Galactic TeV Sources and GLAST

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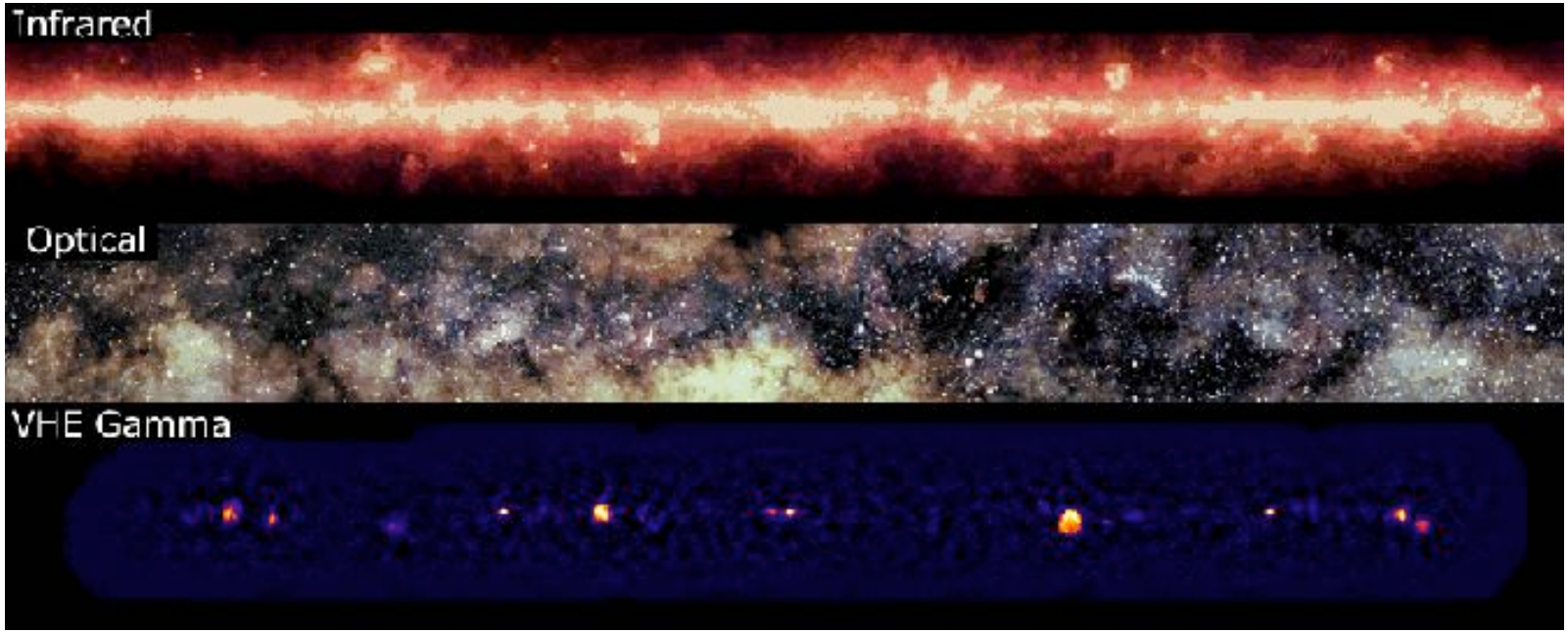
Stanford, 5 Feb 2007

Up to a few years ago had a TeV technique, but not an Astronomy...

- Theta-squared plots
- Hillas parameters
- Alpha distributions
- Significance tests.....

Now REAL Astronomy at TeV energies!

- Surveys and catalogues
- Images and maps
- Light curves
- Spectra



HESS Galactic plane survey

Astro-ph/0510397

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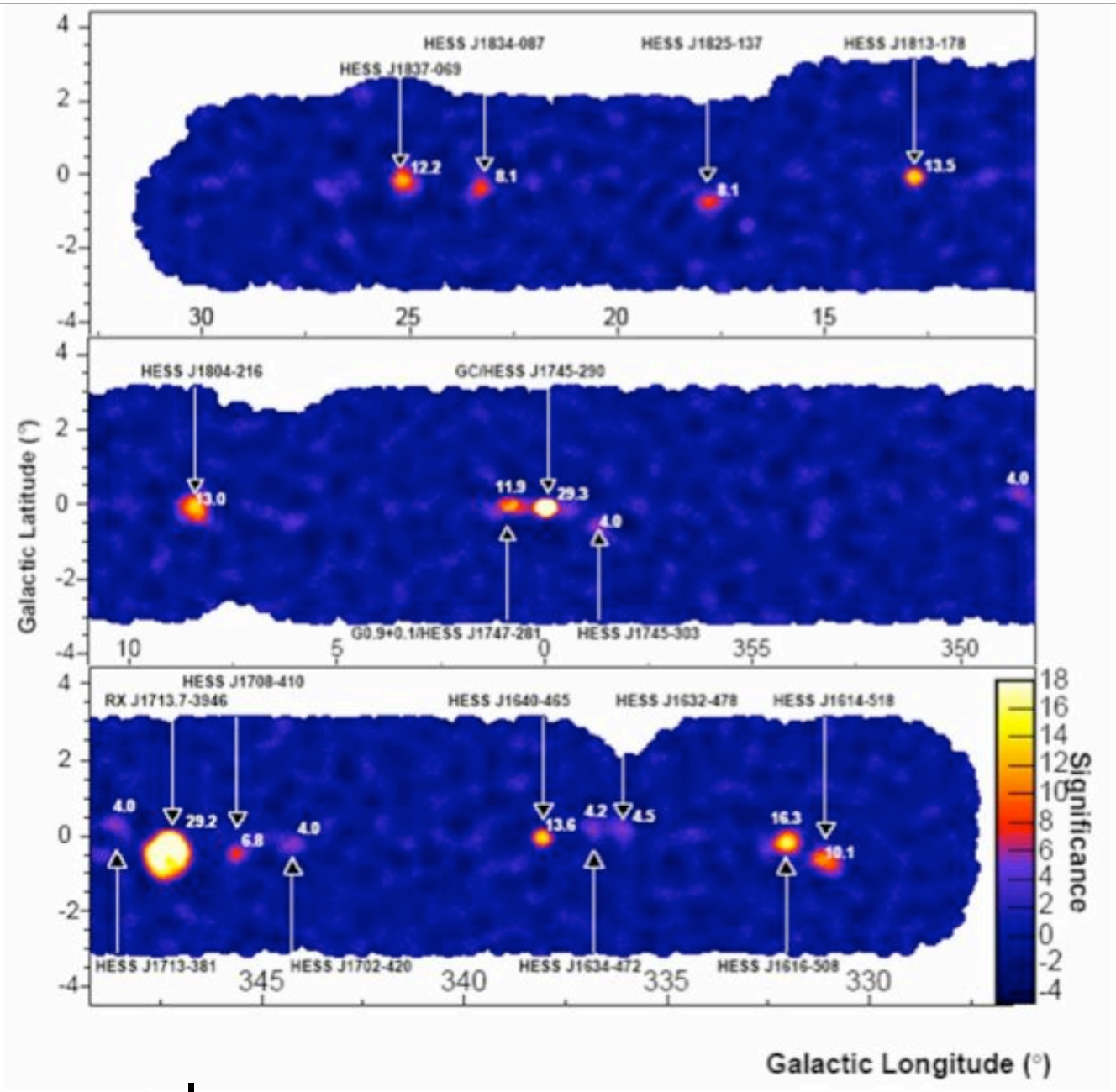

