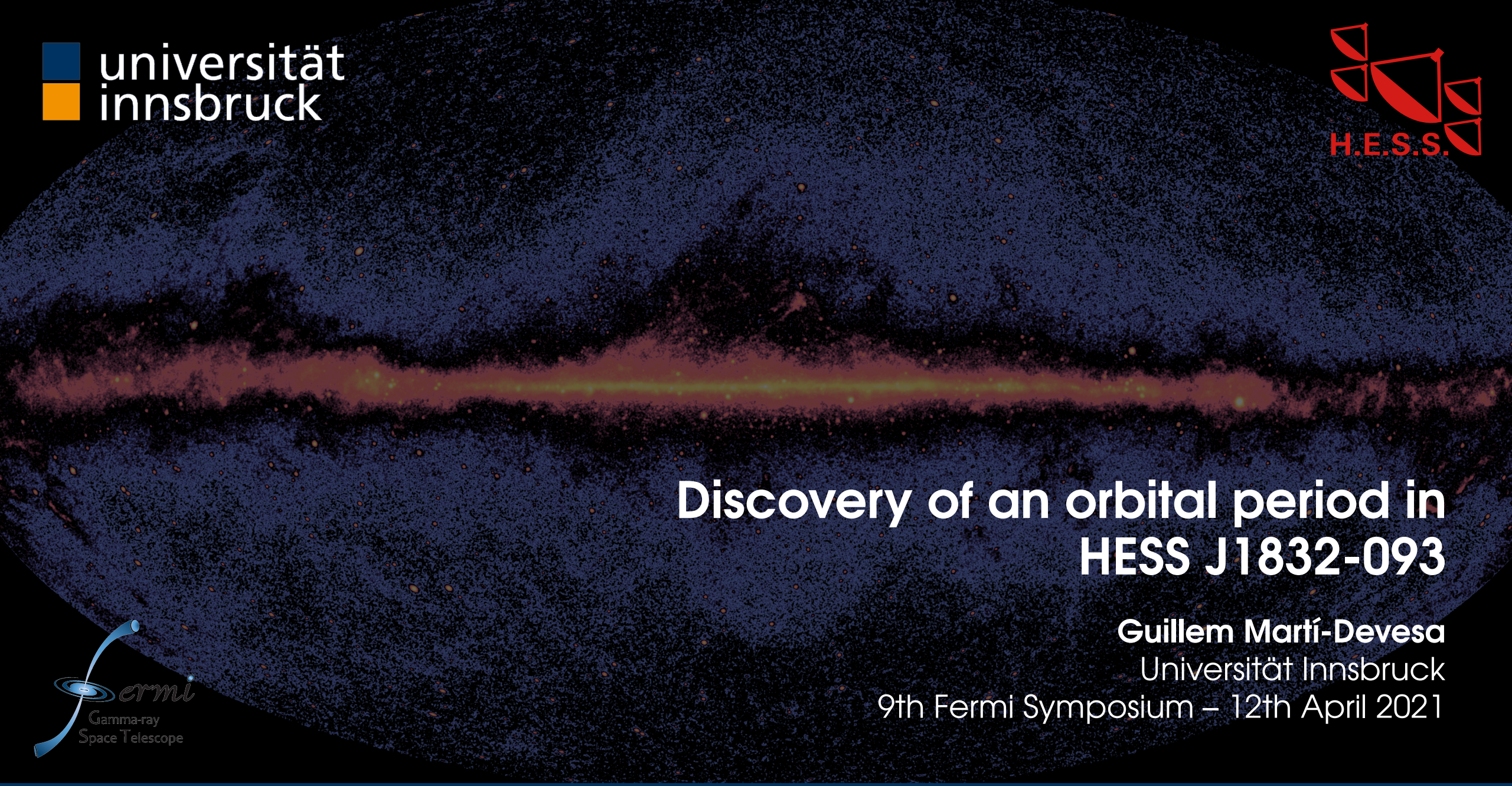


Discovery of an orbital period in HESS J1832-093

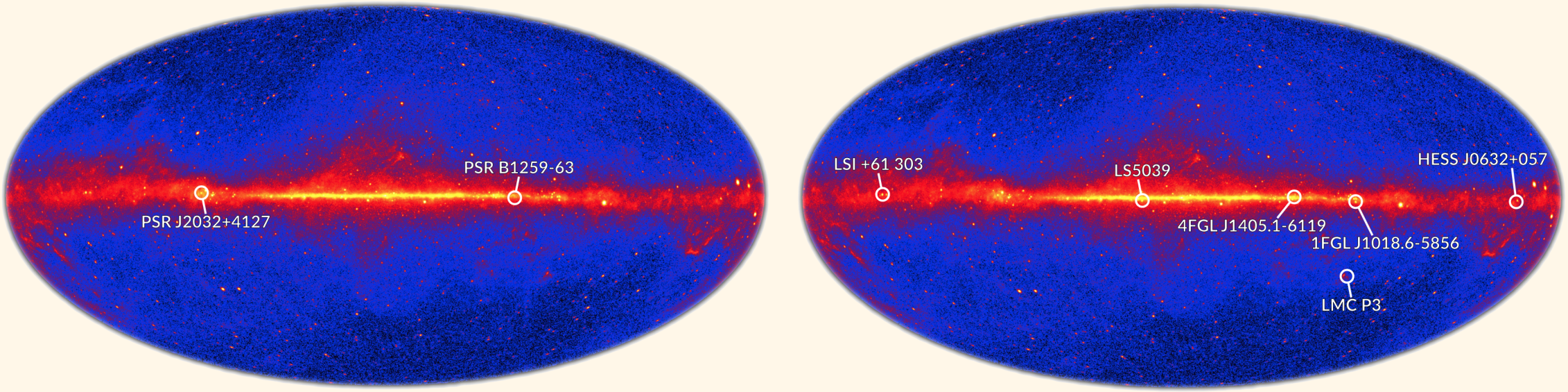
Guillem Martí-Devesa
Universität Innsbruck
9th Fermi Symposium – 12th April 2021

