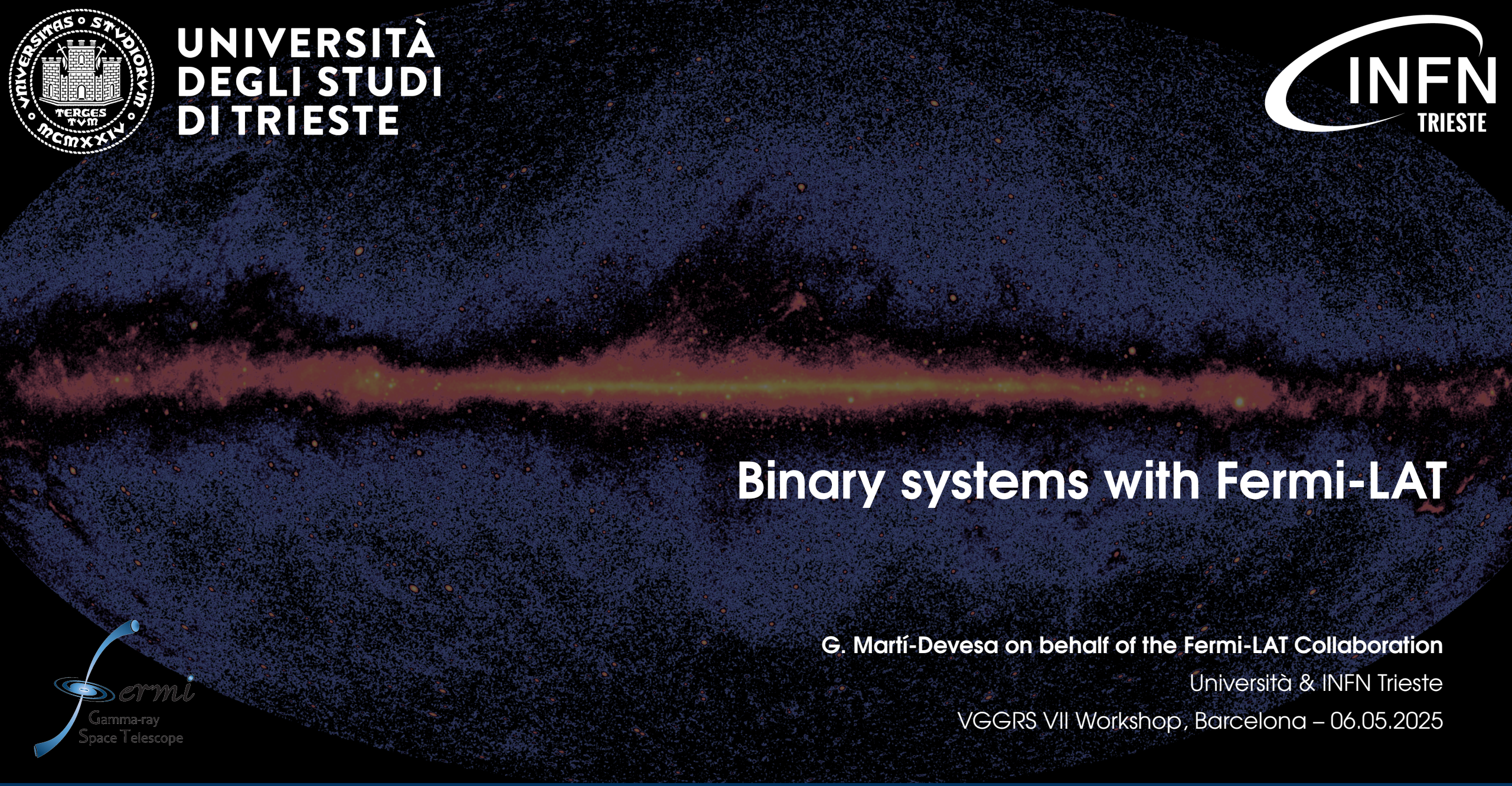
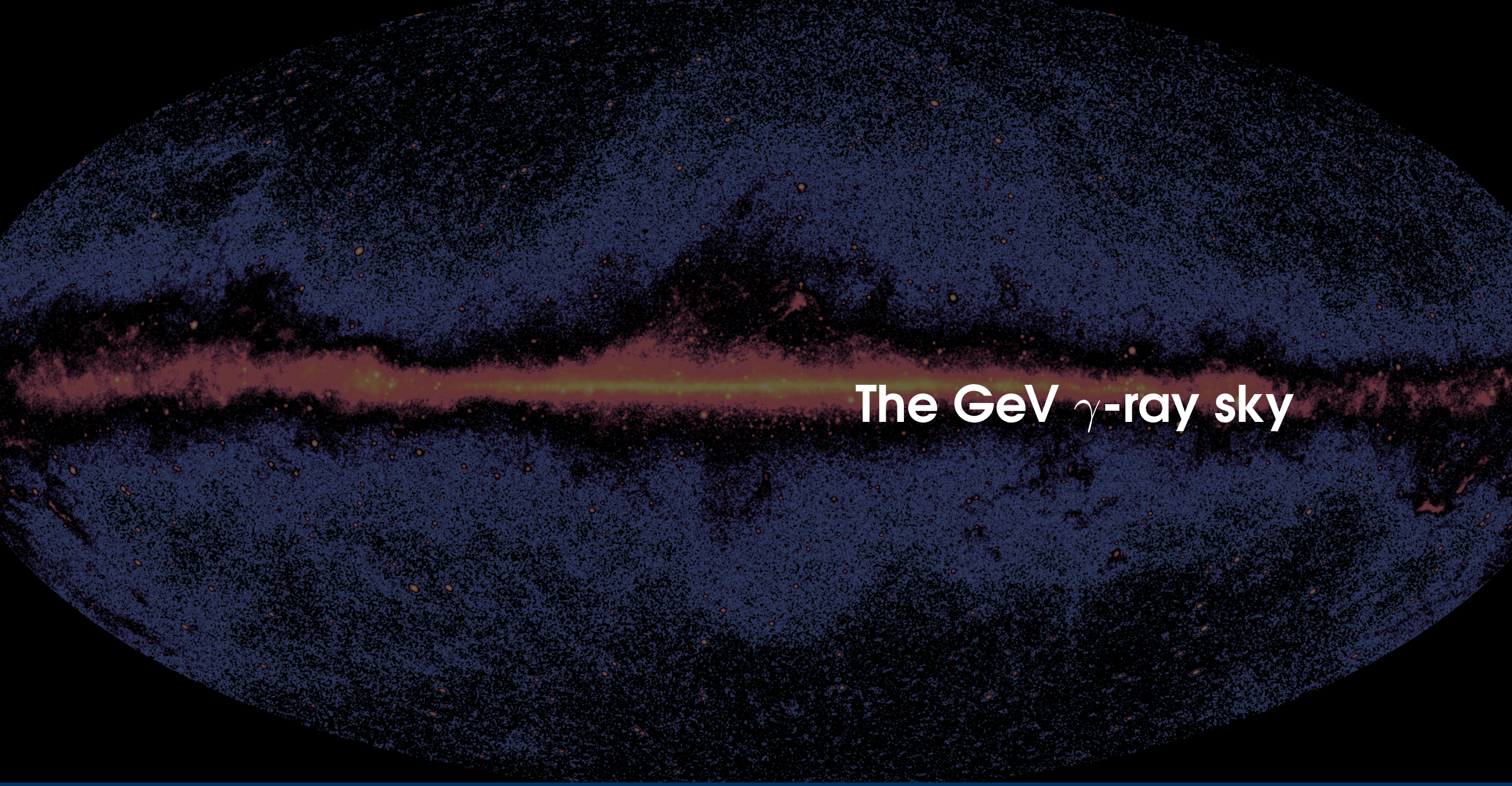