Source catalogue, HESS J1234-567 etc

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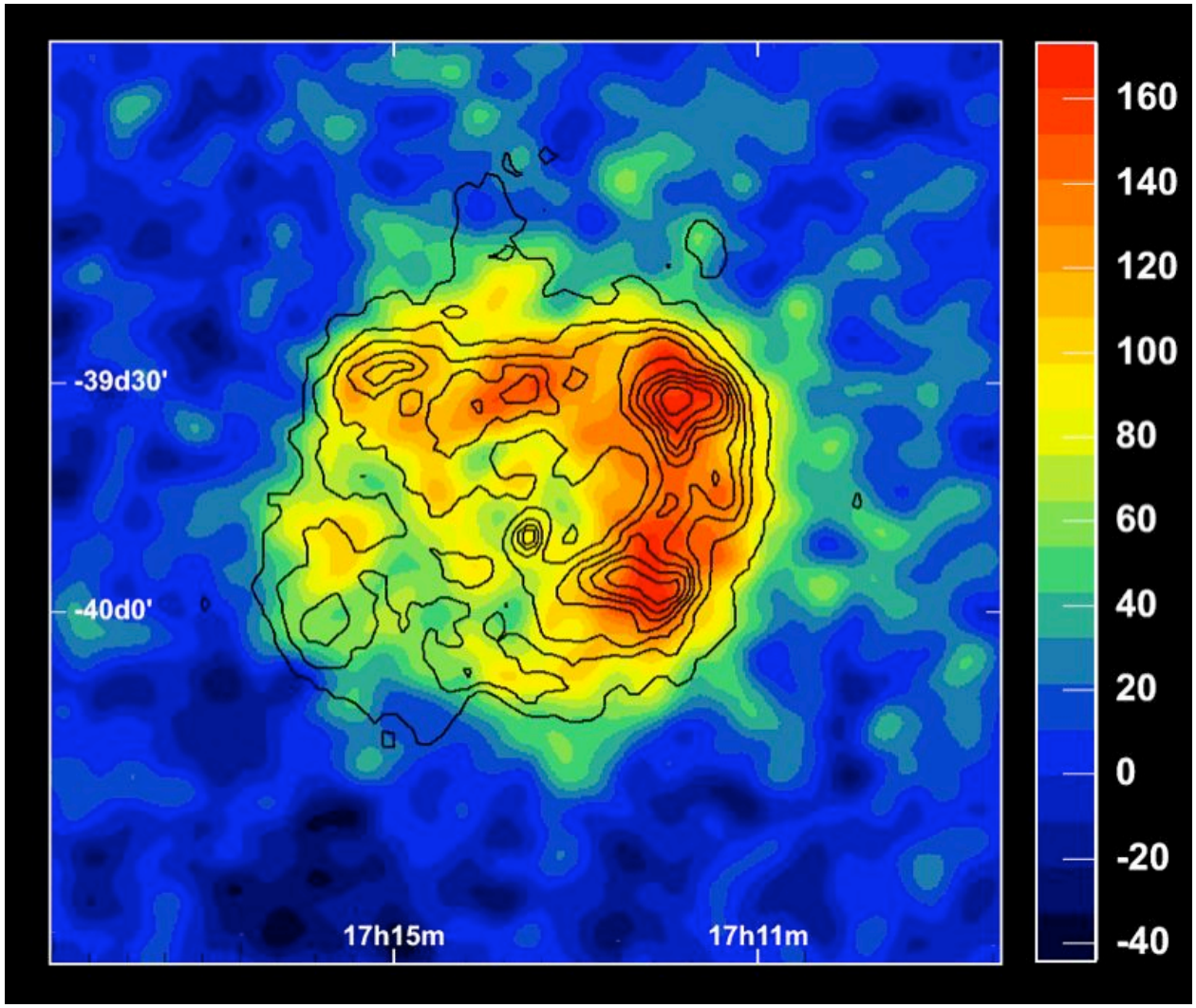

TeV Image of RX J 1713-3946 showing comparison with X-ray morphology

Nature **432** (2004) 75-77

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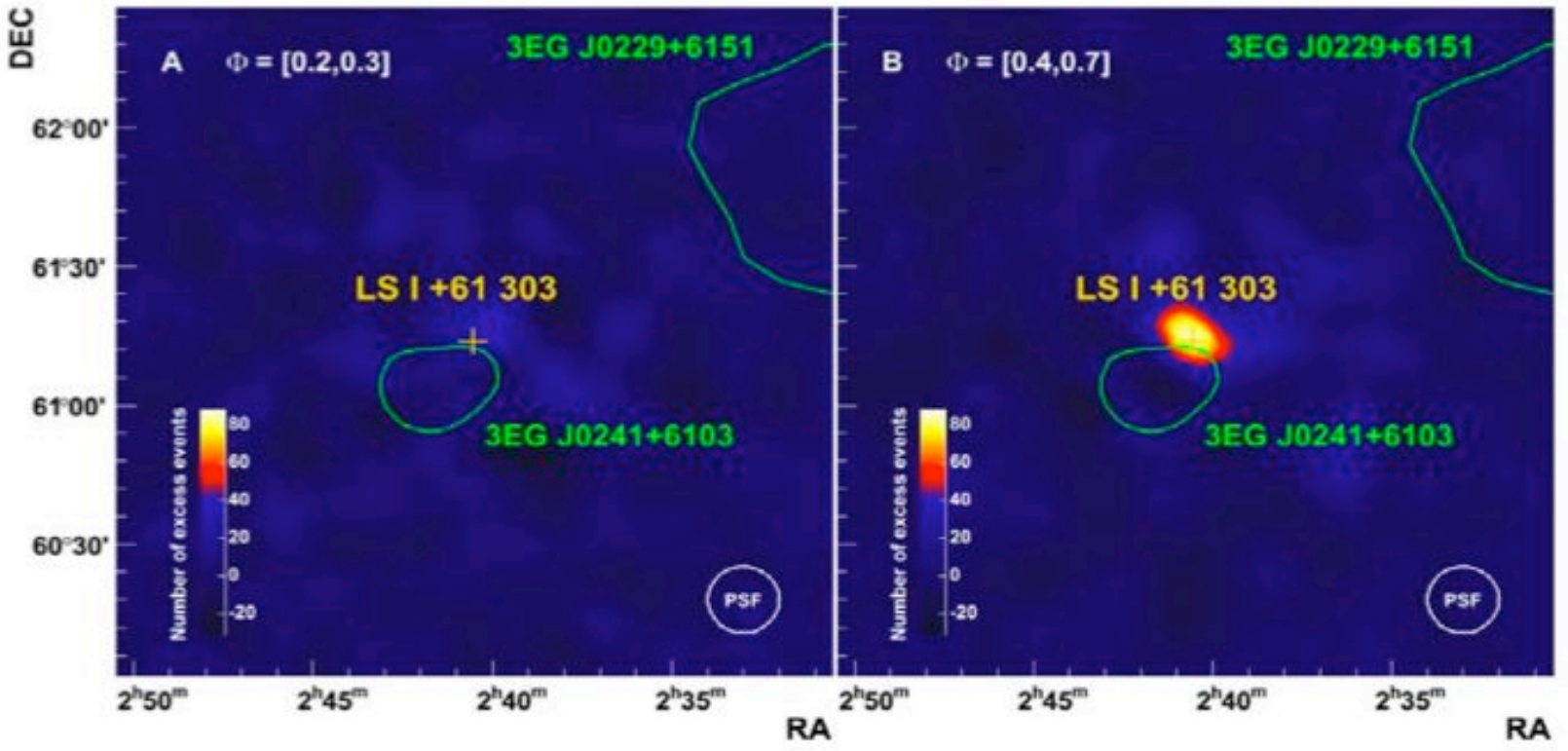
Periastron

