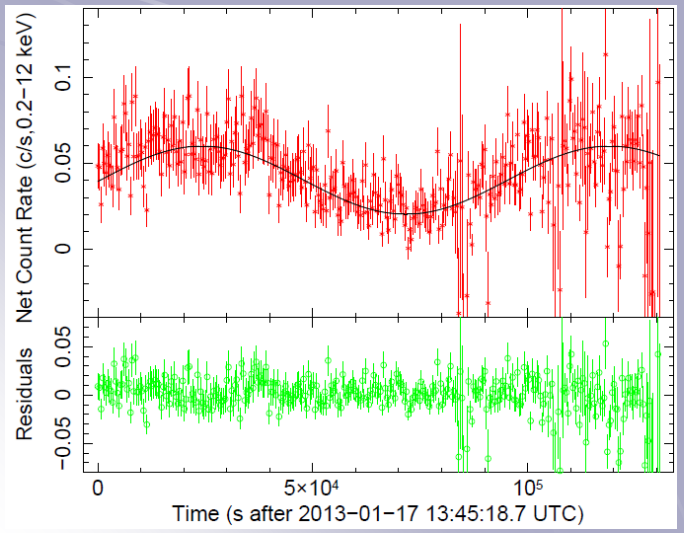


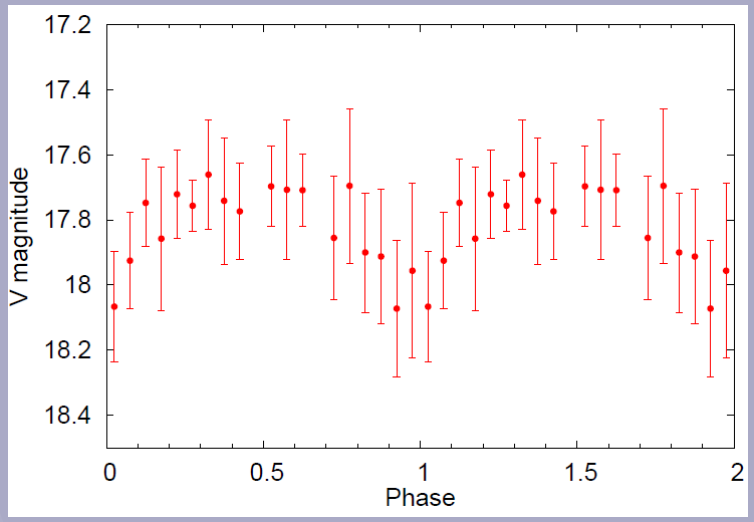












Keane+17: PSR, 2.2 ms, eclipsed?

Linares 2017: L_X~9e31erg/s,Γ~1.3 clear X-ray modul.

V~18 mag CSS src, variable, periodic

P_{opt}=26.3319[14] hr =P_X → P_{orb}

Bright shock & irrad. companion despite wider orbit (~3 x J1023)

arXiv:1707.00698

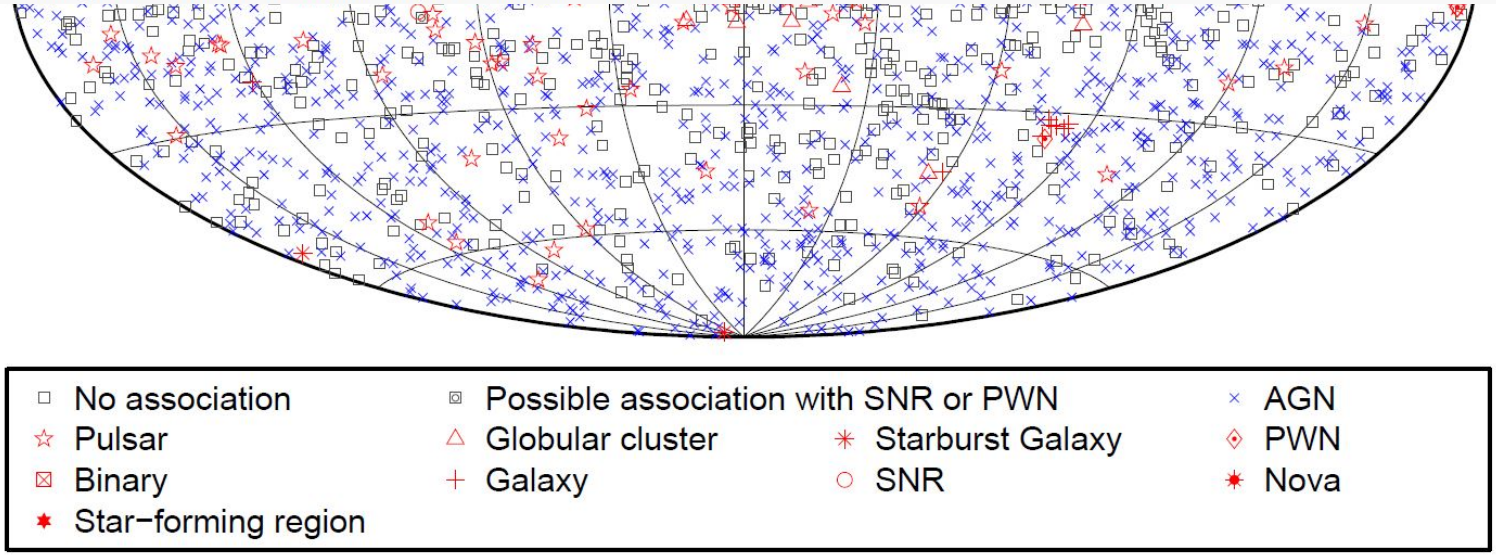
The Future is Bright

Fermi-LAT: driving force and discovery space

Acero et al. (2015)

Preliminary LAT 8-year Point Source List (FL8Y)

This page provides a preliminary Fermi Large Area Telescope (LAT) list of sources (FL8Y) initially meant to help in writing 2018 NASA Fermi Guest Investigator proposals. Based on the first eight years of science data from the Fermi Gamma-ray Space Telescope mission and the 100 MeV-1 TeV range, it is the deepest yet in this energy range. Relative to the 3FGL catalog, the FL8Y source list has twice as much exposure as well as a number of analysis improvements, but is lacking an updated model for Galactic diffuse gamma-ray emission. The FL8Y source list includes 5523 sources above 4-sigma significance, with source location regions and spectral properties. Fifty-eight sources are modeled explicitly as spatially extended, and overall 300 sources are considered as identified based on angular extent or correlated variability (periodic or otherwise) observed at other wavelengths. For 2131 sources we have not found plausible counterparts at other wavelengths. More than 2900 of the identified or associated sources are active galaxies of the blazar class, 218 are pulsars. This source list is meant to be replaced within a few months by the official 4FGL catalog which will benefit from an improved model of diffuse emission.



More than 2000 unidentified GeV sources!

Treasure hidden in the catalog: massive neutron stars.

Summary

- **A 2.3 Msun NS!**
  KEY: IRRADIATION (+new method)

- **COBIPULSE is finding new Spiders!**
  KEY: FERMI-LAT (+multi-wavelength)