The population of γ-ray binaries

Binaries with most of their EM output above 1 MeV

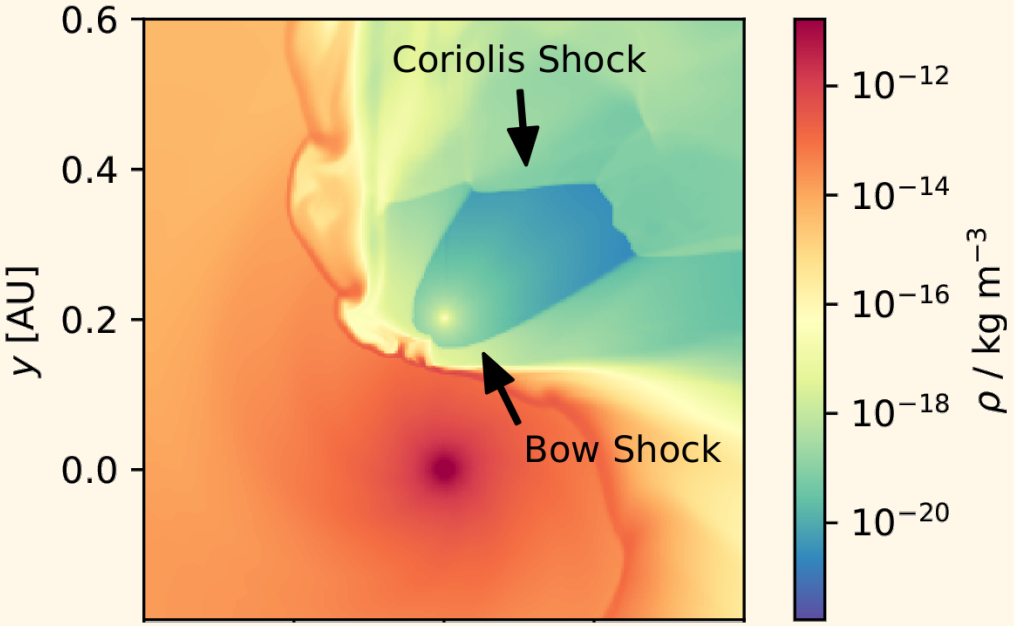
Pulsations detected (2)

Suspected pulsars (6)

