A search of VHE counterparts of galactic Fermi sources

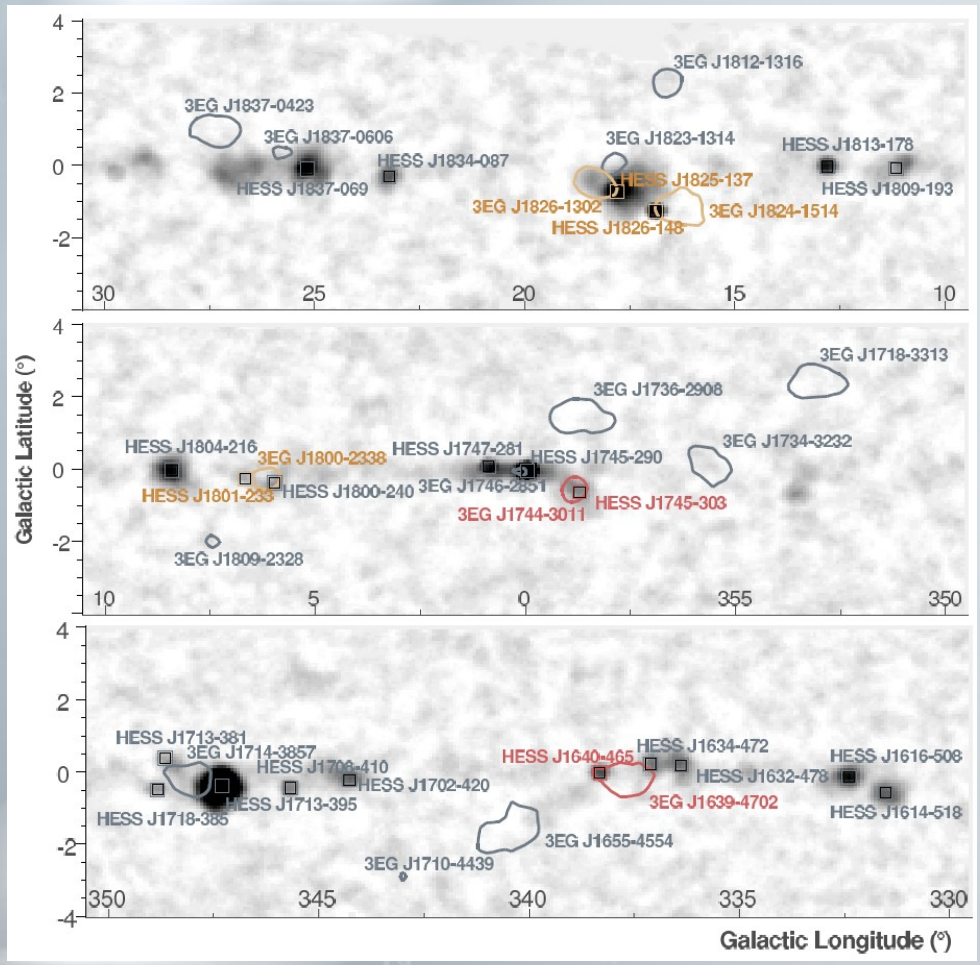
Thomas P.H. Tam, Stefan Wagner (*LSW Heidelberg*)

Emma de Ona Wilhelmi, Omar Tibolla, Werner Hofmann, Ryan Chaves (MPIK)

AGILE 7th Workshop @ Frascati, Italy
29th September 2009

ARI ITA LSW

The GeV/TeV sky before 2007



- 17 3EG sources and 22 VHE sources in the region studied (l = -30^0 – 30^0, b = -3^0 – 3^0)
- The authors did not find correlation between GeV and TeV source position
- But, instrument “mis-match“