Binary systems with Fermi-LAT

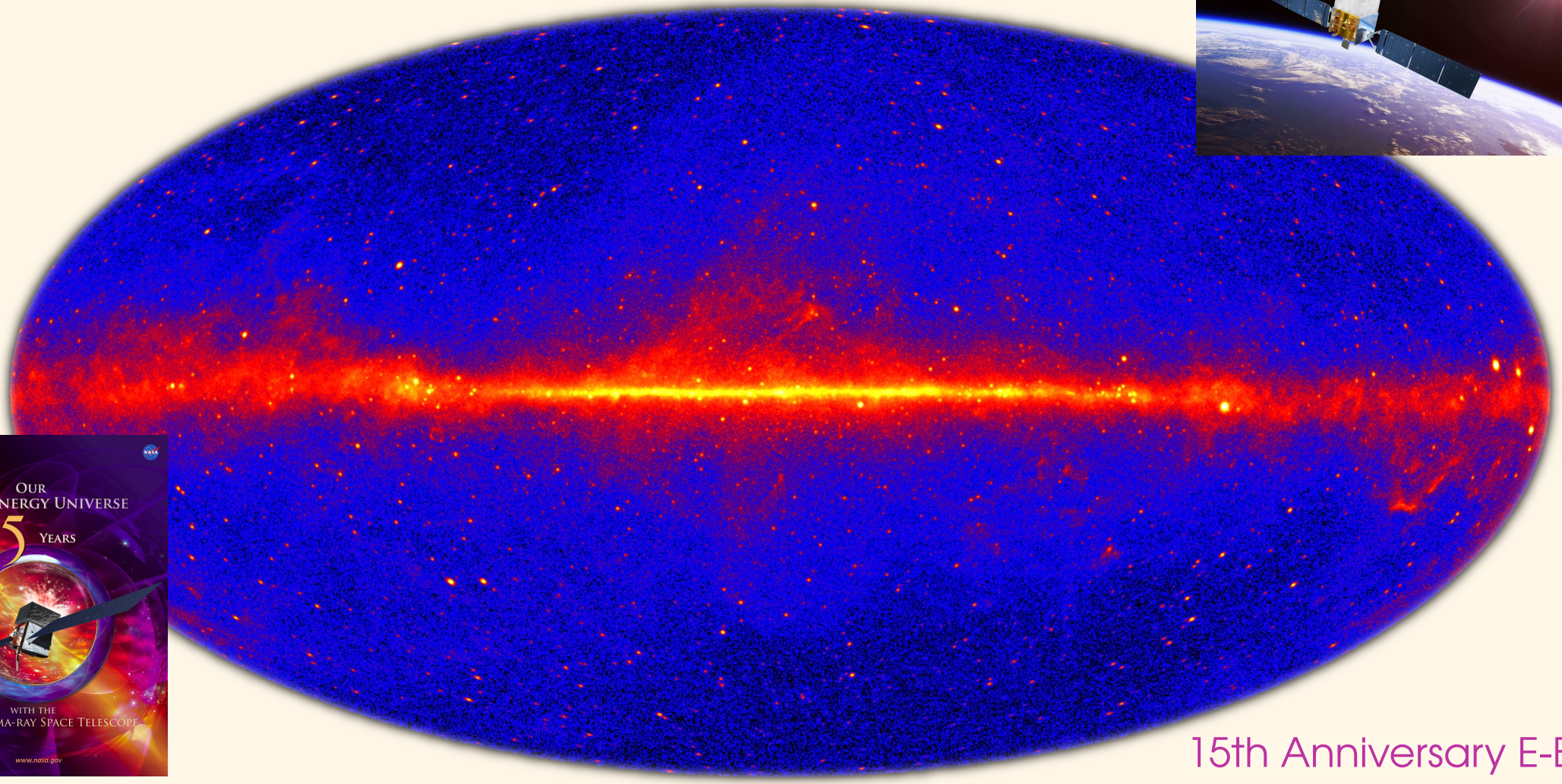
G. Martí-Devesa on behalf of the Fermi-LAT Collaboration

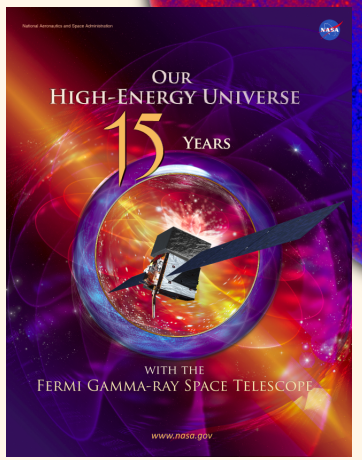
Università & INFN Trieste

VGGRS VII Workshop, Barcelona – 06.05.2025


The GeV γ-ray sky

The GeV sky as seen by *Fermi*-LAT



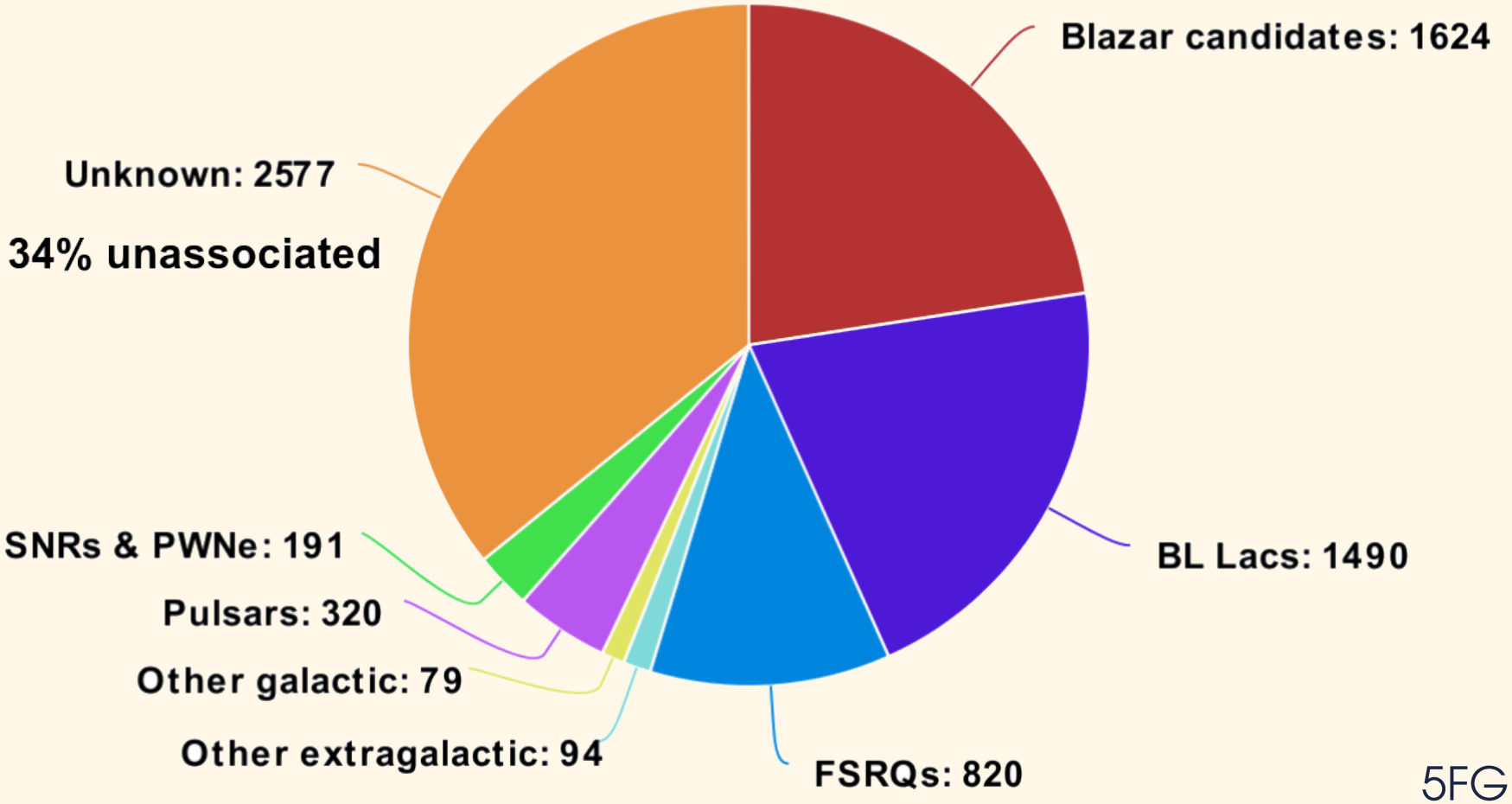


15th Anniversary E-Book

Credit: Fermi-LAT Collaboration

Latest source catalogue: 4FGL-DR4

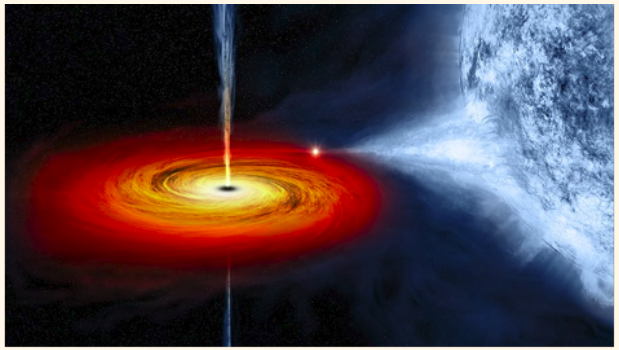
Credit: J. Ballet (Journées PNHE 2023)