Apastron



MAGIC images of LS I +61 303 showing time variability, astro-ph/0605549

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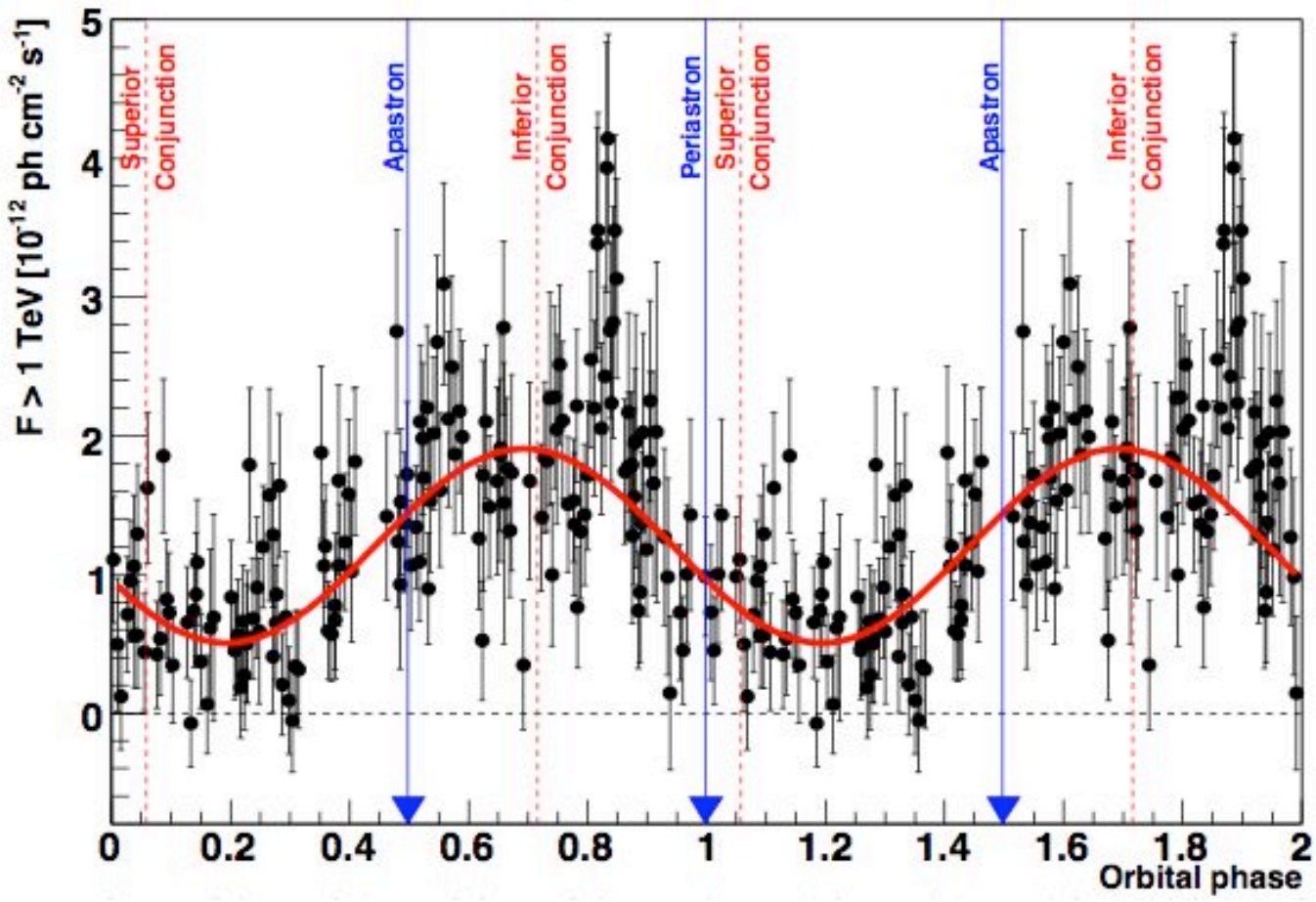

HESS TeV lightcurve of LS5039 showing orbital modulation - astro-ph/0607192

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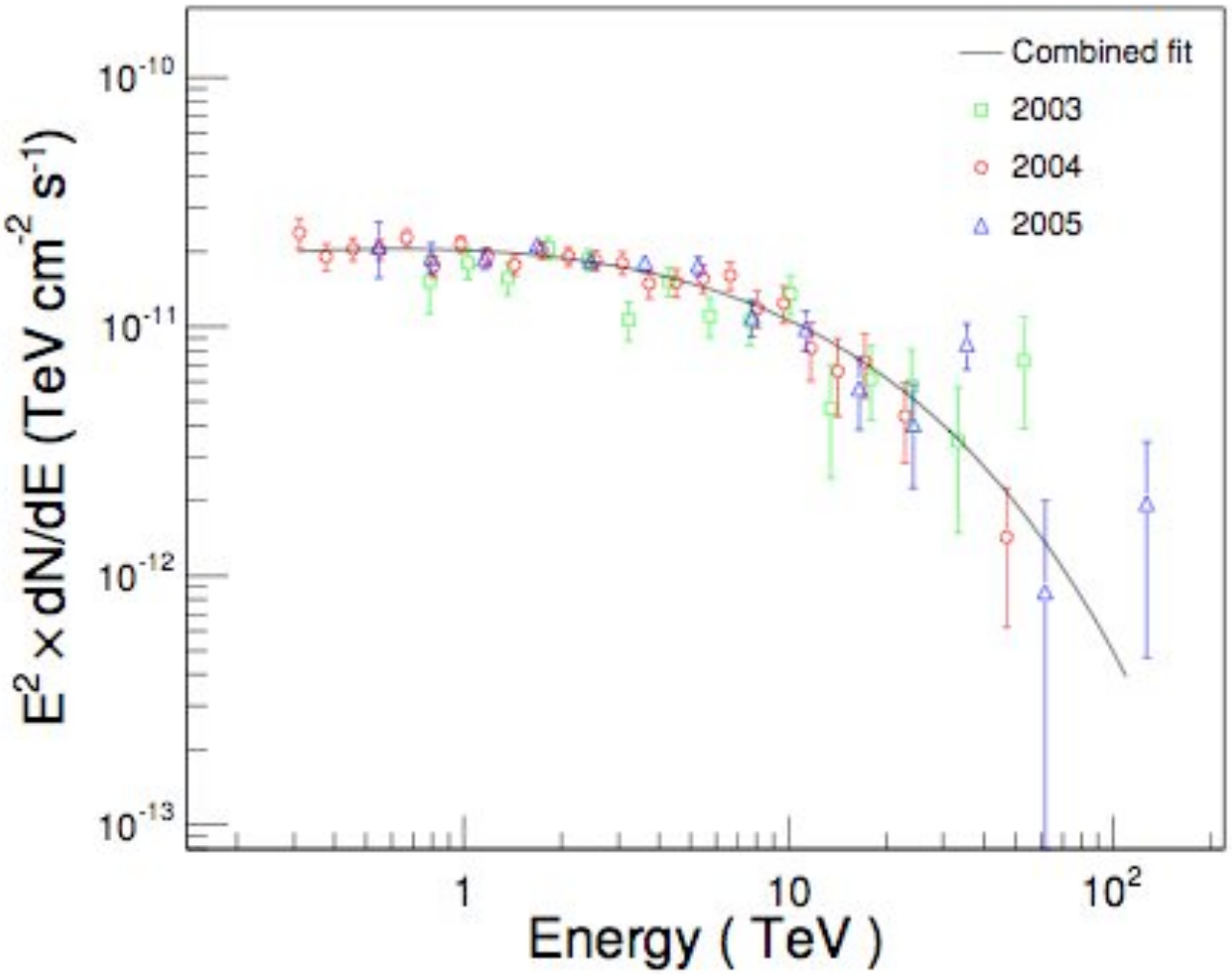

Energy spectrum of RX J1713-3946 showing hard spectrum with high-energy cut-off, astro-ph/0611813

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Galactic TeV Sources

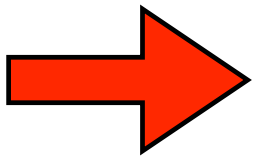
- Supernova Remnants (SNRs)
- Pulsars and PWNe
- Dark Accelerators
- Young Star clusters
- Microquasars
- Diffuse emission

Will not cover...