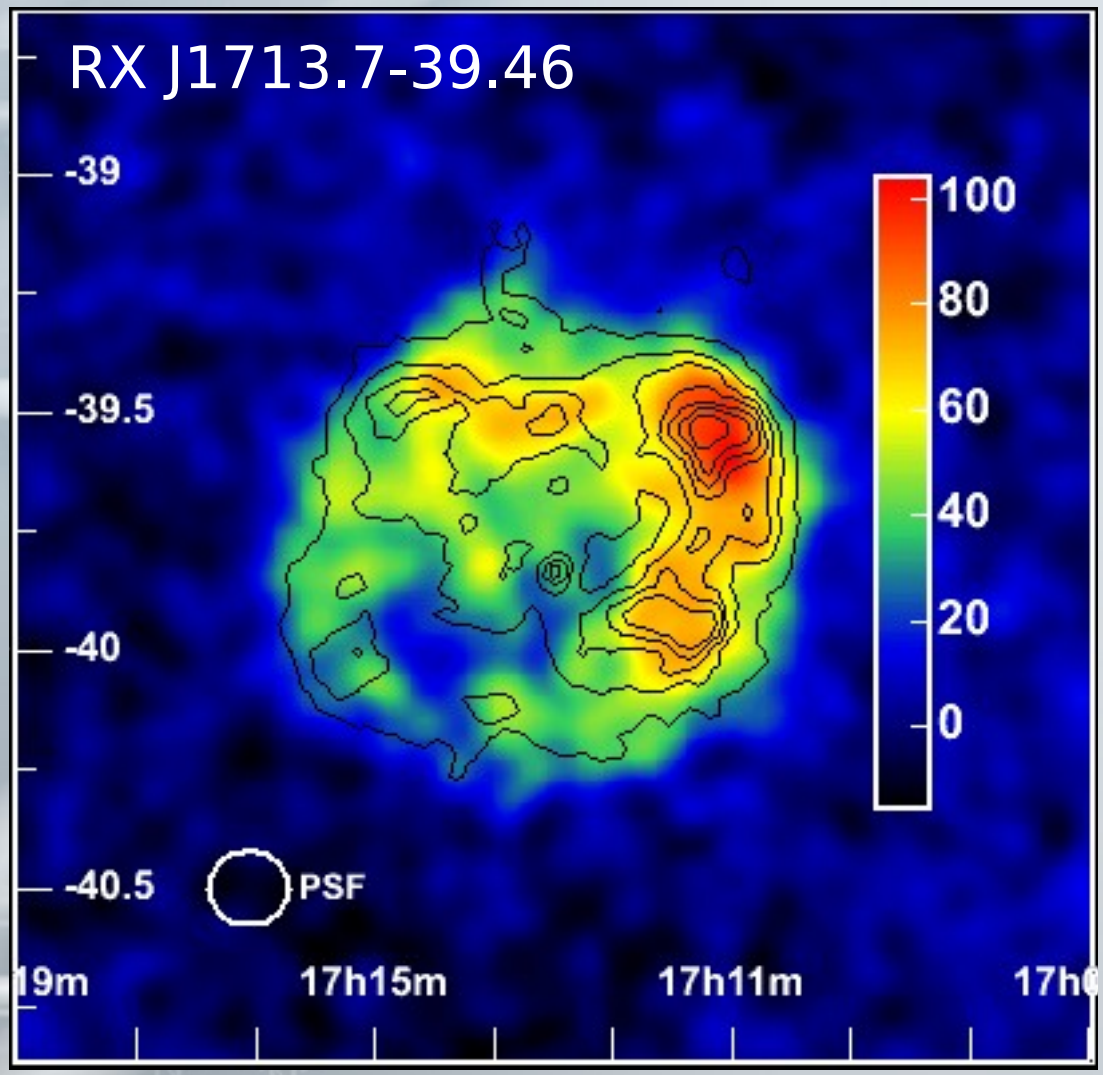
Funk, S. et al. (2008)

Fermi/LAT and IACTs

Gamma-ray detectors in space and on ground

	Fermi/LAT	IACTs
Energy range	20 MeV – 300 GeV	100 GeV – 100 TeV
Field of View	whole sky	5 deg
Effective area	8000 cm^2	10^9 cm^2
Angular resolution	0.6 deg above 1 GeV	about 0.1 deg
Sensitivity	10^{-8} ph cm^{-2} s^{-1}	$1.4x10^{-11}$ erg cm^{-2} s^{-1}

Superior angular resolution of IACTs



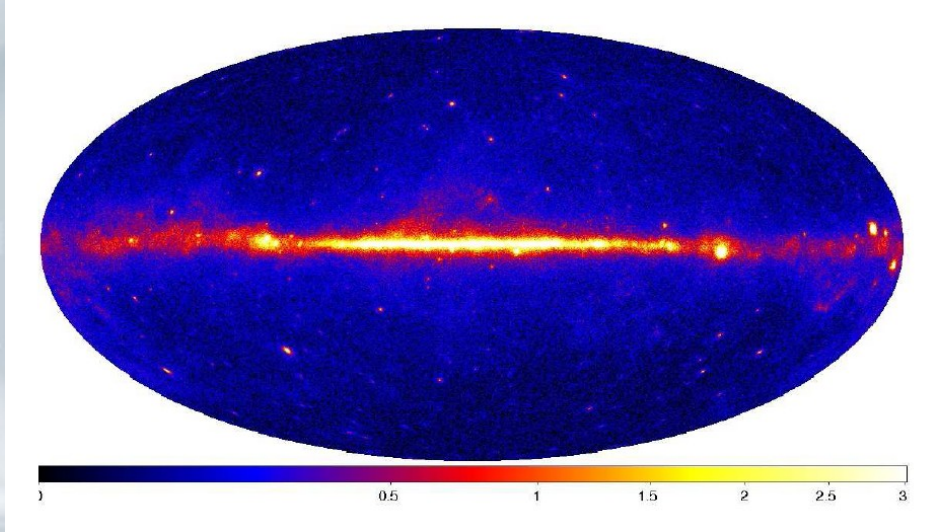
Resolved supernova-remnant

Color: HESS excess image

Contour: ASCA 1-5 keV smoothed

Aharonian et al., (HESS collaboration), 2005

Fermi/LAT Bright Sources



- 205 sources with >10 sigma significance
- Not flux-limited, limiting flux depends on source position and spectrum
- Contains 15 PSRs, 15 new LAT PSRs, 2 HMXBs, 121 AGN, 1 globular cluster (47 Tuc), LMC, 13 SNR/PWN-candidates, and 37 UnIDs
- AGN not included in the following study