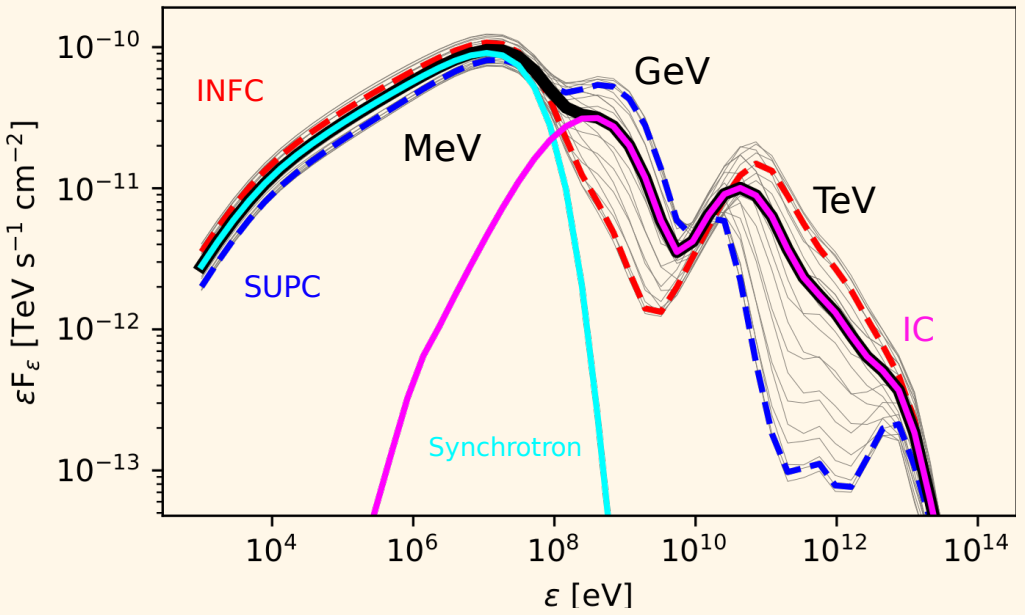


Credit: Fermi-LAT Collaboration / D. Huber

The pulsar-wind scenario

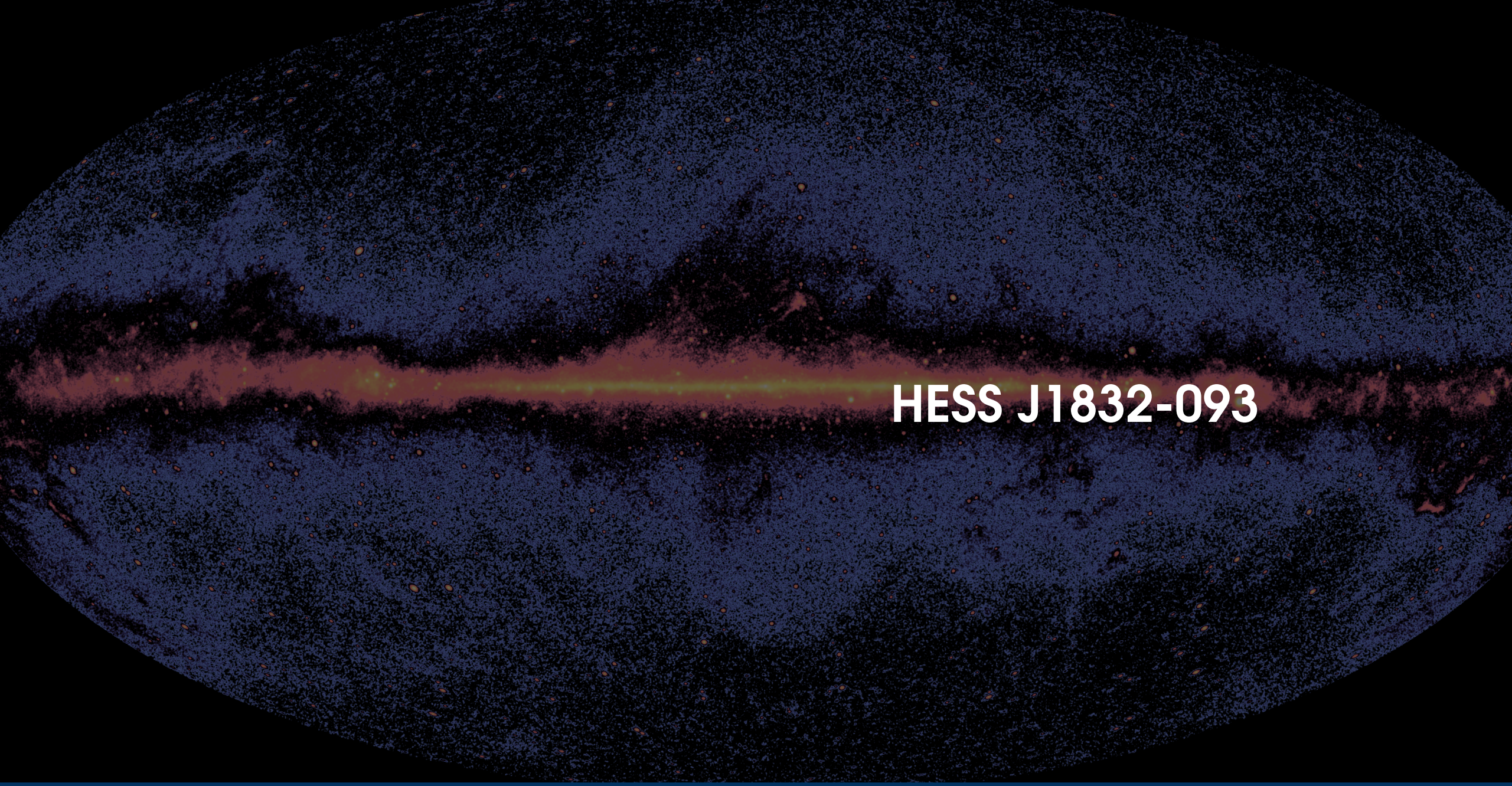


Highly dependent on the geometry!



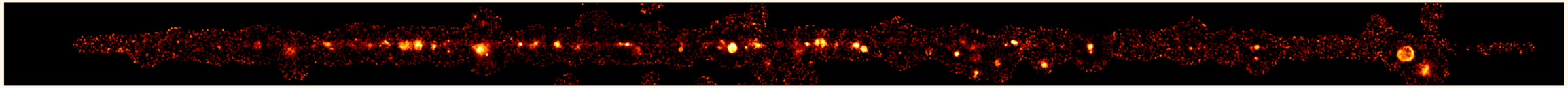
Huber et al. 2021, A&A, 646, A91

Check David Huber's poster *"Relativistic Fluid Modeling of the Gamma-Ray Binary LS5039"* for more


HESS J1832-093

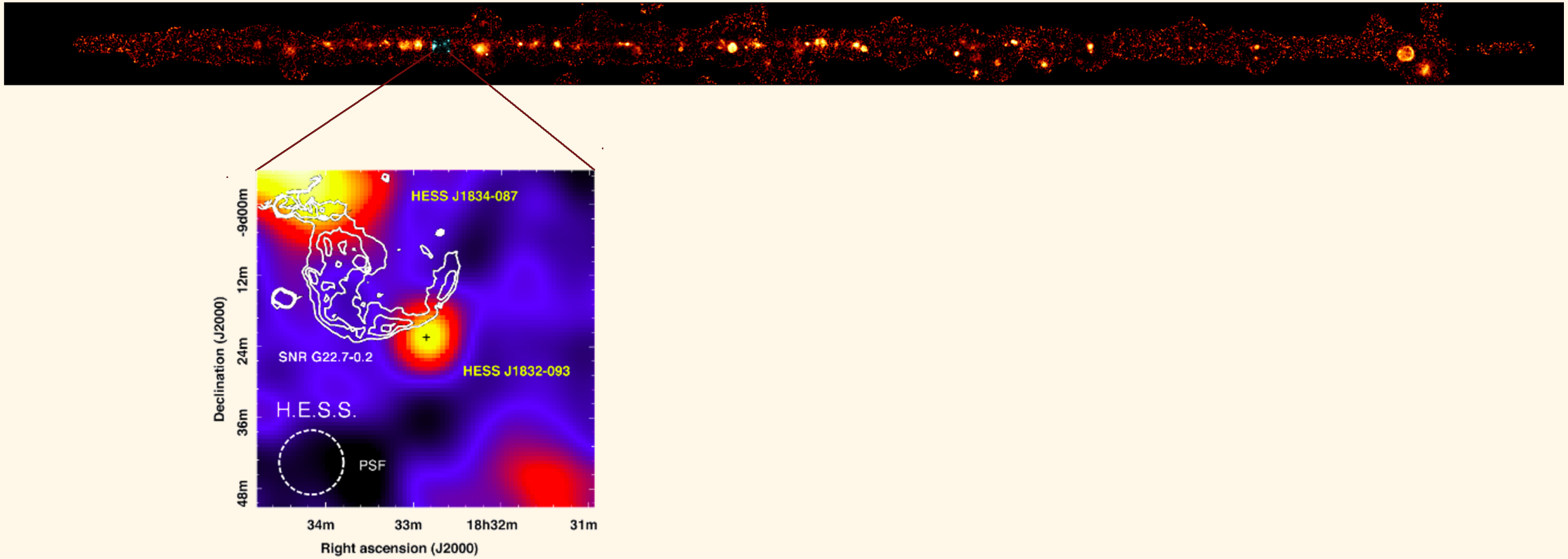
A known VHE source, a binary candidate

Credit: H.E.S.S. Collaboration



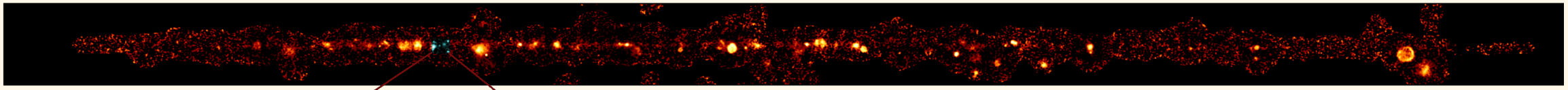
A known VHE source, a binary candidate

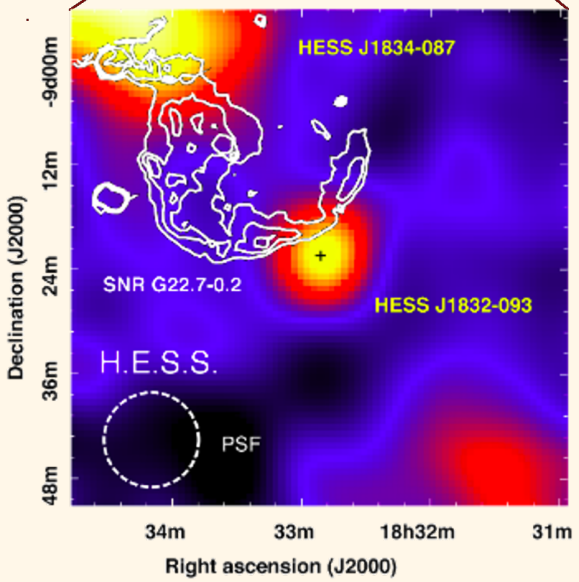
H.E.S.S. Collaboration 2015, MNRAS, 446, 1163