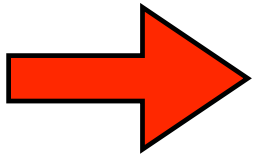
- Galactic centre
- Binary pulsar PSR B1259-63

Supernova Remnants

- Long suspected to be cosmic accelerators
- Prime drivers for design of HESS



P14.12 - Lemoine-Goumard, Marianne; Observations of the shell-type supernova remnants RX J1713.7-3946 and RX J0852.0-4622 with H.E.S.S.



P2.1 Gamma-Rays Produced in Cosmic-Ray Interactions and the TeV-band Spectrum of RX J1713-3946 - C. Huang

Astron. Astrophys. 287, 959–971 (1994)

ASTRONOMY
AND
ASTROPHYSICS

The gamma-ray visibility of supernova remnants. A test of cosmic ray origin

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Received 4 January 1993 / Accepted 17 November 1993

A detailed discussion of instrumental sensitivities and backgrounds shows that detection of SNRs in the $E_\gamma > 100\,\mathrm{MeV}$ band with, for example, the Energetic Gamma Ray Experiment Telescope (EGRET) will be difficult, but should not be impossible. However, and significantly, the prospects look much better in the TeV band accessible to modern imaging atmospheric Cherenkov telescopes. It should be possible to detect SNRs out to distances of several kpc if the region of the ISM into which they are expanding has a high enough density ($n > 0.1\,\mathrm{cm}^{-3}$) so that their γ-ray luminosity is high enough.

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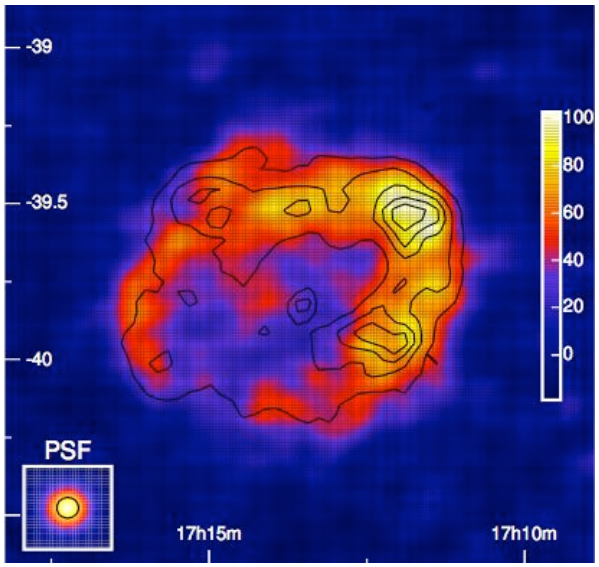
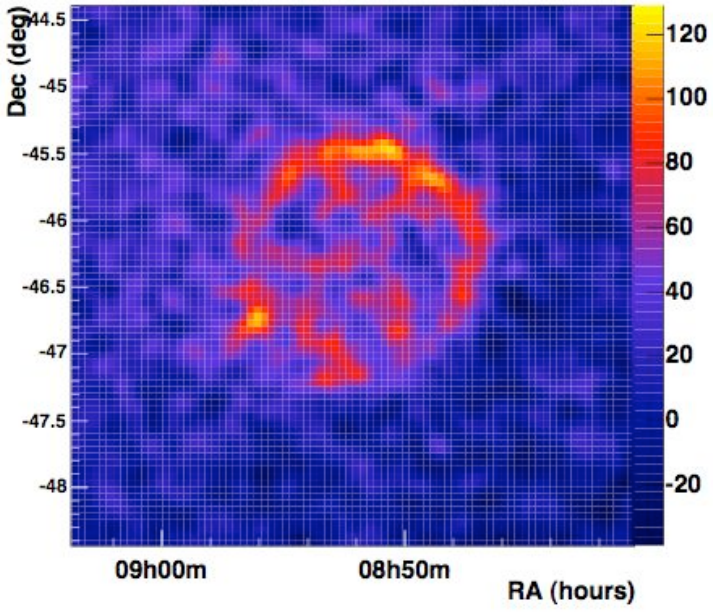
Thirteen years later!





Two well resolved shell-type SNRs in southern hemisphere. Other plausible identifications in HESS catalogue, also Cas-A in northern sky. Interesting differences, but need more objects to say much! But clear that particles are accelerated to at least 100TeV....

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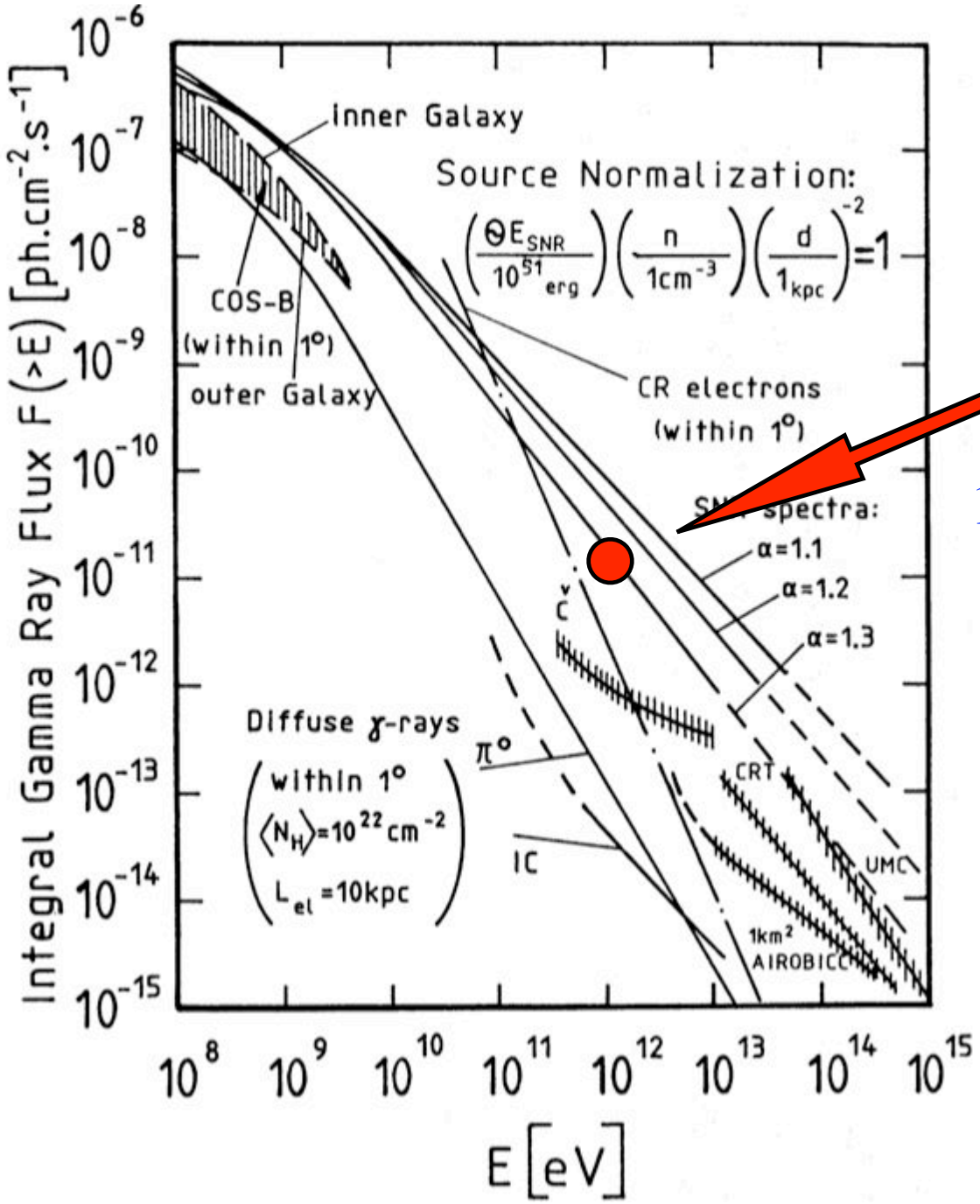