Searching for GeV/TeV spatial coincidence

Fermi bright sources as given in BSL paper

- For each source, take *gal. long.*, *gal. lat.*, and *95% confidence region*

VHE sources in the literature

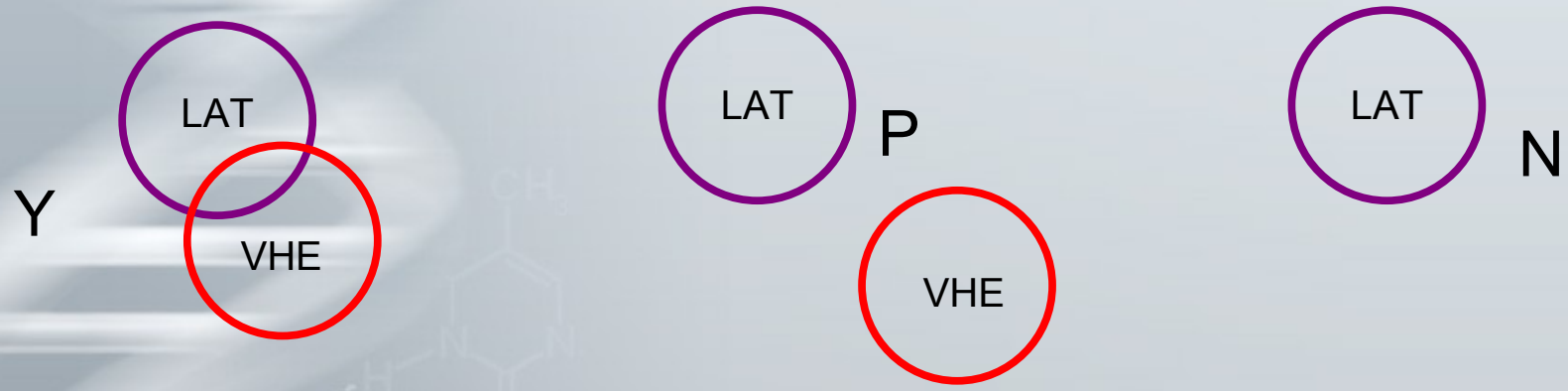
- For each source, take *gal. long.*, *gal. lat.*, and *extension radius*

Defining level of spatial coincidence

- Define **d** = distance between the LAT and VHE centroid positions;
  e = the sum of error radii (LAT+VHE, c.f. previous page)

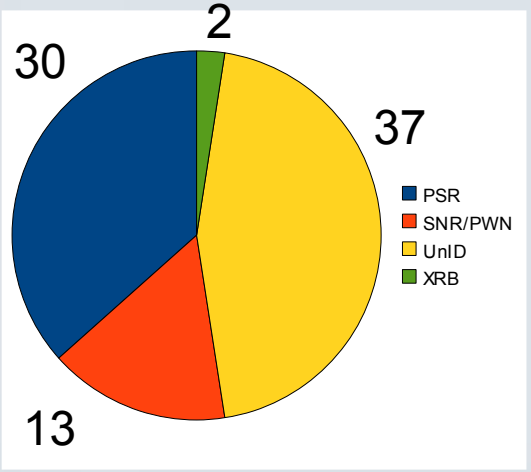
- For each LAT source, if a VHE source or hotspot is found where
  d - **e** < 0: a positional coincidence case (A)
  0 < **d** - **e** < 0.3°: an offset case (B);

- If no VHE source (with its error radius) was found with
  d - **e** < 0.3°: no coincidence with any VHE source (C)

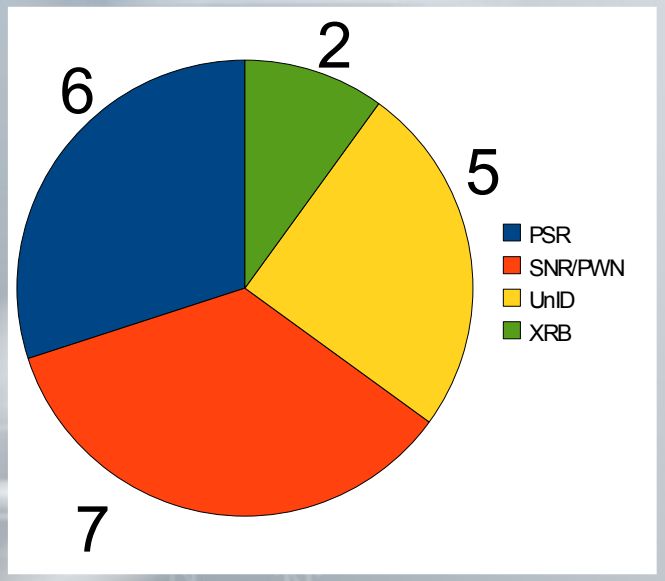


How many galactic Fermi Bright Sources are coincident with a VHE source?