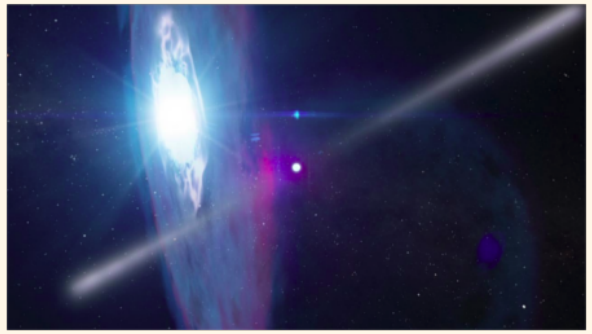


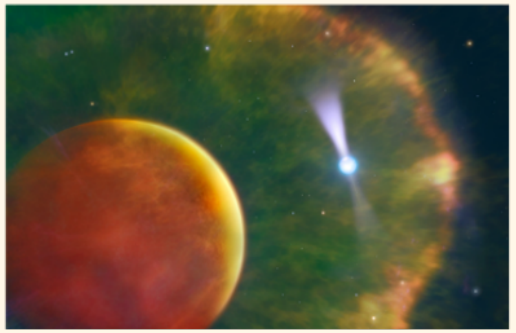
5FGL in prep!

What we know

Binaries at high energies

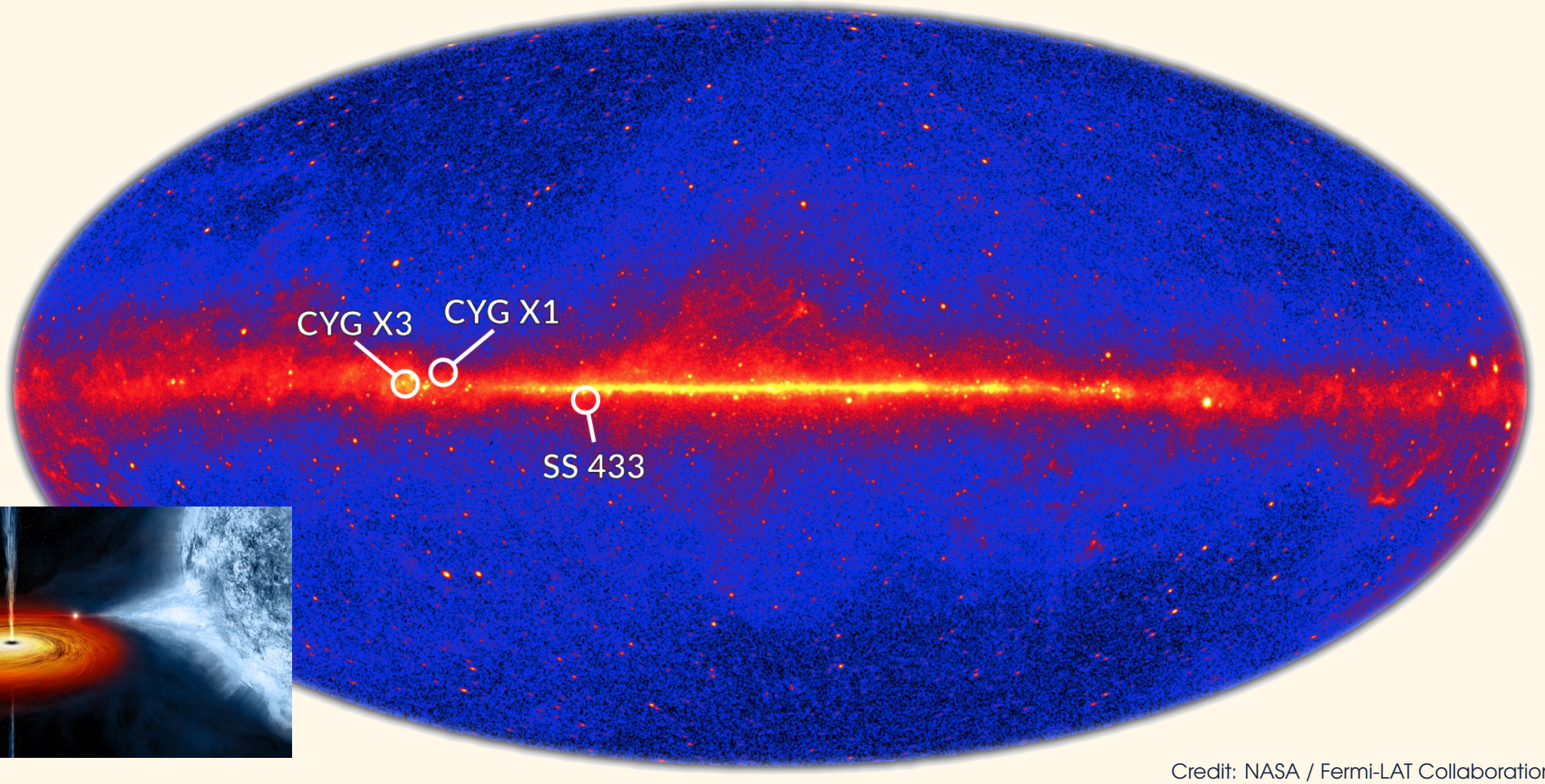






Binaries in the Galactic Plane

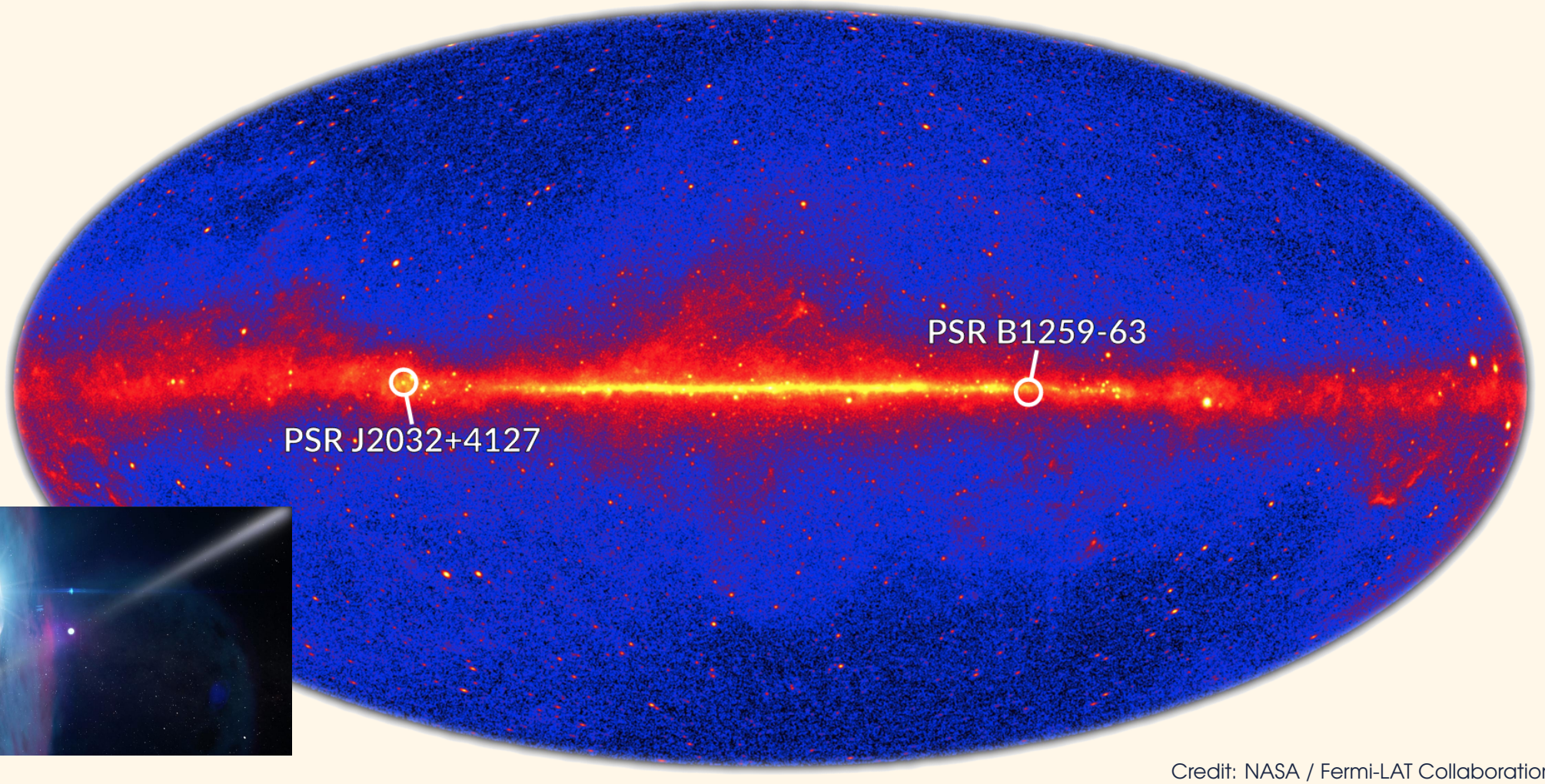
Microquasars



Credit: NASA / Fermi-LAT Collaboration / D. Huber

Binaries in the Galactic Plane

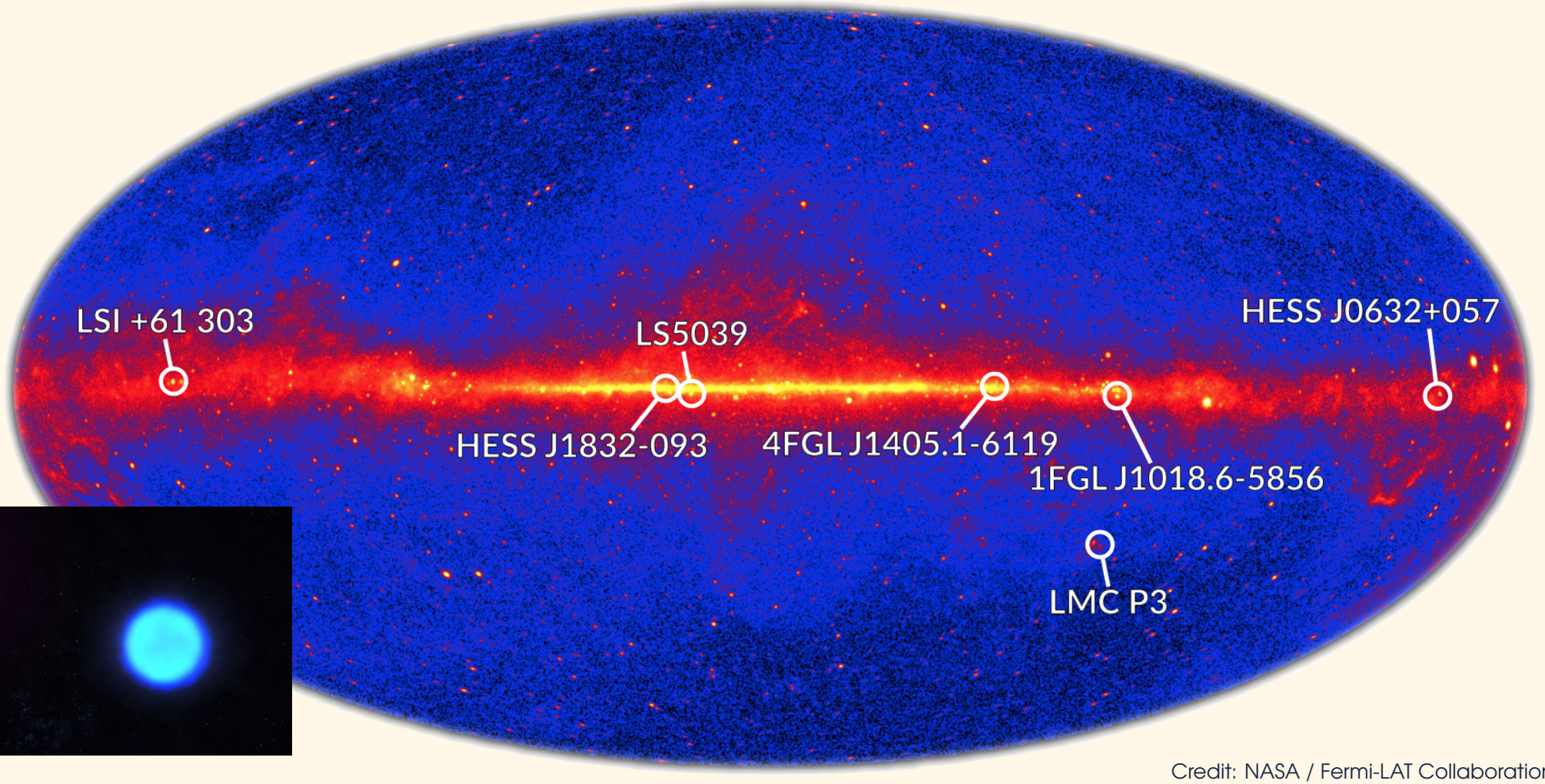
Long period binaries

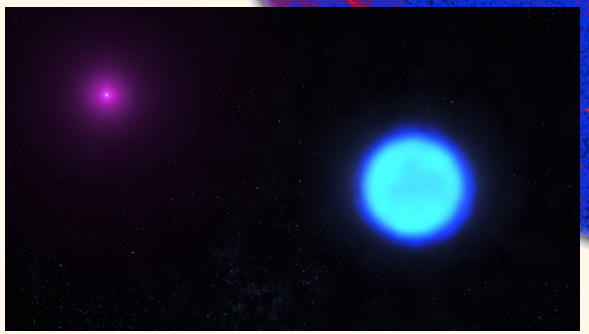


Credit: NASA / Fermi-LAT Collaboration / D. Huber

Binaries in the Galactic Plane

Gamma-ray binaries

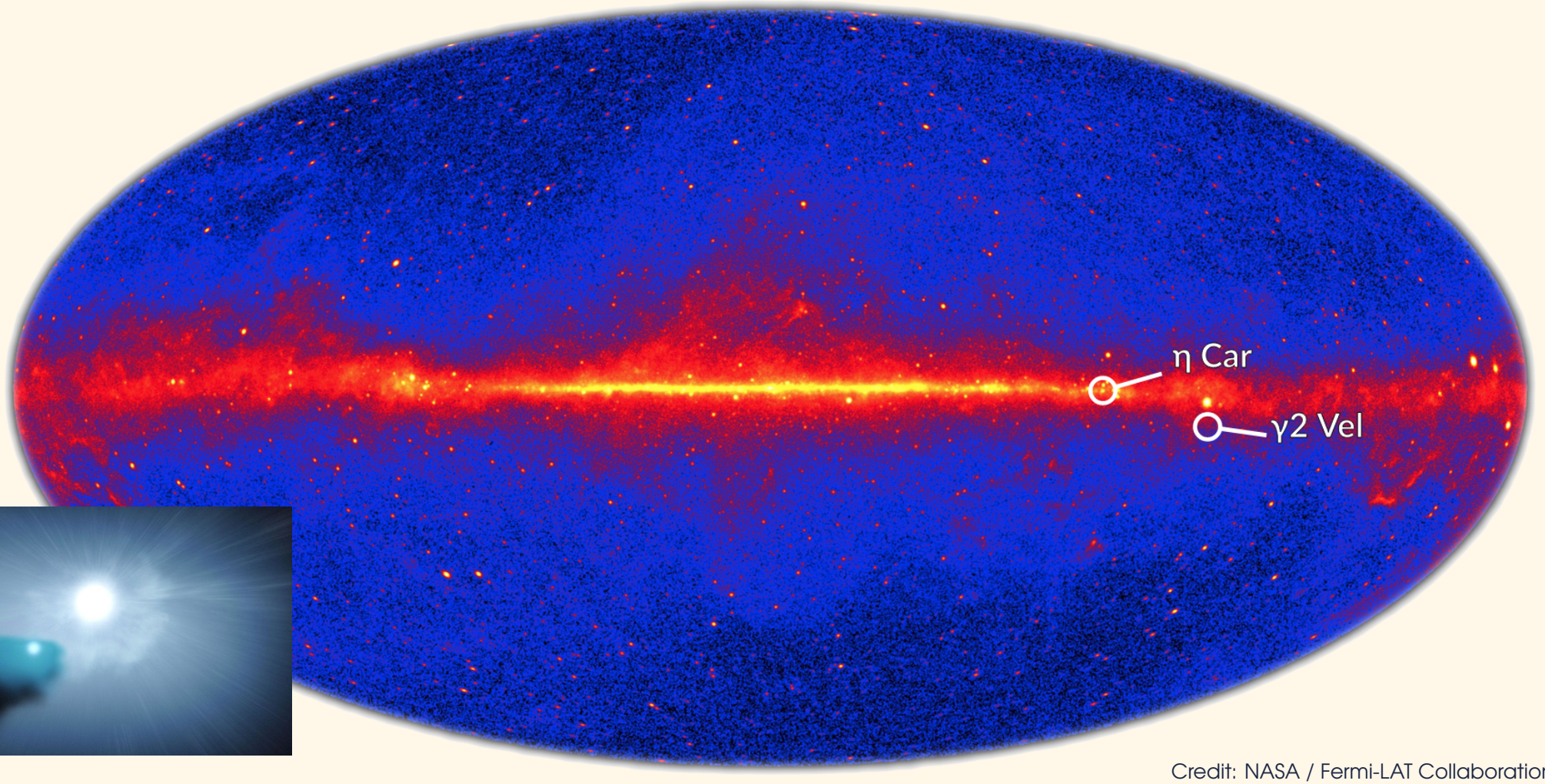


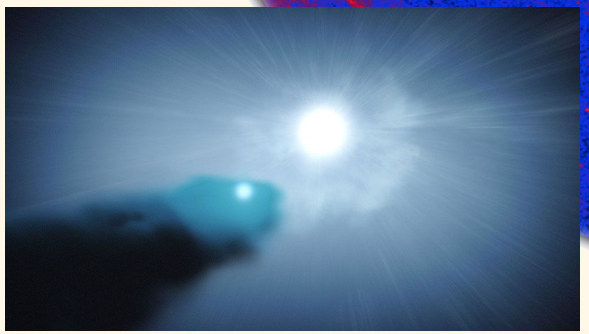


Credit: NASA / Fermi-LAT Collaboration / D. Huber

Binaries in the Galactic Plane

Colliding-wind binaries





Credit: NASA / Fermi-LAT Collaboration / D. Huber

What we recently learned

A) Preparing for T CrB

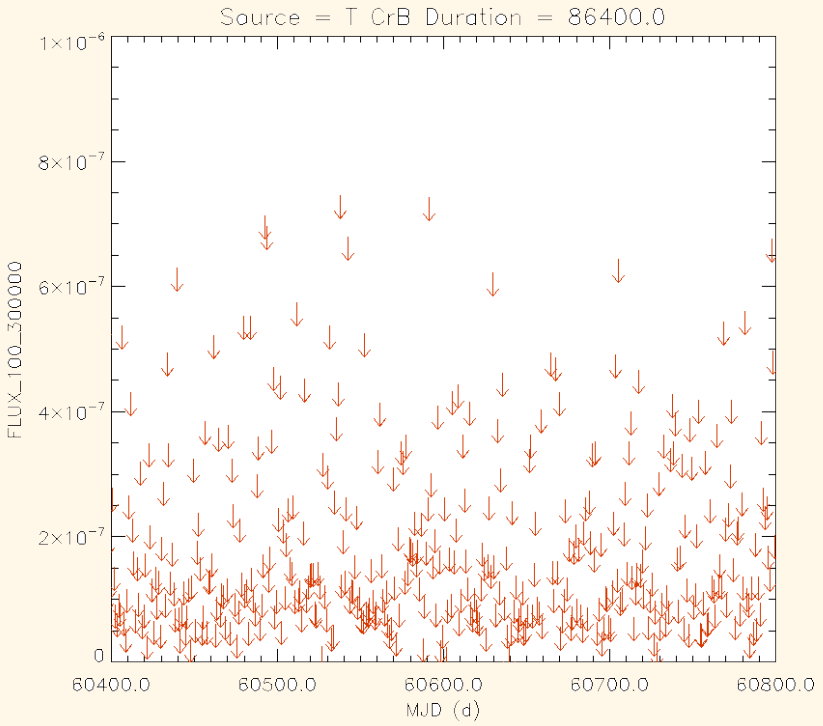
B) Short update on PSR B1259-63 and HESS J0632+057

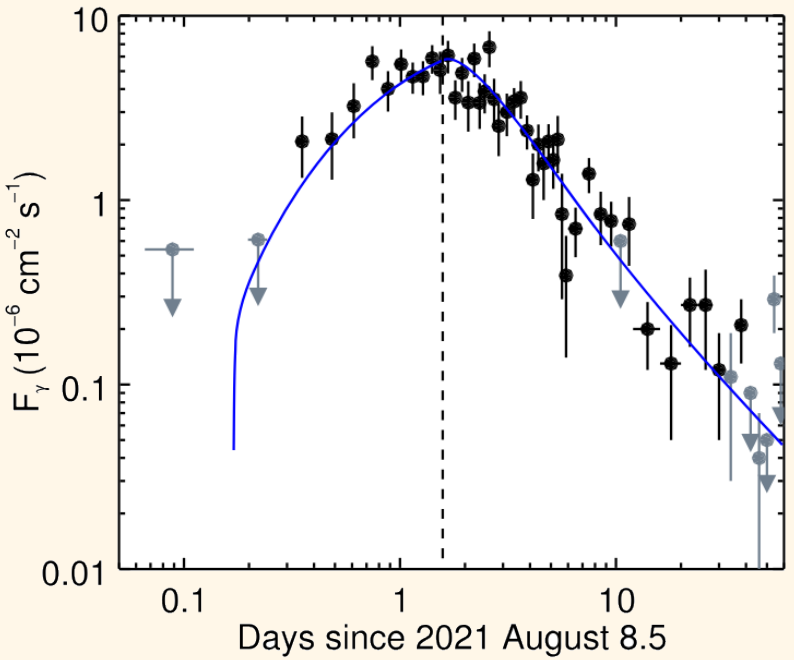
C) Any news on CWBs?

D) On V4641 Sgr and GRS 1915+105 with *Fermi*-LAT

A) Preparing for T CrB