RXJ1713-3946

$1.5 \times 10^{-11}\, cm^{-2}\, s^{-1}$

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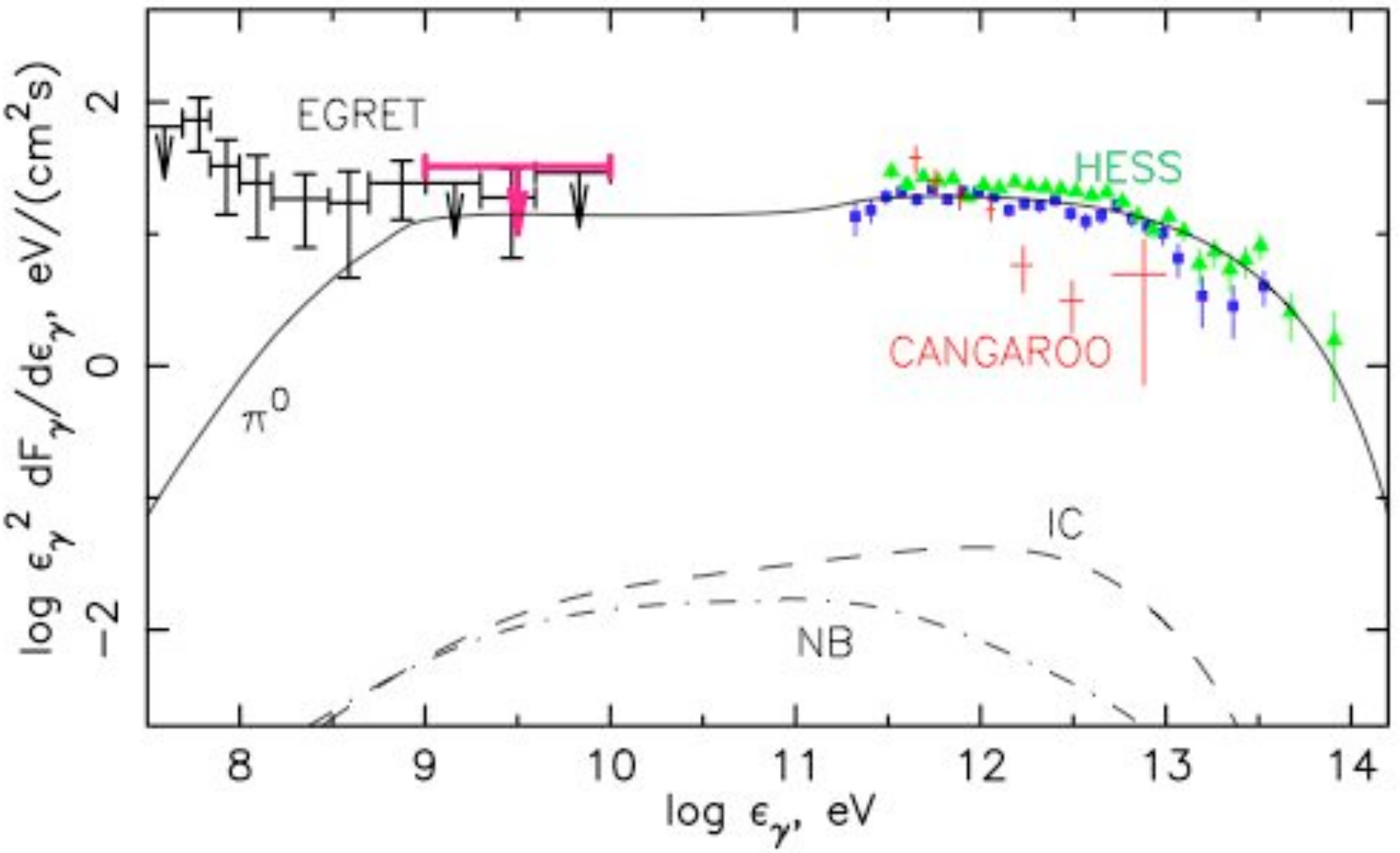

Theoretical fit by Berezhko and Völk to RXJ1713 spectrum; GLAST+TeV will be crucial to distinguish between leptonic and hadronic models! Note magnetic field amplification is essential for these models.

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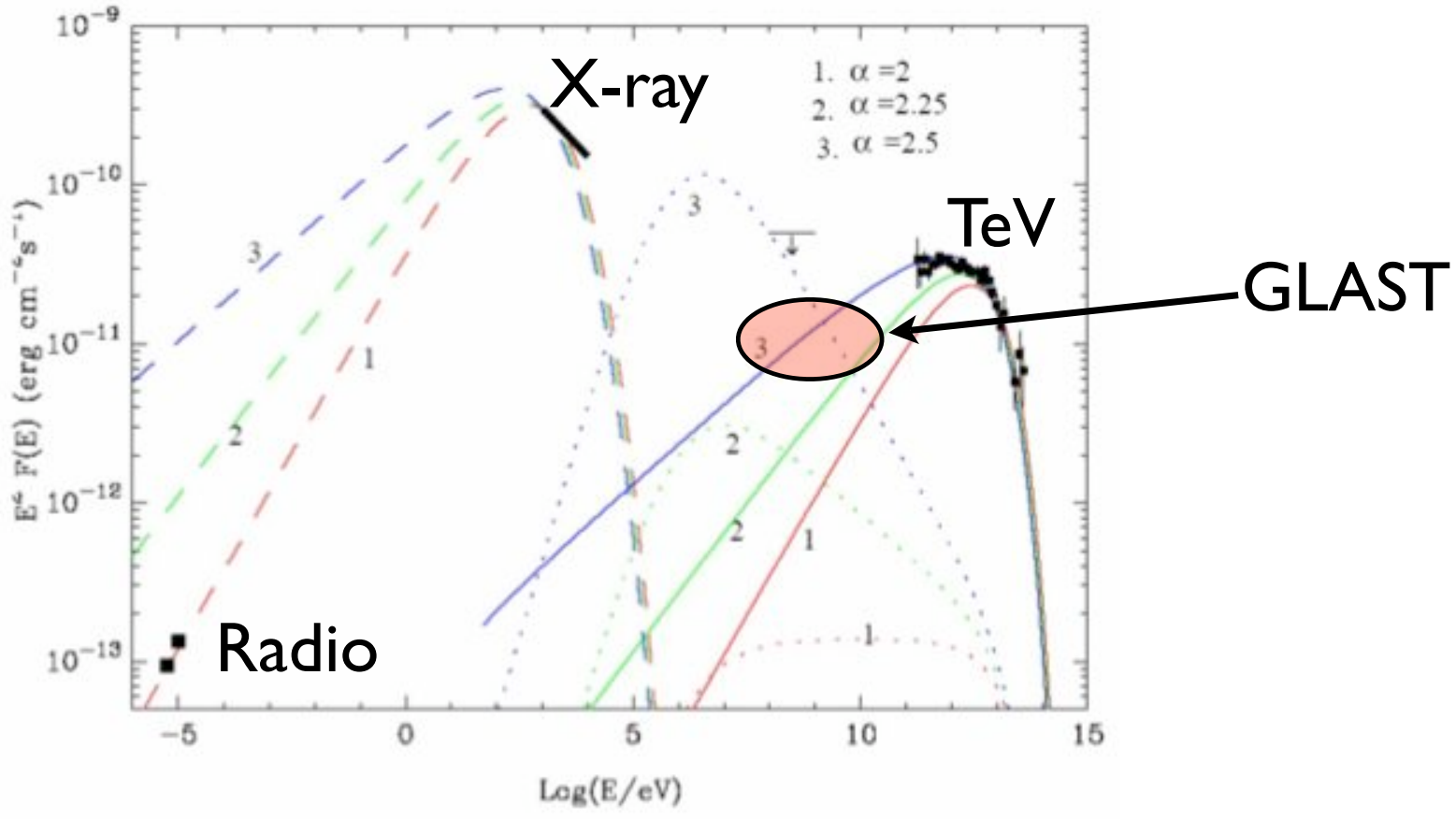
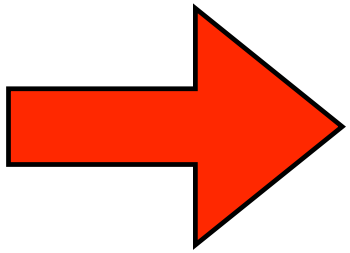


Simple one-zone leptonic models for RXJ1713 with different electron spectra (from W. Hofmann, Moscow review talk).