A known VHE source, a binary candidate

Martí-Devesa & Reimer 2020, A&A, 637, A23



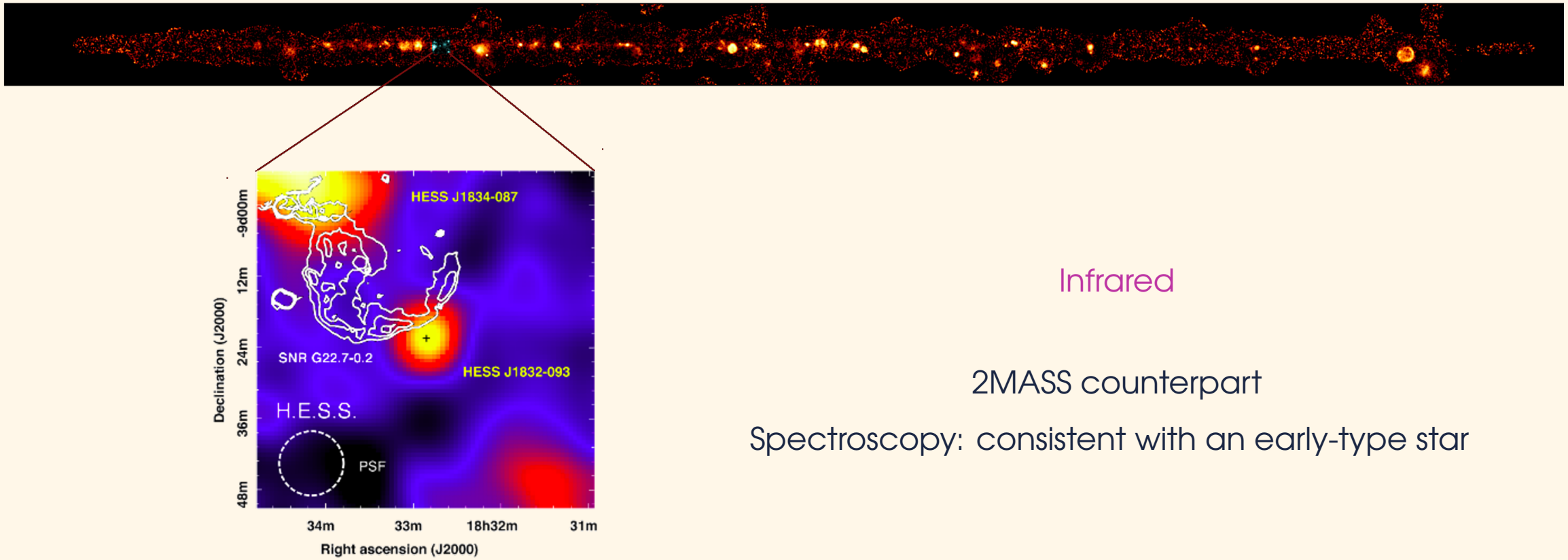


Visible or UV

No counterpart

A known VHE source, a binary candidate

Tam et al. 2020, ApJ, 899, 75



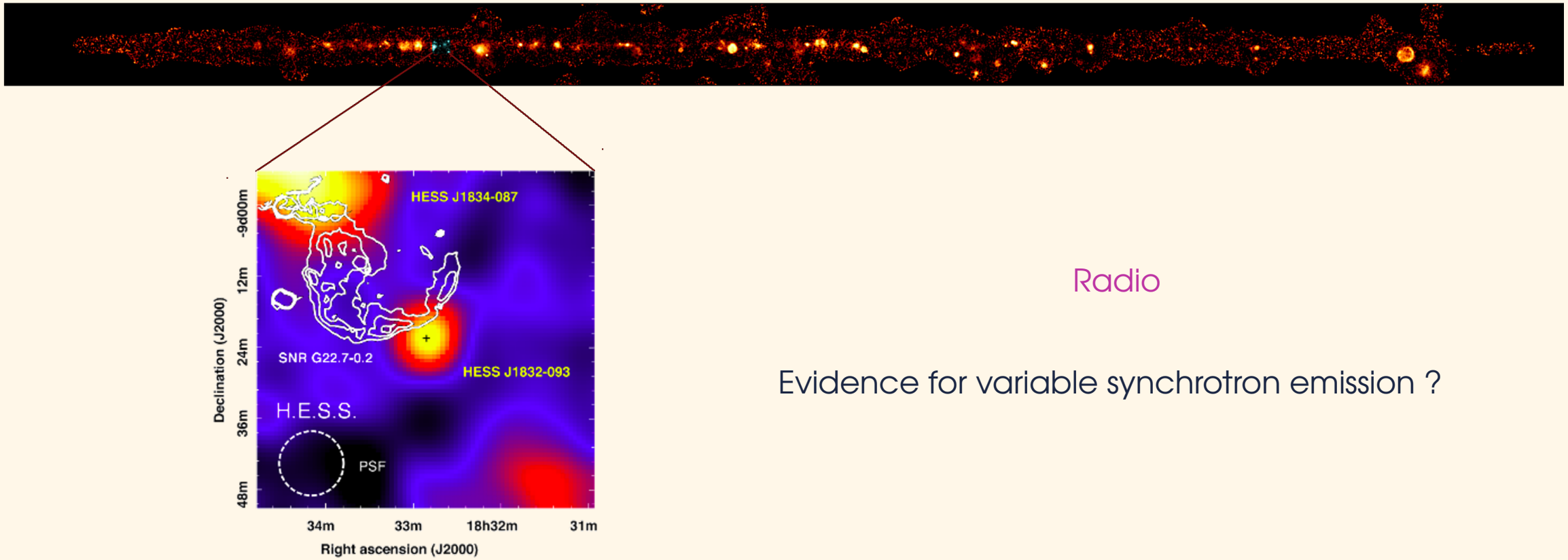
Infrared

2MASS counterpart

Spectroscopy: consistent with an early-type star

A known VHE source, a binary candidate

Moldón 2017, VGGRS IV Workshop

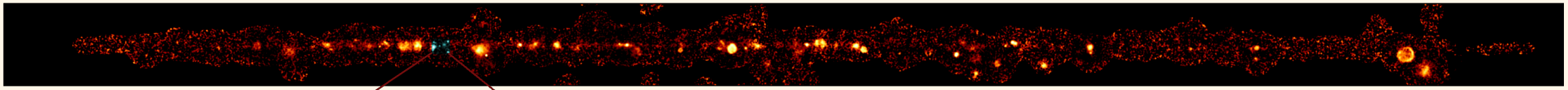