Nearby ($d \sim 0.9$ kpc) symbiotic nova, expected soon(ish?). LAT alert particularly relevant during solar conjunction (late November). Available daily light curve
https://fermi.gsfc.nasa.gov/ssc/data/access/lat/msl_lc/source/T_CrB





FSSC and Cheung et al. 2022

B1) The 2024 periastron of PSR B1259-63

While some weak GeV detections usually preceded periastron, bulge of emission usually afterwards (see D. Malyshev?)

In 2024, bright, short flare pre-periastron

Post-periastron flare back at $\sim$ 30 days after the passage

Rapid GeV gamma-ray flare from PSR B1259-63/LS 2883 21 days before its upcoming periastron passage

ATel #16656; *T. Burnett (UW), K. Wood (TSC, resident at NRL), C. C. Cheung, M. Kerr (NRL), T. Johnson (GMU, resident at NRL), G. Marti-Devesa (University and INFN Trieste), P. Michelson (Stanford), on behalf of the Fermi-LAT Collaboration*
*on **15 Jun 2024; 15:11 UT***
Credential Certification: Teddy Cheung (Teddy.Cheung@nrl.navy.mil)

Subjects: Gamma Ray, >GeV, Neutron Star

Referred to by ATel #: 16747, 16778

Tweet

The Large Area Telescope (LAT), one of the two instruments on the Fermi Gamma-ray Space Telescope, has observed a transient gamma-ray source positionally consistent with the PSR B1259-63/LS 2883 binary system, 21 days before its upcoming periastron passage (2024 Jun 30).

Preliminary analysis indicates that the transient source has >5-sigma significance in the 6-hr interval (12:00-18:00 UT) of 2024 Jun 9, with a (E >100 MeV) flux of (3.2 +/- 0.9) x 10^-6 photons cm^-2 s^-1 and photon index of 2.3 +/- 0.2 (statistical uncertainties only). An independent analysis narrows this down to the 33-minute run centered at MJD 60470.665, 2024-06-09 15:57 UTC, with 7-sigma significance. A search for significant LAT flux following the flare and up to this time produces only upper limits, searching on timescales from single orbits to the full five days. In the preceding four periastron passages observed by the LAT there has been little or no pre-periastron detected flux. The orbital phase of this flare implies a significantly different viewing geometry from all previous flares detected by the LAT, since the neutron star velocity vector is in the hemisphere away from the direction to Earth.