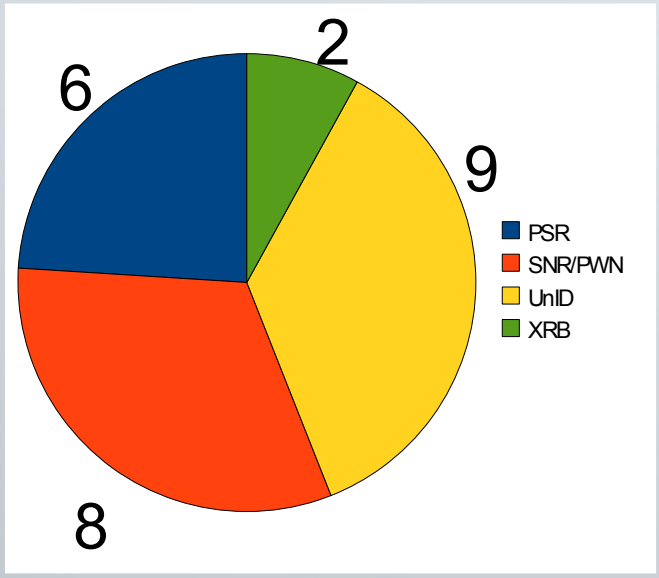
82 in total



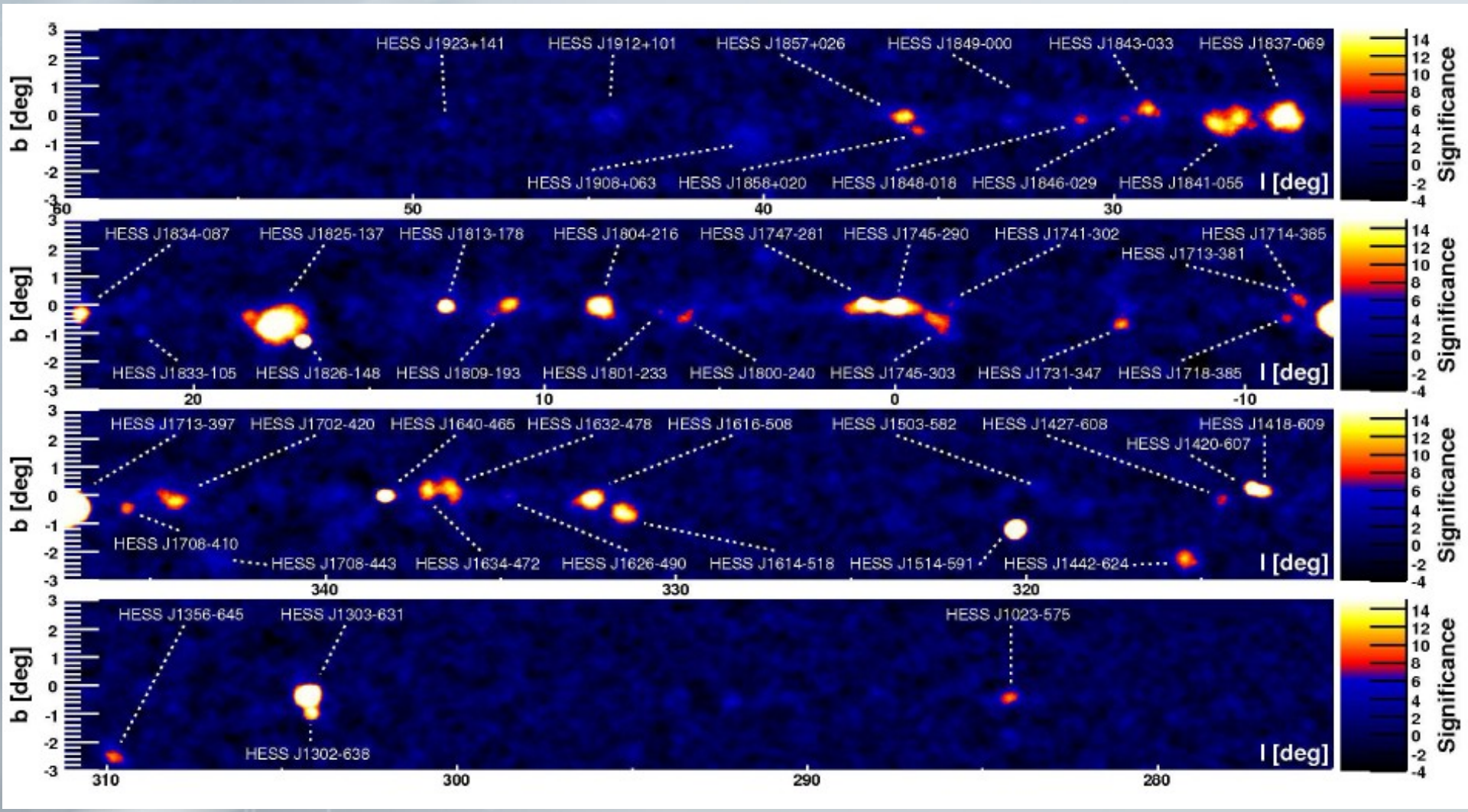
21 in total



26 in total

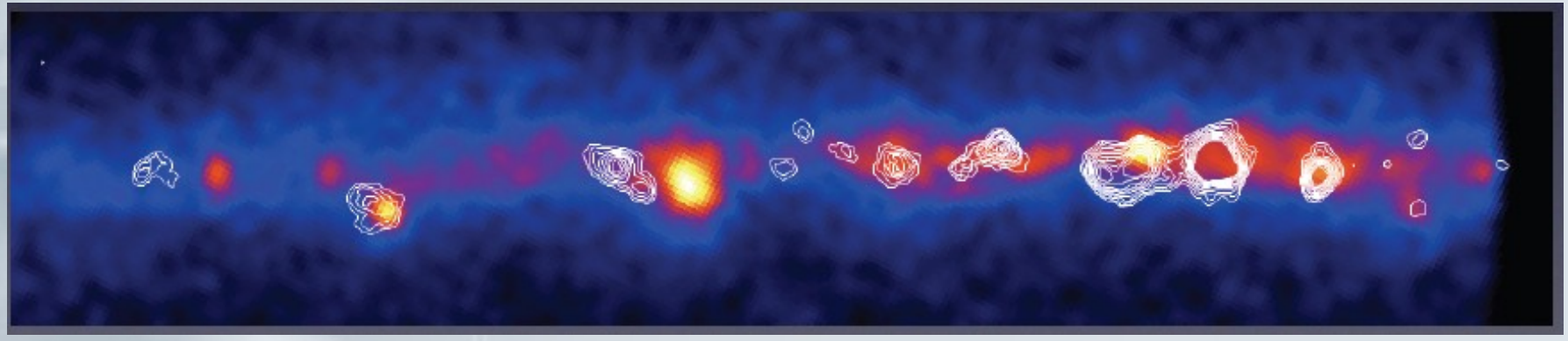