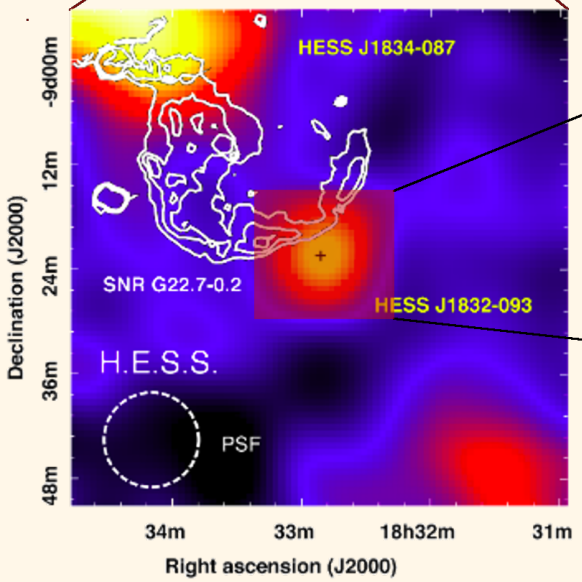
Radio

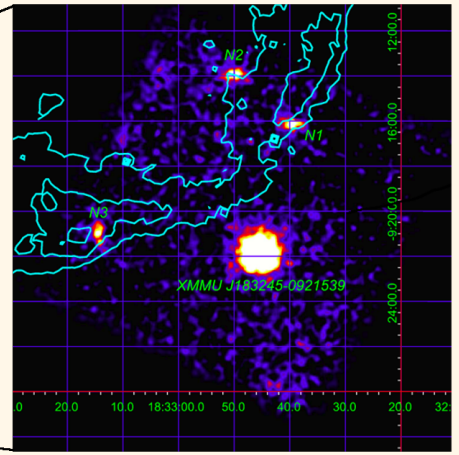
Evidence for variable synchrotron emission ?

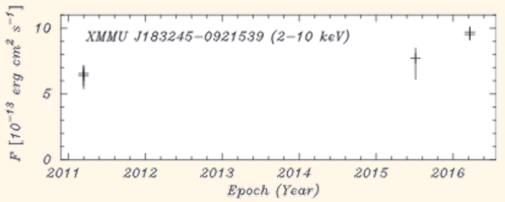
A known VHE source, a binary candidate

Mori et al. 2017, ApJ, 848, 80







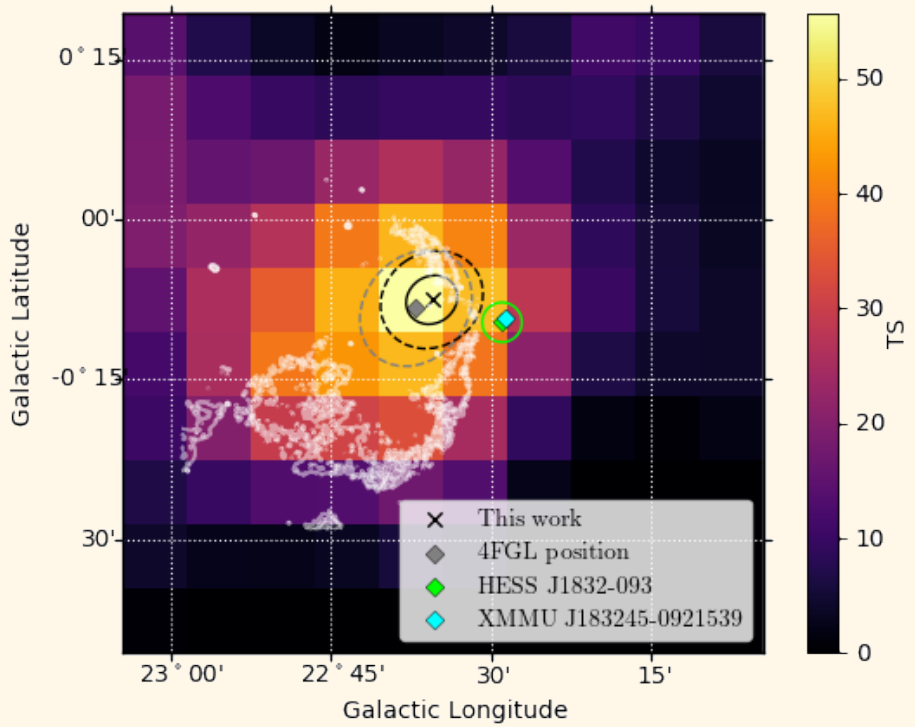


X-rays

Variability

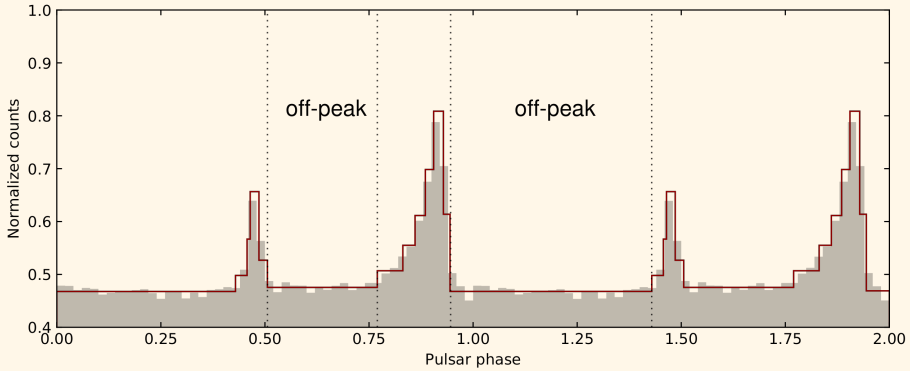
Counterpart candidate at GeV energies

4FGL J1832.9-0913: Binary or SNR?