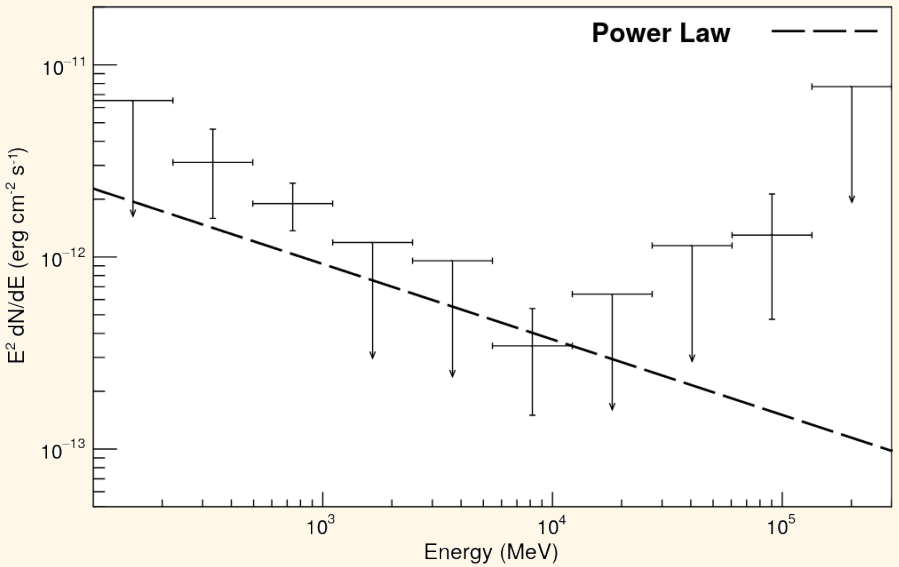
B2) HESS J0632+057 with LAT and FAST

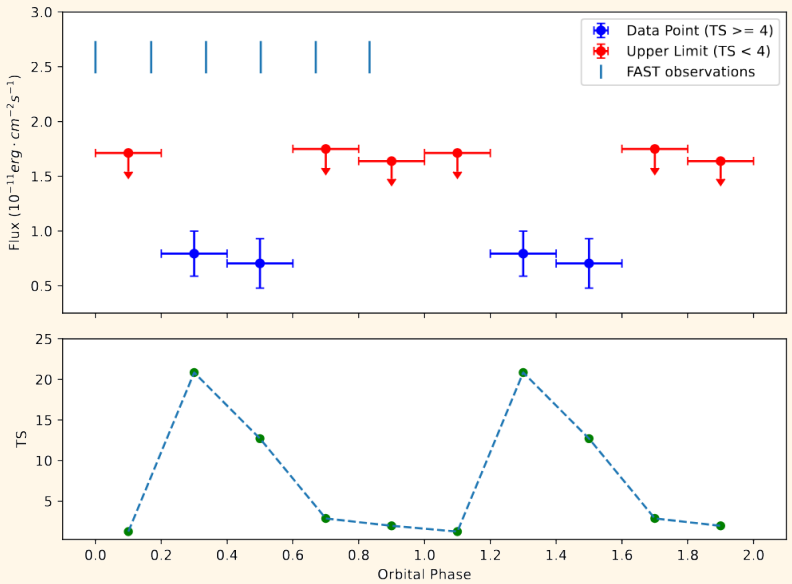
Updated LAT view with 15 yr of data by Yang et al. 2025

GeV flux slightly lower but consistent within 2σ with Li et al. 2017

Orbital flux higher at the same phases as in X-ray and TeV

No radio pulsations down to 2μJy
(6 observations sampling one orbit)





Yang et al. 2025

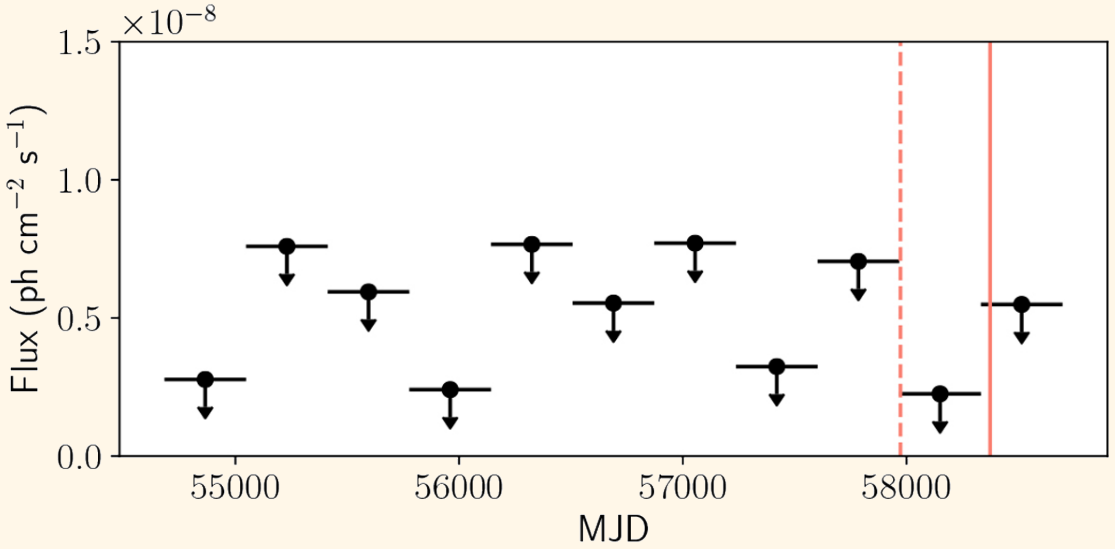
C) News on CWBs? Not really

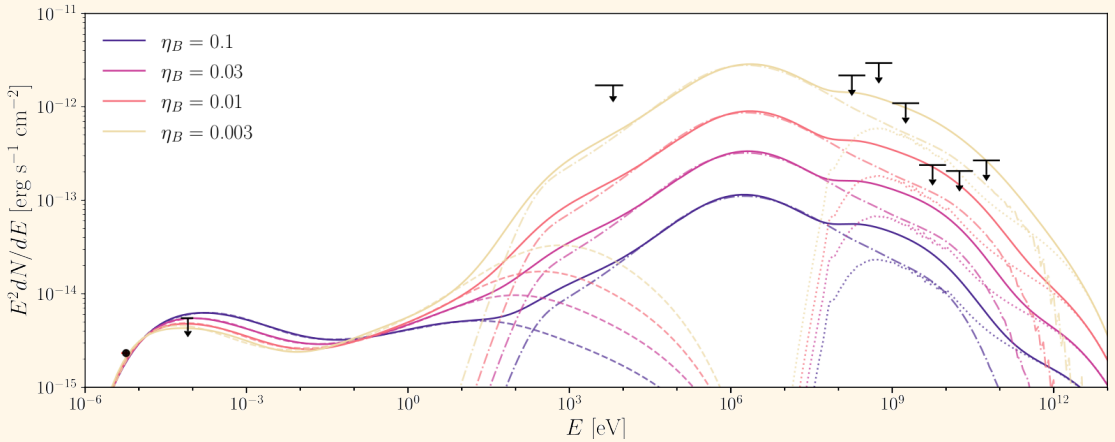
Only known GeV systems remain:
η Car and γ^2 Vel

Searches on HD 93129A, WR 22, WR 39, WR 25, WR 21a unsuccessful (Marti-Devesa & Reimer 2021)

Apep also not detected. Evidence in hard X-ray with NuSTAR (del Palacio et al. 2023).