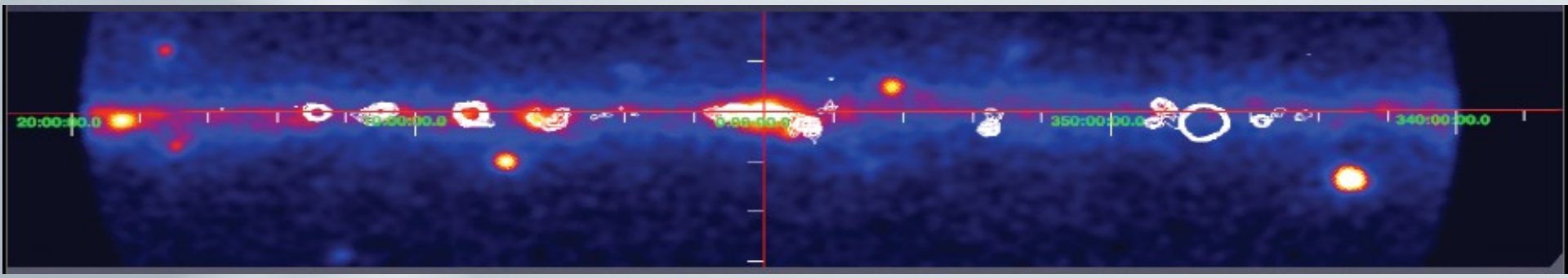
H.E.S.S. galactic plane survey (2003-2009)

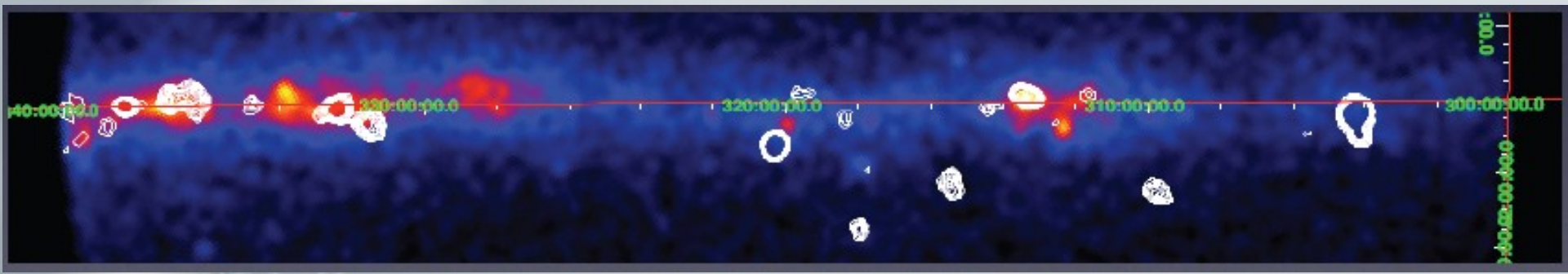


Chaves+ @ ICRC 2009

The Galaxy seen using LAT and H.E.S.S.