Martí-Devesa & Reimer 2020, A&A, 637, A23

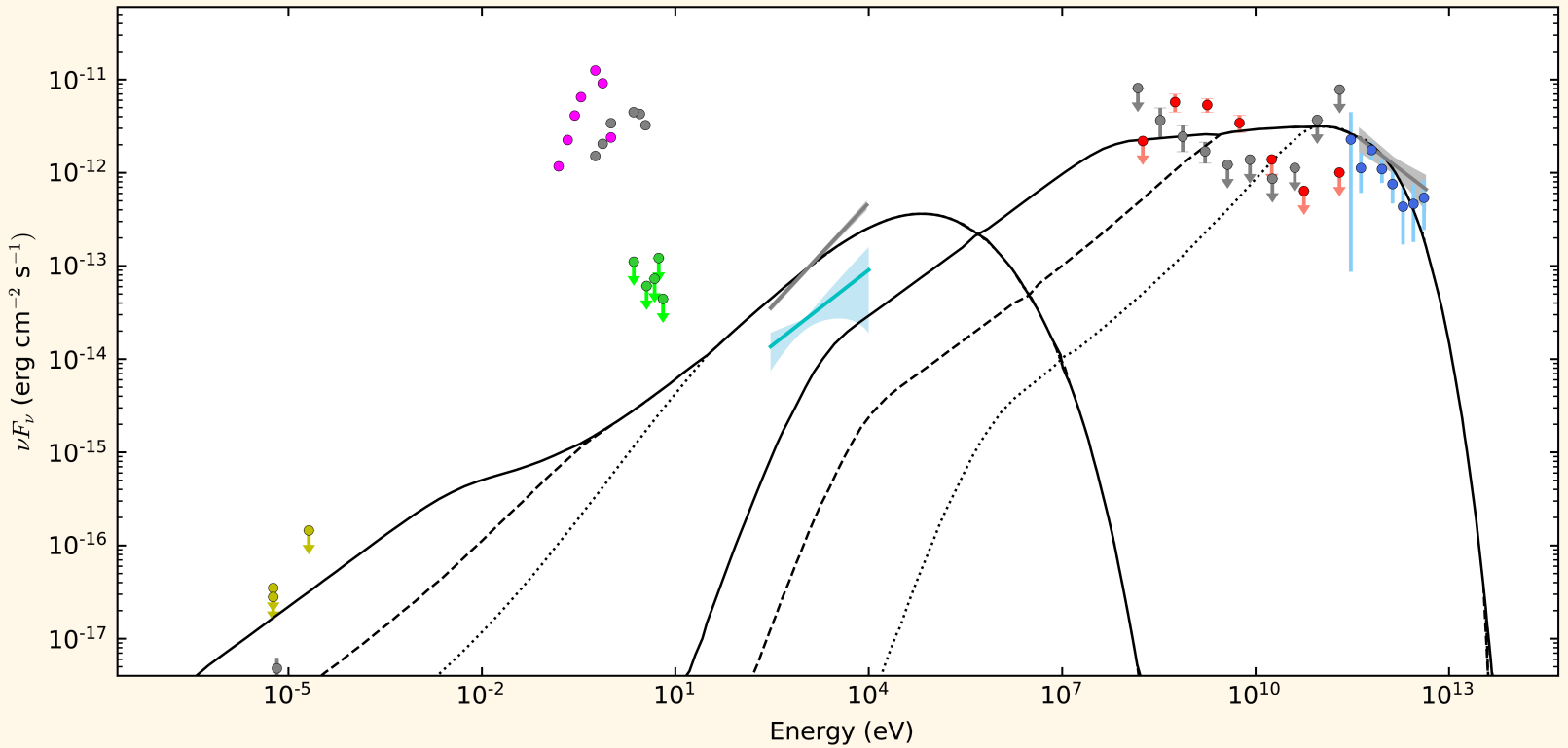
Gating the pulsar PSR J1833–1034



Impact of the galactic diffuse model is not negligible – the source can move beyond the 95% error region (Abdollahi et al. 2020, ApJS, 247, 33A)

Spectral energy distribution (SED)

HESS J1832-093 (colour) vs HESS J0632+057 (grey)



Martí-Devesa & Reimer 2020, A&A, 637, A23

Can we identify a period?