Radio view: See talks by Paula, Santiago, and Michaël





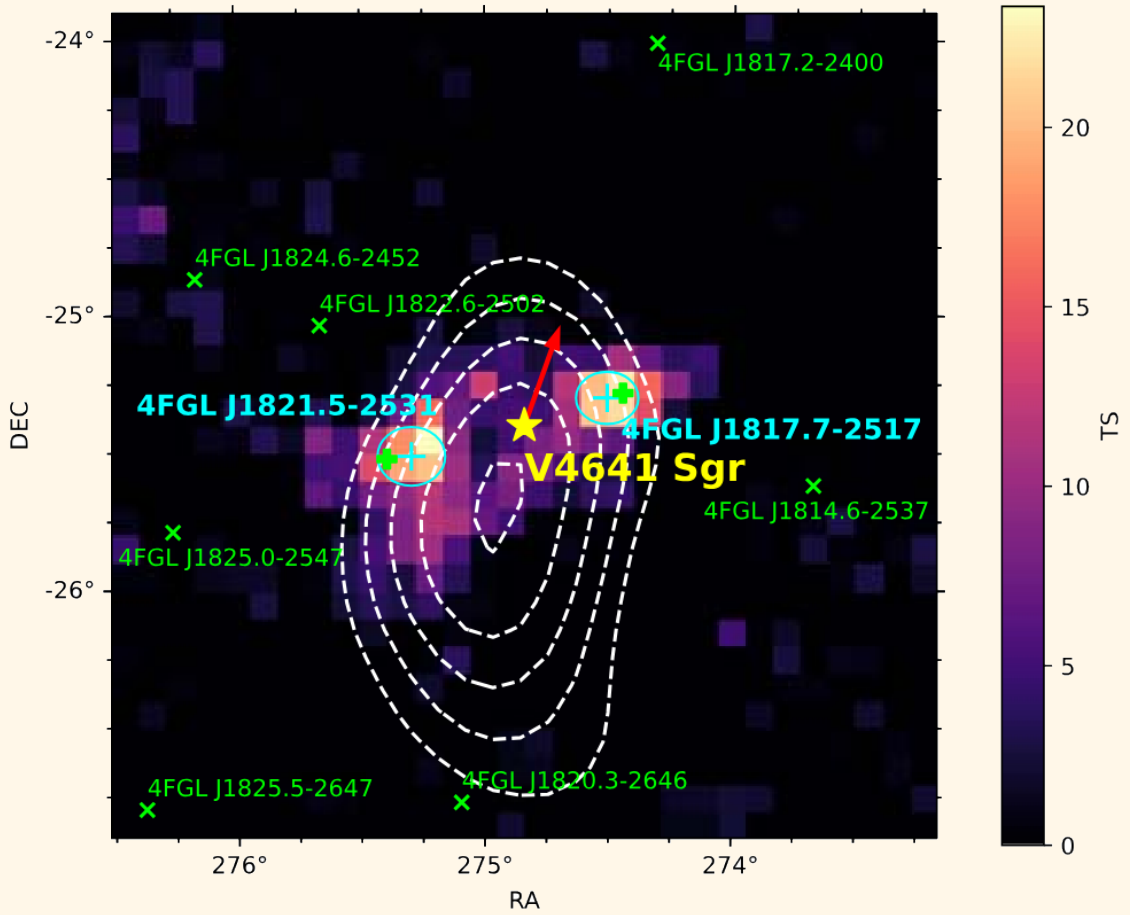
Martí-Devesa & Reimer 2021, Martí-Devesa et al. 2023

D1) V4641 Sgr

Search for GeV emission by Zhao et al. 2025

No GeV flux emission found, or flares
($F_{\mathrm{GeV}} < 5.4 \times 10^{-13}$ erg cm^{-2} s^{-1})

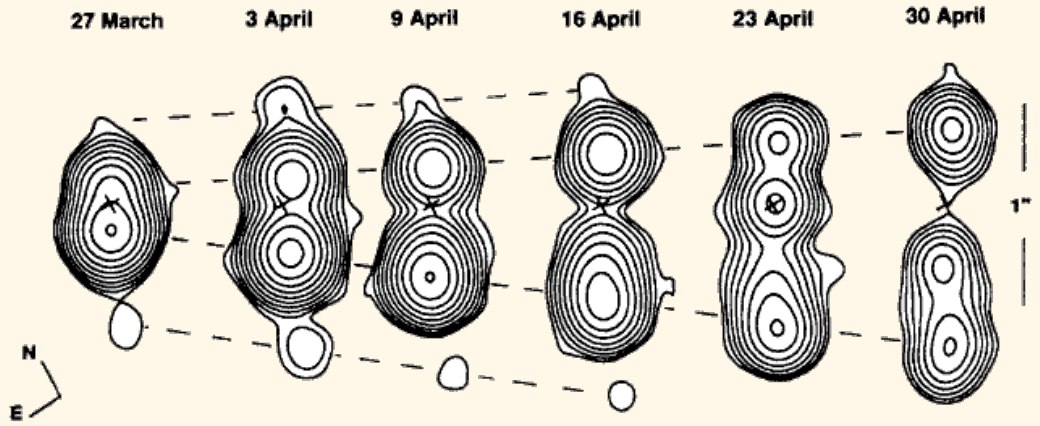
No extended emission coincident with LHAASO
($F_{\mathrm{GeV}} < 1.1 \times 10^{-12}$ erg cm^{-2} s^{-1})