Inner Galaxy region ($l = -85^0 - 60^0$, $b = -3^0 - 3^0$)

- 41 Fermi bright sources in the above region
- 16 among them are coincident with a VHE source (21, if possibly-coincident cases are included)

LAT Source class	0FGL sources	spatially coincident cases[a]
pulsars	10	4
SNR/PWN candidates	11	6 (7)
Unidentified sources	19	5 (9)
Total[b]	41	16 (21)

[a] The numbers in brackets include slightly offset cases (P).
[b] including LS 5039

- ***cannot*** be a chance coincidence, opposed to Funk+ (08), a previous study using EGRET catalog

GeV-TeV SED construction: LAT

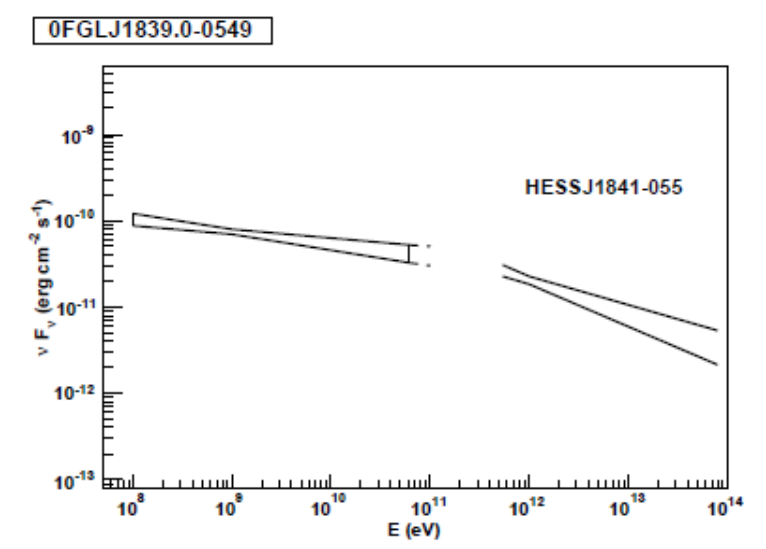
- The BSL paper provides photon flux values and errors in two energy bands: Low energy: 0.1-1 GeV (F_{23}, dF_{23}) and High energy 1-100 GeV (F_{35}, dF_{35})
- Assume single power-law, then

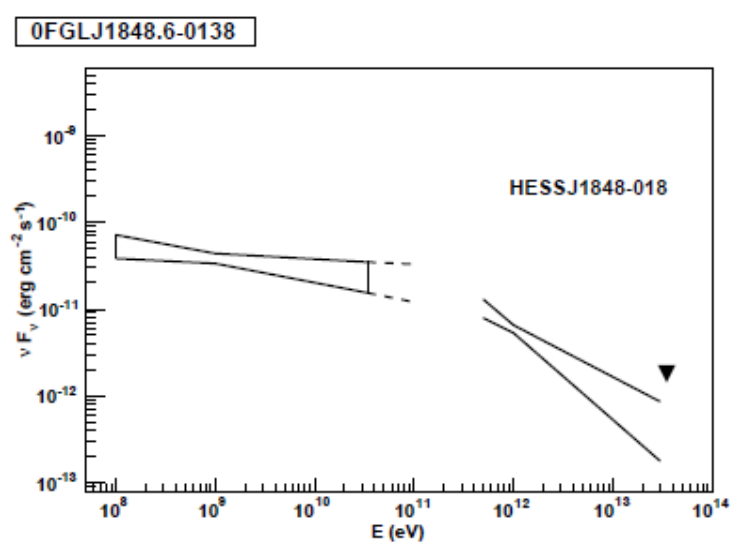
$$F_{23} = A \int_{0.1}^{1} E^{-\Gamma} dE \quad \ldots\ldots (1)$$

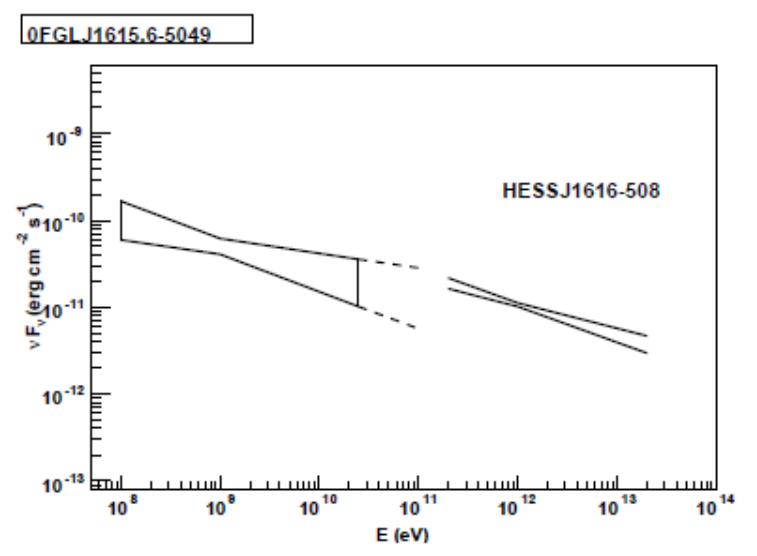
$$F_{35} = A \int_{1}^{100} E^{-\Gamma} dE \ldots\ldots (2)$$