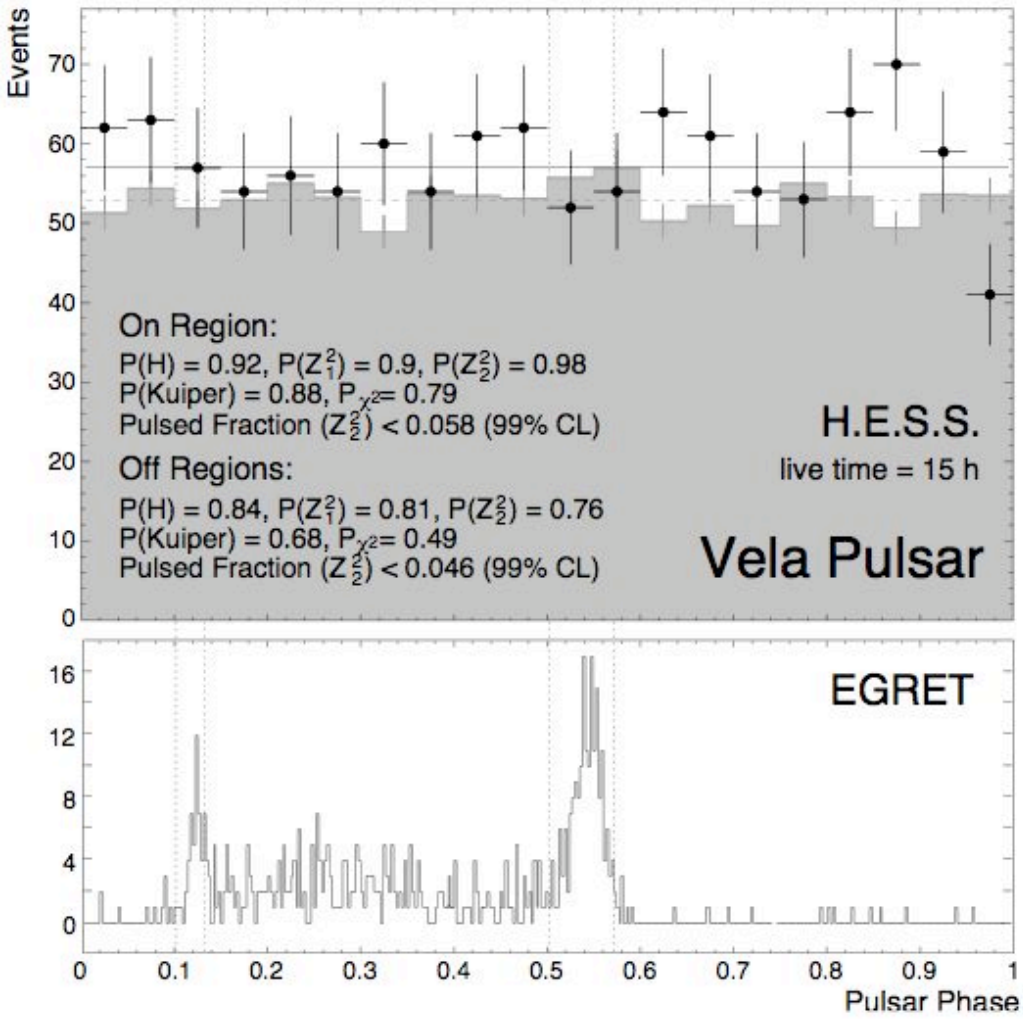
Pulsars and PWNe

- No pulsed emission detected at TeV - only upper limits so far.
- TeV surveys powerful tool to find PWNe (see talk by G. Pühlhofer on dark sources).
- Most PWNe appear to be offset from pulsar position.
- Evidence of spectral evolution in at least one PWN.



Sessions 4.1-4.4

P14.14 - Otte, Nepomuk; Pulsars and plerions observed with the MAGIC telescope



Search for pulsed emission from the Vela pulsar.
Major opportunity for GLAST.

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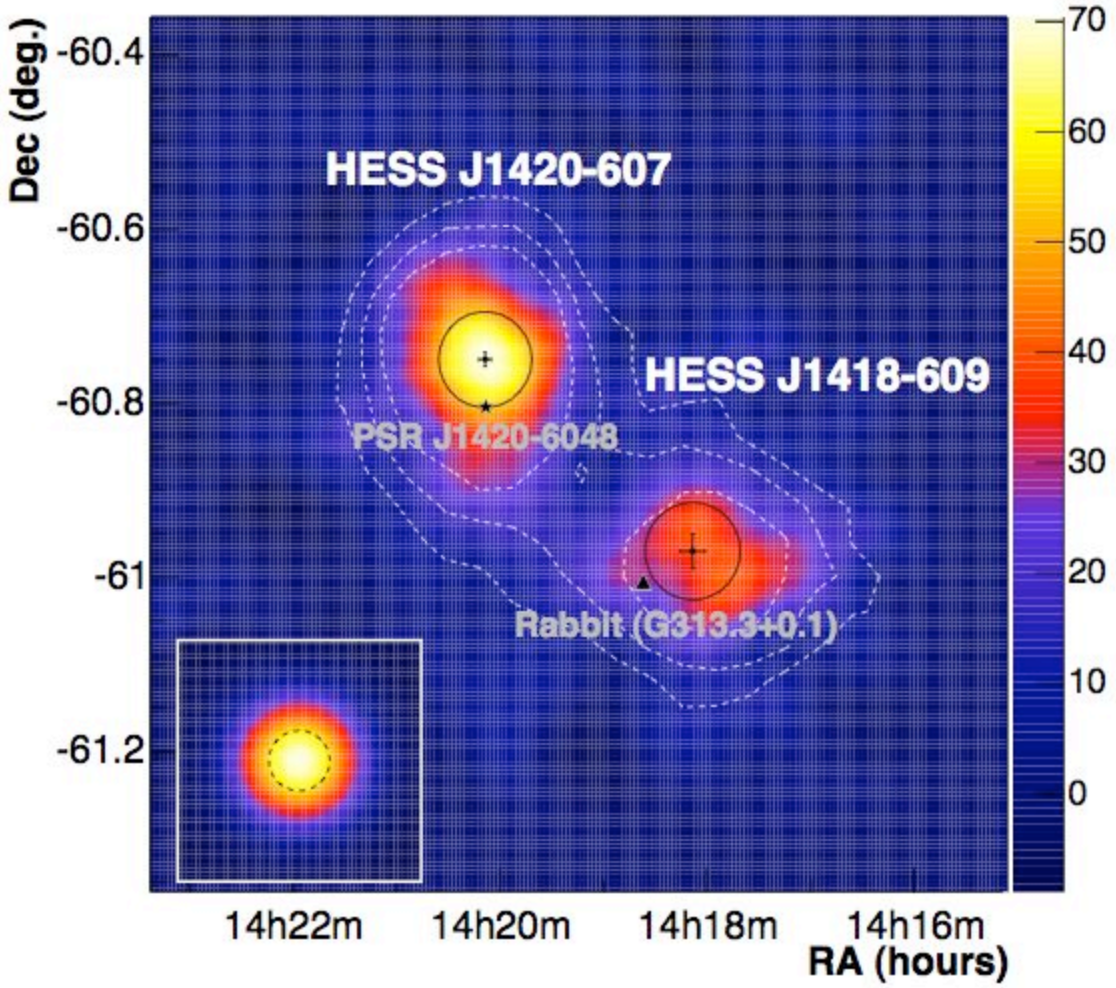