Zhao et al. 2025

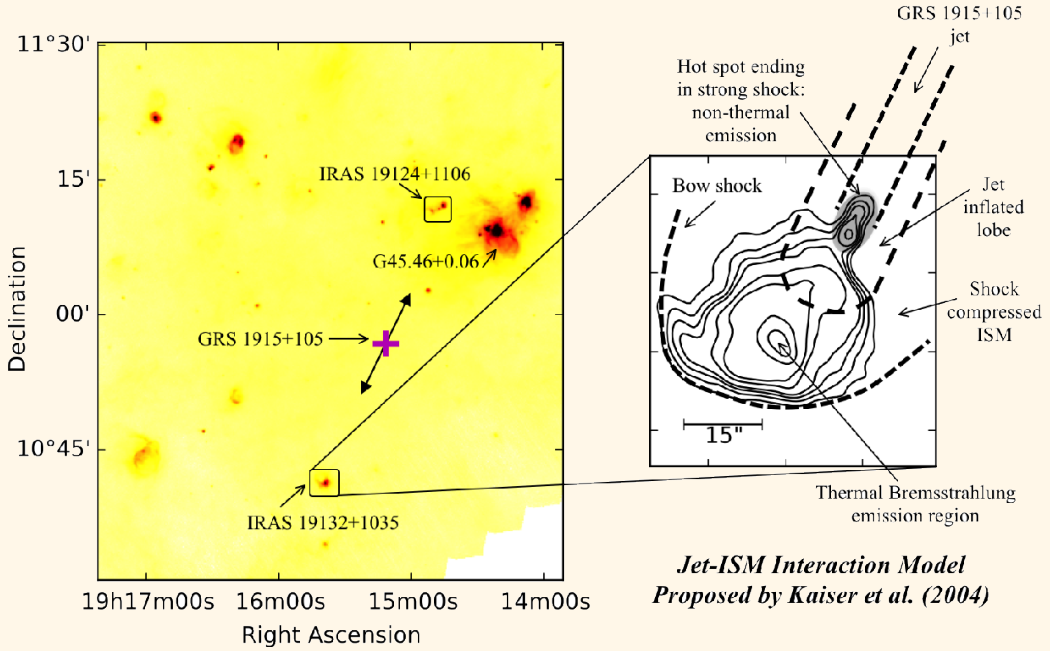
D2) GRS 1915+105

Close to the central object



Credit: Mirabel & Rodriguez 1994

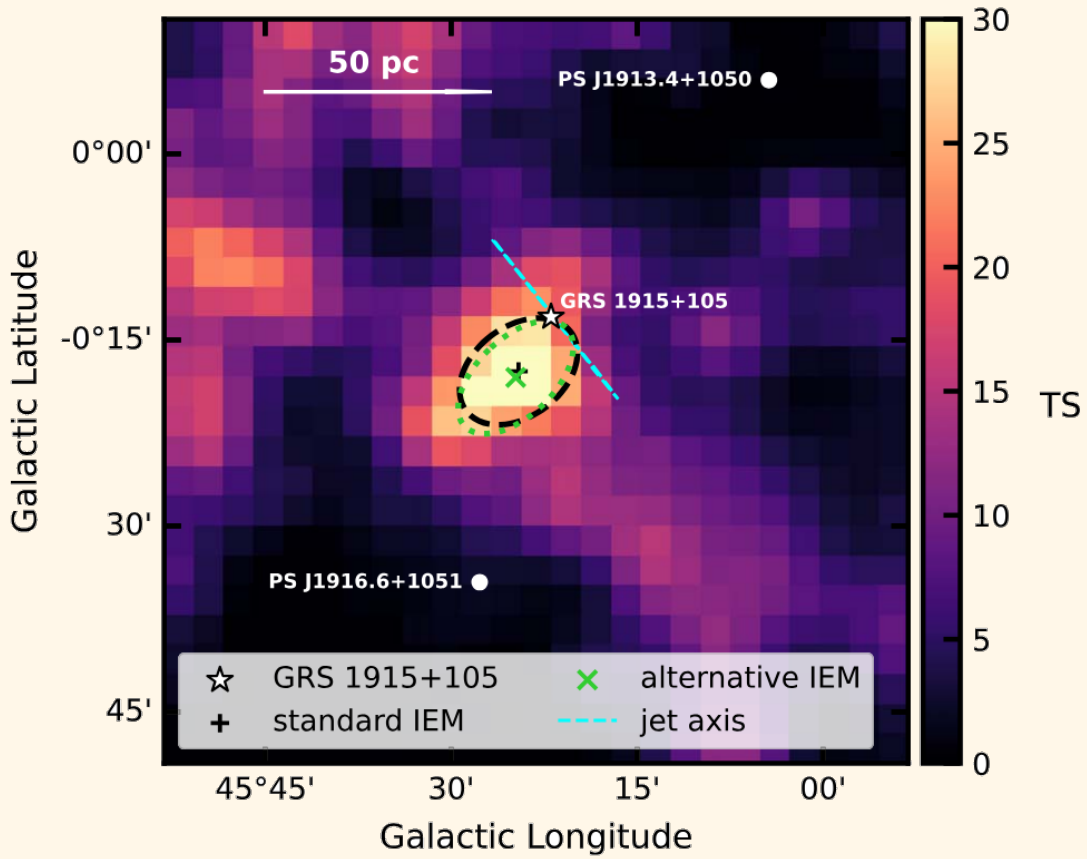
Large scales

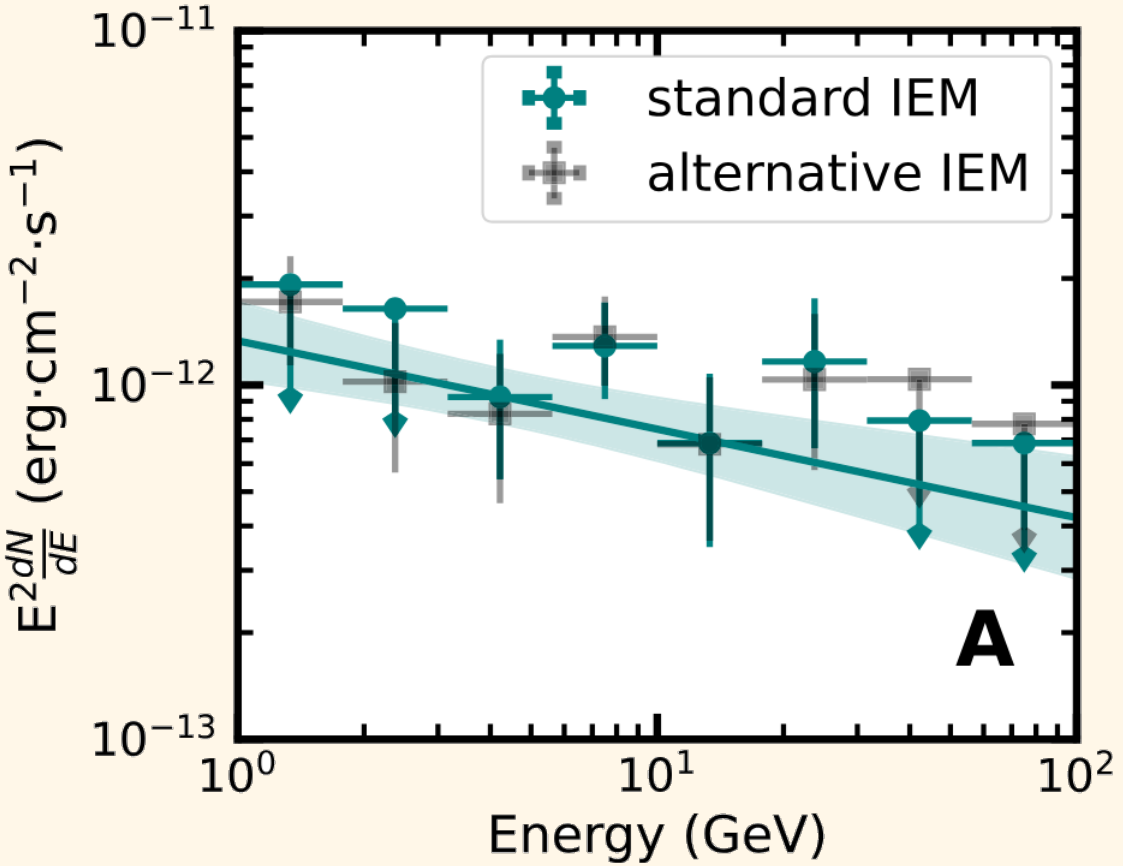


Credit: Tetarenko et al. 2018

Known variabilities: Fast QPOs, orbital period, radio variability, X-ray state change in 2018

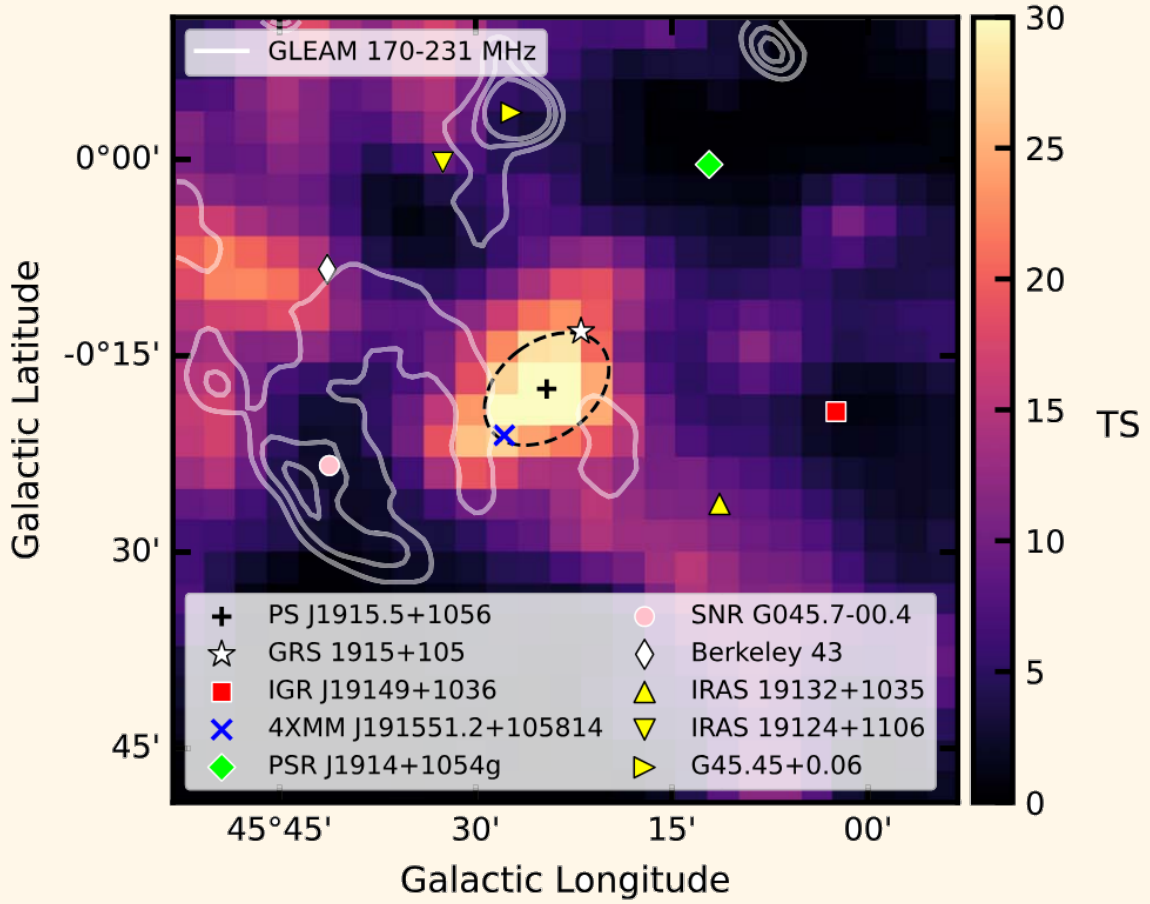
D2) GeV counterpart for GRS 1915+105





Martí-Devesa & Olivera-Nieto 2025

D2) GeV counterpart for GRS 1915+105



Martí-Devesa & Olivera-Nieto 2025

- GRS 1915+105: Leptonic and hadronic scenarios tested. Hadronic preferred
- SNR G045.7-00.4: AIC preference for extended source + point-like source
- 4XMM J191551.2+105814? Orders of magnitude fainter in X-rays
- Blazar? Using 4LAC catalog, not likely (< 0.08 blazars expected)

We find no variability, or flux change after July 2018. We cannot exclude other associations, but GRS 1915+105 seems the most plausible


... and summary

Summary

Take-home message: Wide variety of systems detected in the GeV band: revisit known systems (e.g. PSR B1259-63) or search for "new" ones (e.g. GRS 1915+105)