- From F_{23} and F_{35}, A and Γ can be obtained
- Power-law spectra drawn from 0.1-100 GeV
- Errors in A and Γ (dA and $d\Gamma$) were obtained by error propagation
- Caveat: The power-law assumption is generally not valid, especially for pulsars

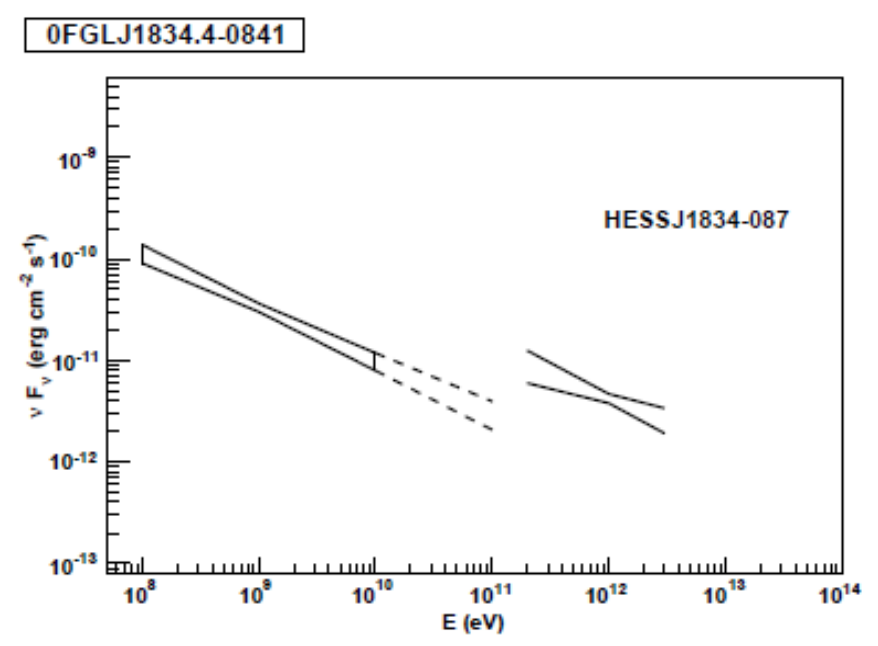
Looks like single component for most non-PSR sources