The "kookabura" region from astro-ph/0606311

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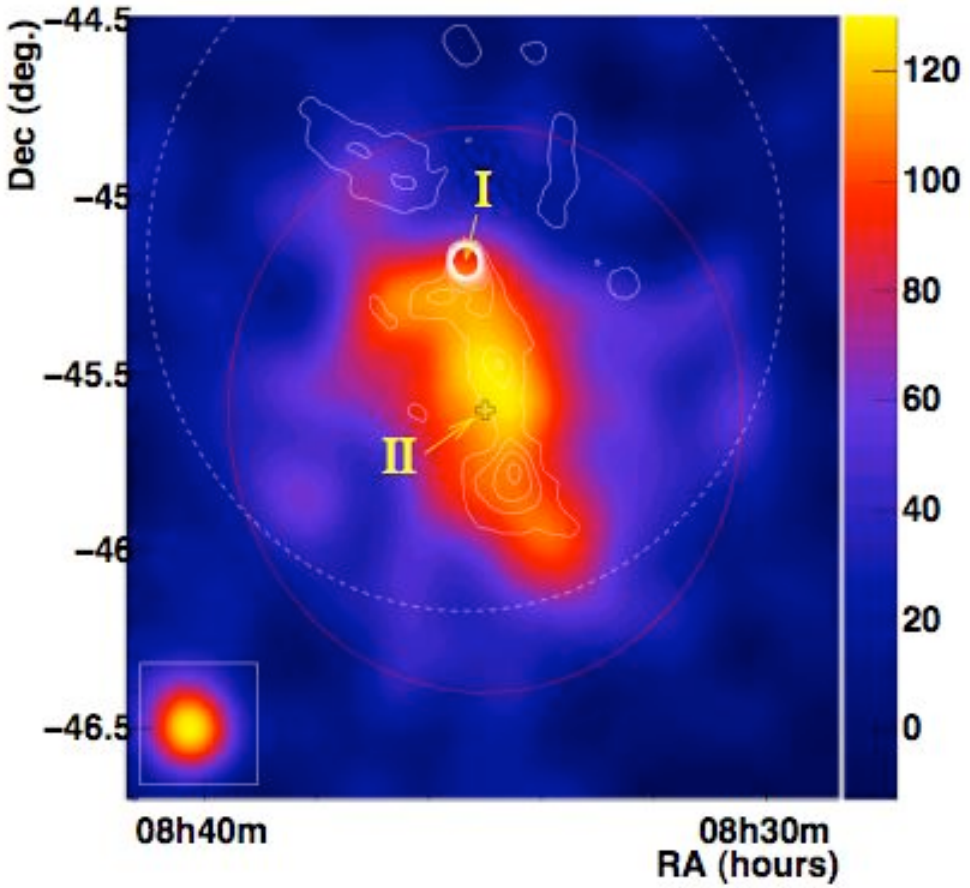

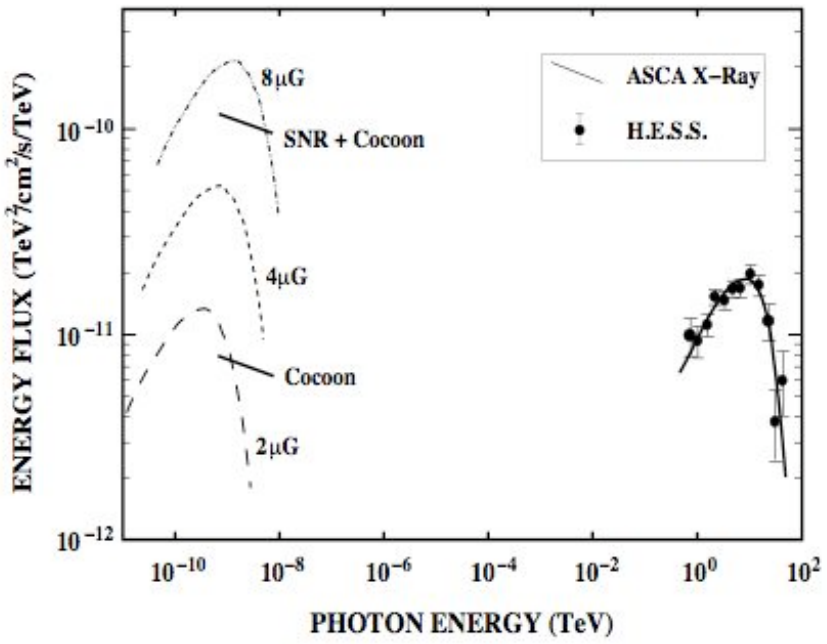

The VelaX pulsar nebula and spectrum - astro-ph/0601575

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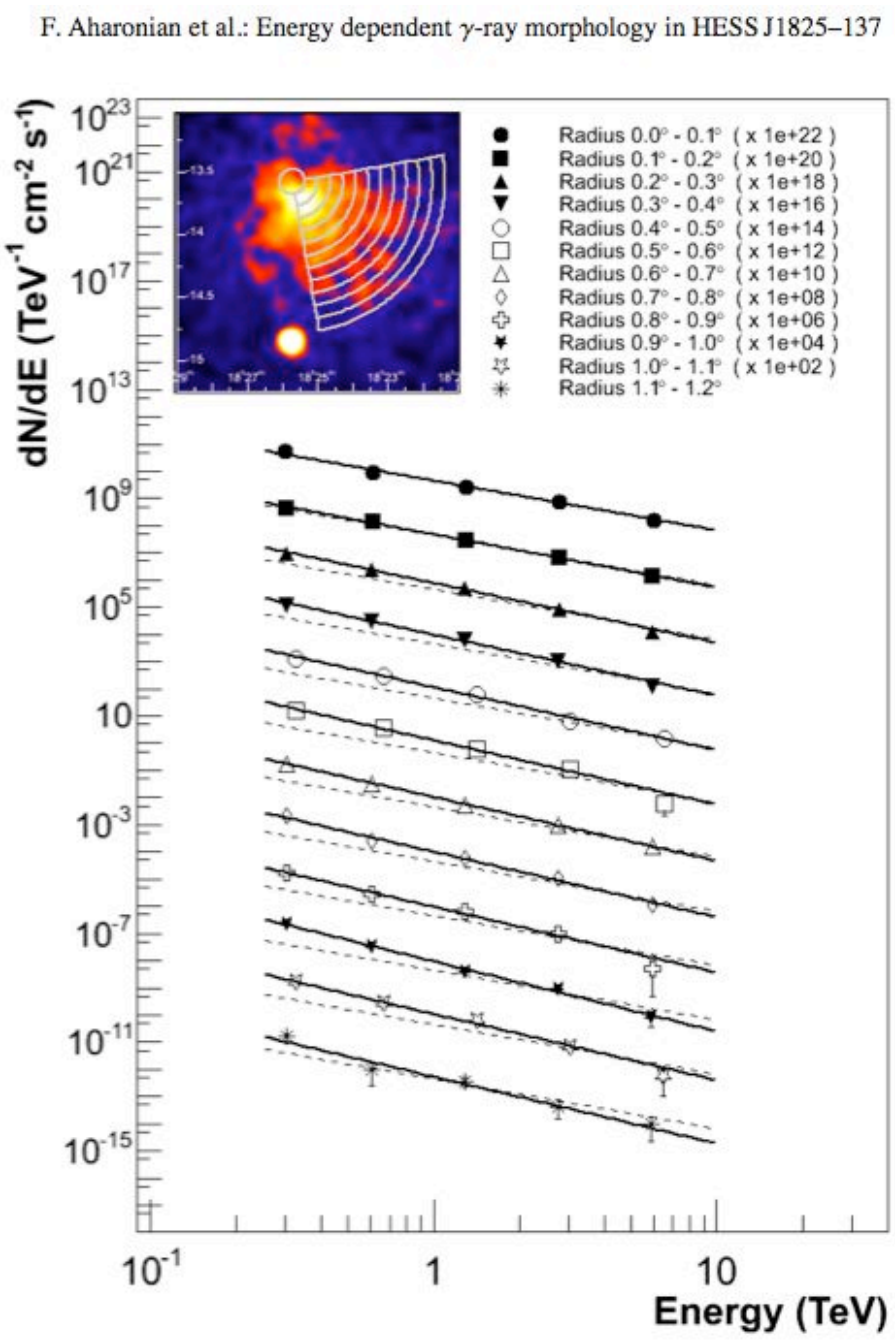