Archival data from the
Swift X-Ray Telescope

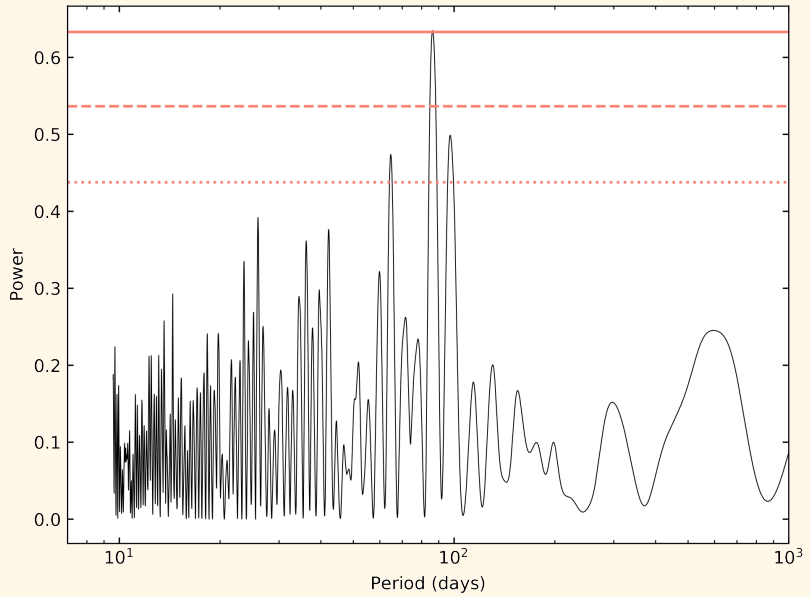
Total: $\sim$ 120 ks of observations

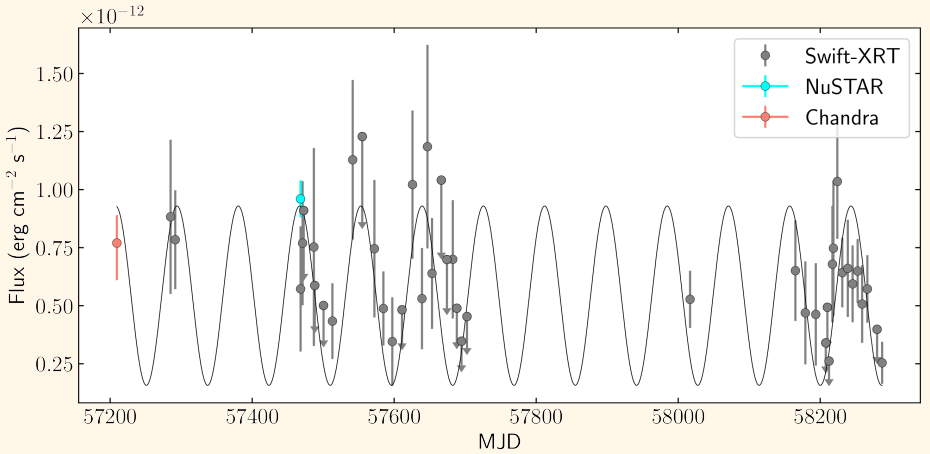
Lomb-Scargle periodogram on X-ray data:
86.28 ± 3.77 days period

Analytical approximation $\sim 5\sigma$
Bootstrap $\sim 3\sigma$

$\downarrow$

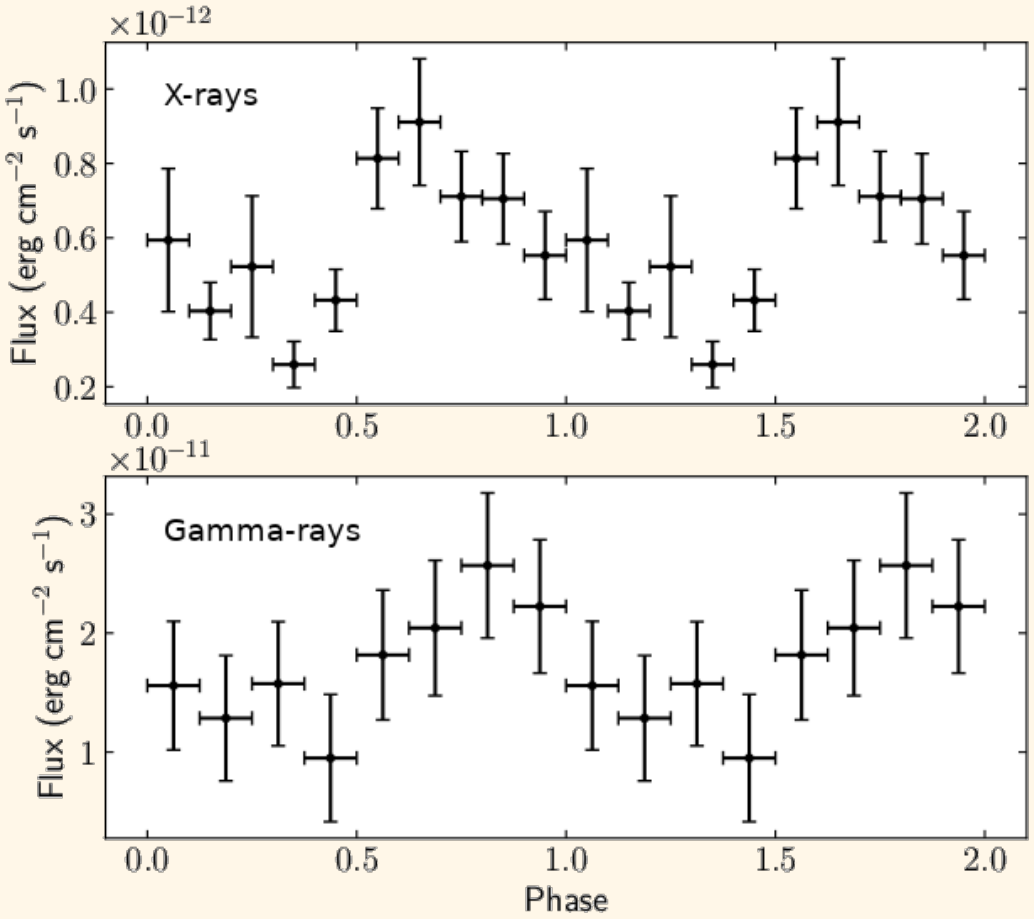
1.5 ks and 2.5 ks binning provide consistent results





Martí-Devesa & Reimer 2020, A&A, 637, A23

What about 4FGL J1832.9-0913?



- Lomb-Scargle of weighted events: period not found $\rightarrow$ source too faint