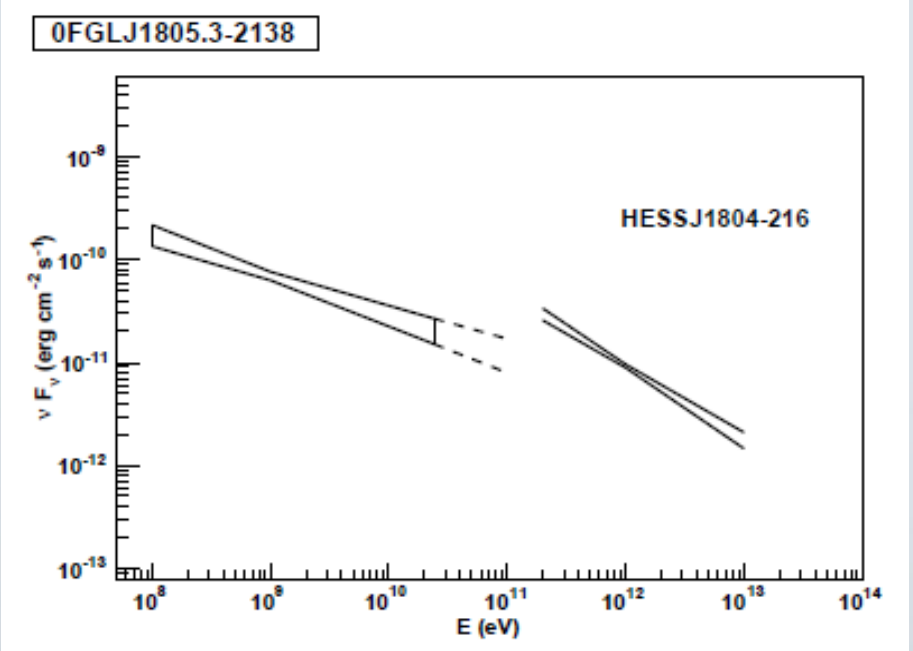




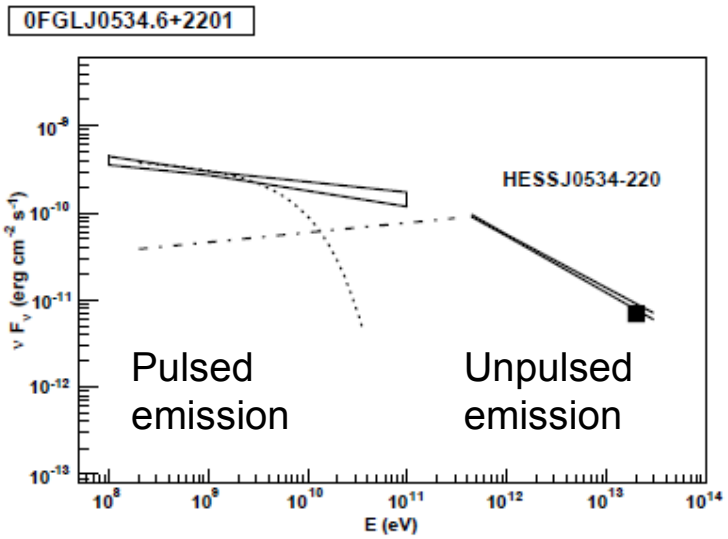


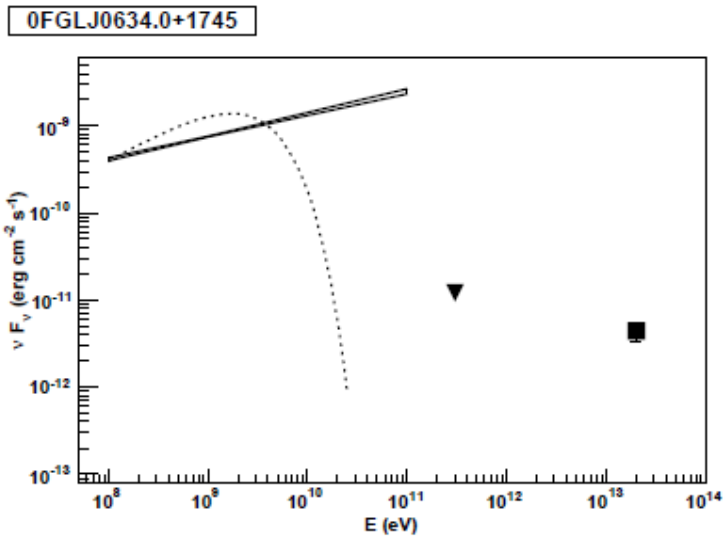
For a couple of sources it doesn't work..

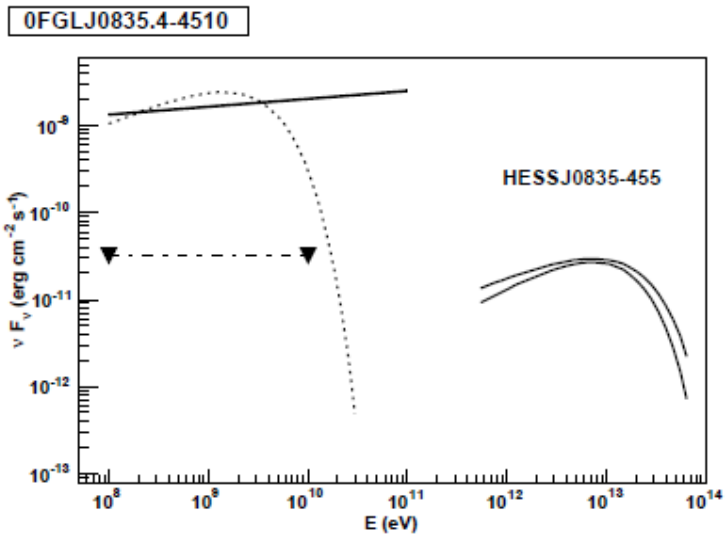


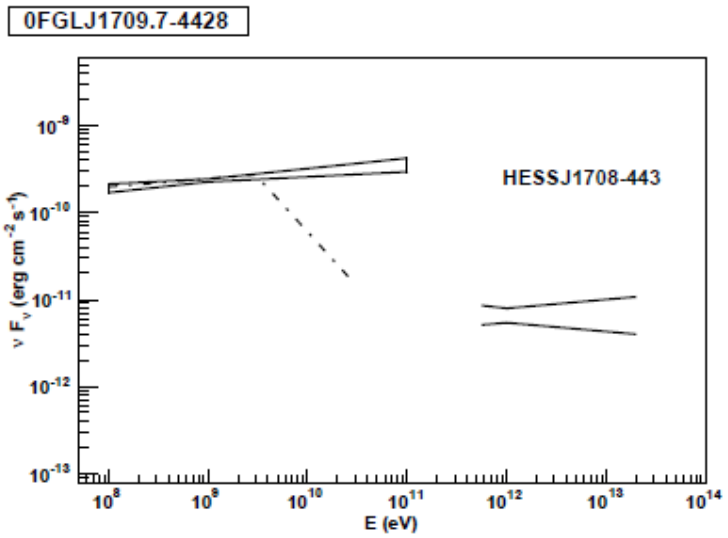


GeV pulsars and TeV pulsar wind nebulae









Conclusions

- A large number of coincidence cases seen between GeV/TeV galactic sources than a previous study using EGRET sources
- Boardband spectra from MeV and TeV are constructed for coincident sources
- A single spectral component is unable to describe some sources detected in both GeV and TeV energies. Two spectral components may be needed in these cases to accommodate some SEDs.
- There exists a common GeV/TeV source population: Gamma-ray pulsars and their TeV PWN, SNR, unidentified objects

Spared slides

GeV photon flux VS TeV photon flux