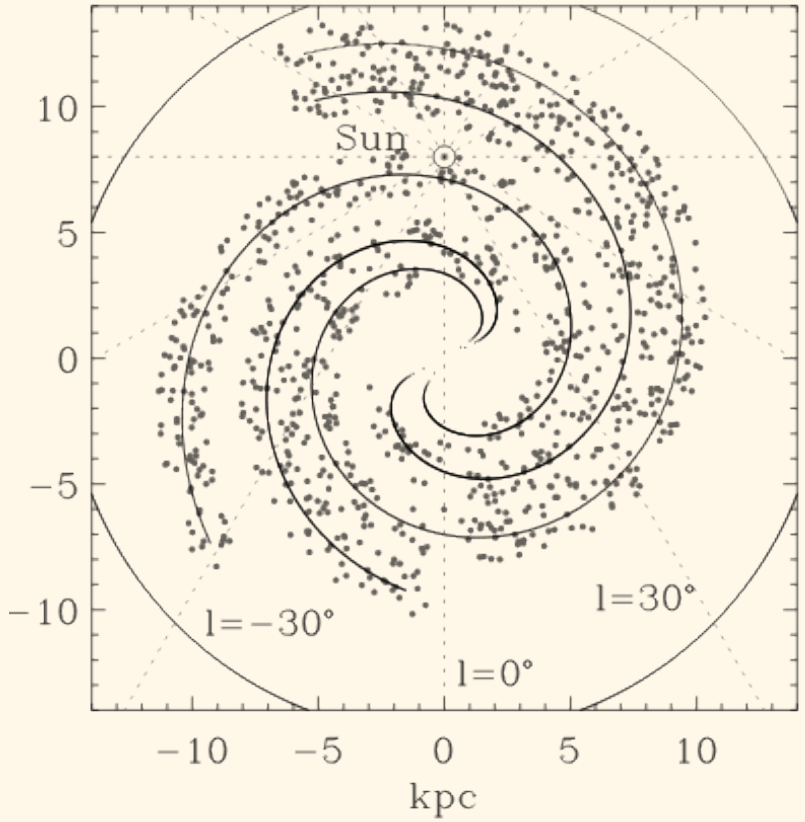
- Phase-folding weighted bins: method adapted on from Leahy 1987 (A&A, 180, 275). Originally designed for X-ray observations

Evidence of periodicity at $\sim$ 87 days $\rightarrow$ systematic error dominated by binning

- Phase-folding likelihood analysis: evidence of periodicity at $\sim$ 87 days

Martí-Devesa & Reimer 2020, A&A, 637, A23

Impact on the population



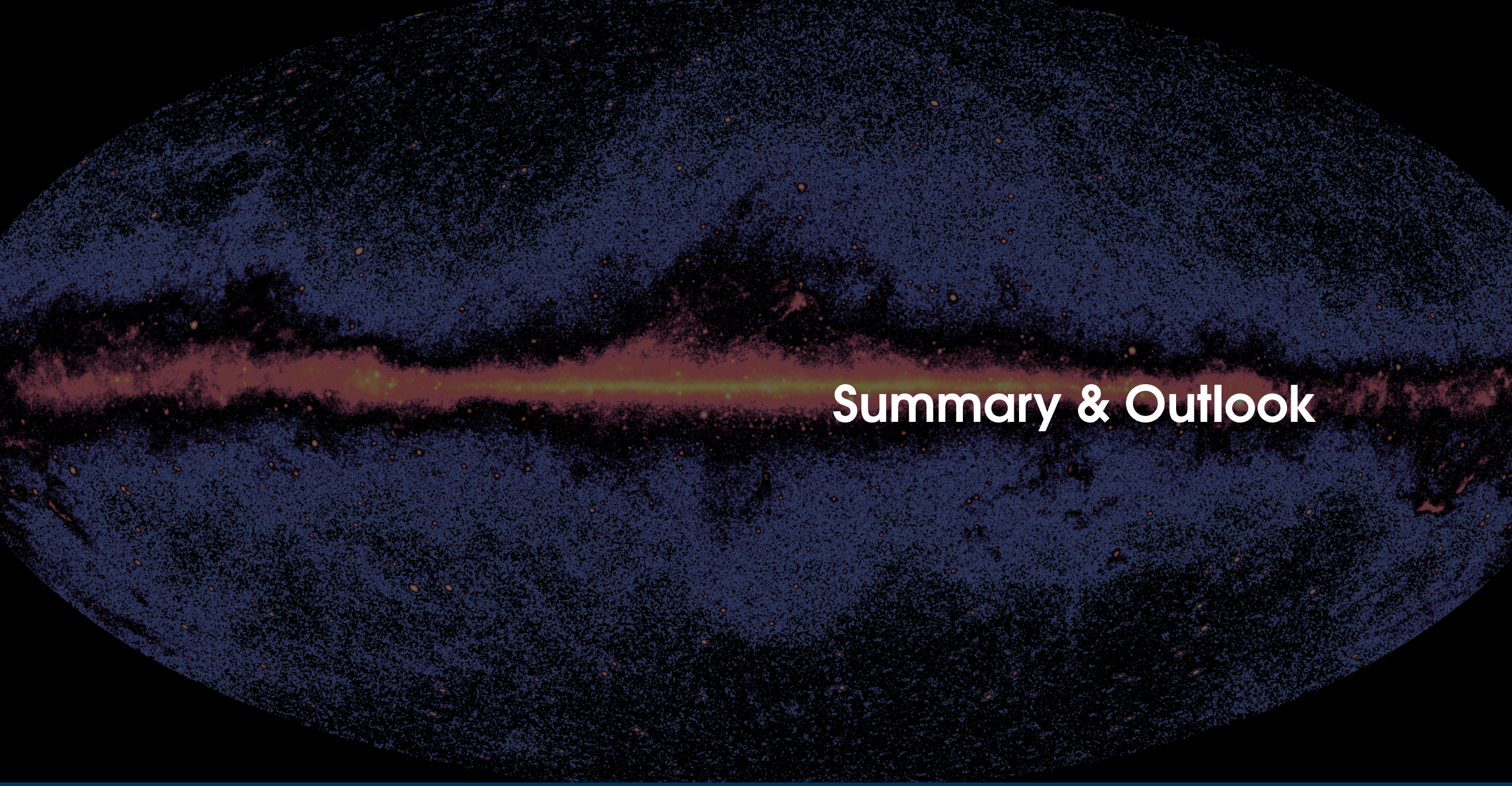
Dubus et al. 2017, A&A, 608, A59

$L_{VHE} \sim L_{HE}$, unlike "classical" systems

Very similar to HESS J0632+057, second GeV-faint binary

HESS J0632+057-like systems are the major source of uncertainty in population models (Dubus et al. 2017, A&A, 608, A59)

How many GeV-faint binaries are we missing?



Summary & Outlook

Summary

1. HESS J1832-093 is the 9th γ-ray binary
2. Its orbital period is 86.28 ± 3.77 days as found from *Swift*-XRT data
3. Evidence of such variability is found on 4FGL J1832.9-0913, establishing a connection between the X-ray and GeV sources
4. HESS J0632+057 is no longer an exception, and systematic searches may miss GeV-faint binaries

Summary

1. HESS J1832-093 is the 9th γ-ray binary
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Outlook

5. Future multi-wavelength campaigns could establish the geometry of the system and allow its modelling
6. New techniques needed to identify similar systems