Spectrum softens as one moves away from the pulsar consistent with aging of the electron population. In principle this allows one to get a "fossil" record of the pulsar wind as a function of time....

astro-ph/0607548

P14.11 - Lemiere, Anne; Time dependent modeling of the archetypal middle-age gamma-ray PWN HESS J1825-137

P14.1 - Djannati-Atal, Arache; Relic electron glow in middle-aged pulsar wind nebulae: a new class of VHE sources revealed by HESS

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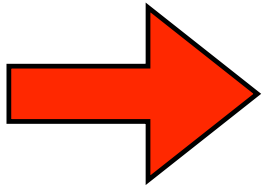
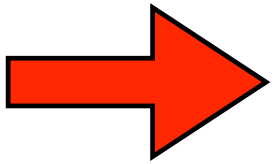
Dark Accelerators

- Unidentified sources in HESS survey
- No obvious X-ray or radio counterparts
- Extended sources (0.2')
- Obvious targets for GLAST!



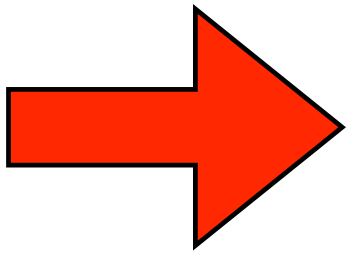
P7.3 How to unravel the nature of dark TeV gamma-ray sources - G. Pühlhofer



P7.7 X-ray observations of unidentified H.E.S.S. Gamma-ray sources - S. Funk

Young star clusters

- New source category
- Theoretically not unexpected, but
- Why so little radio synchrotron?



P4.4 HESSJ1023-575: Non-thermal Particle Acceleration Associated with a Young Stellar Cluster - O. Reimer

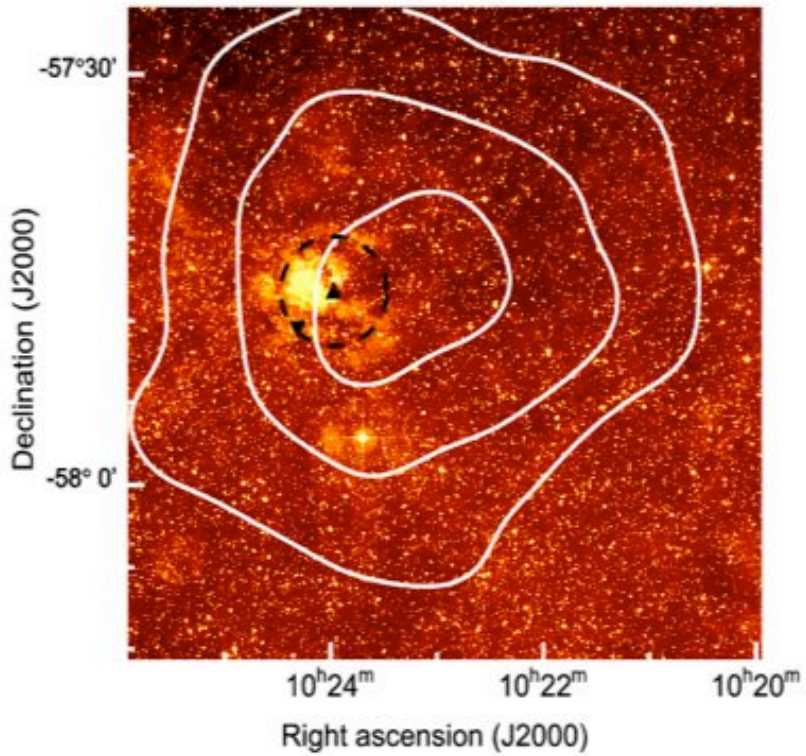


Fig. 4. HESS J1023–575 significance contours (corresponding 5, 7 and 9 σ), overlaid on a B-band image from the Second Palomar Observatory Sky Survey (POSS-2). The filled circle denotes the best fit position with 1σ statistical uncertainties. The WR binary WR 20a is indicated by an upright filled triangle in the Westerlund 2 stellar cluster (dashed circle), the reversed filled triangle denotes the location of WR 20b.

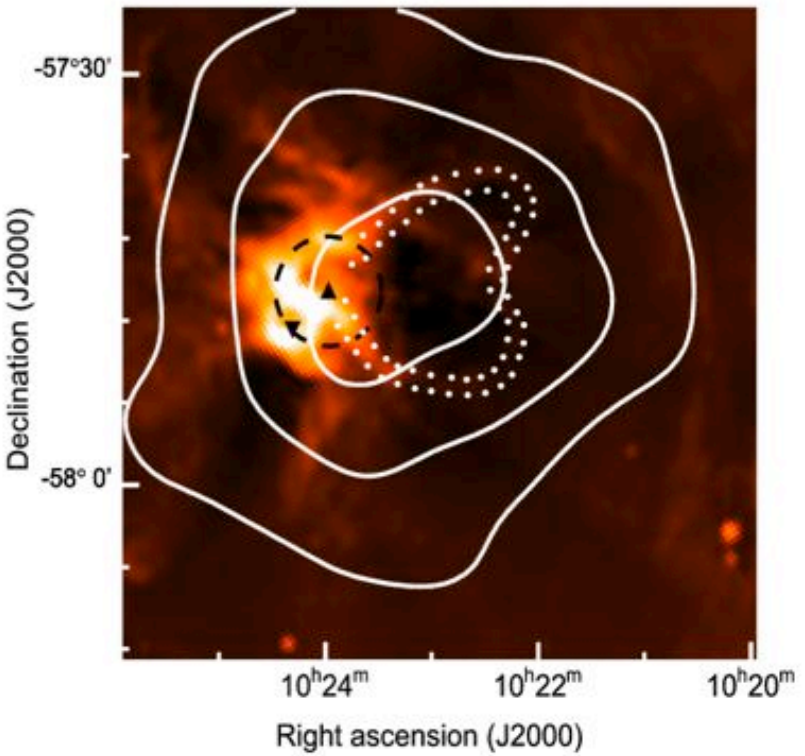


Fig. 5. HESS J1023–575 significance contours (corresponding 5, 7 and 9 σ), overlaid on a 843 MHz image from the Molonglo Observatory Synthesis Telescope (MOST). Black symbols and dashed circle as in Fig. 1. The wind-blown bubble around WR 20a, and the blister to the west of it are seen as depressions in the radio continuum map. The blister is indicated by white dots as in Whiteoak & Uchida (1997), and appears to be compatible in direction and location with the center of gravity of HESS J1023–575.

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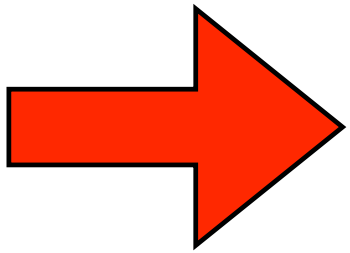
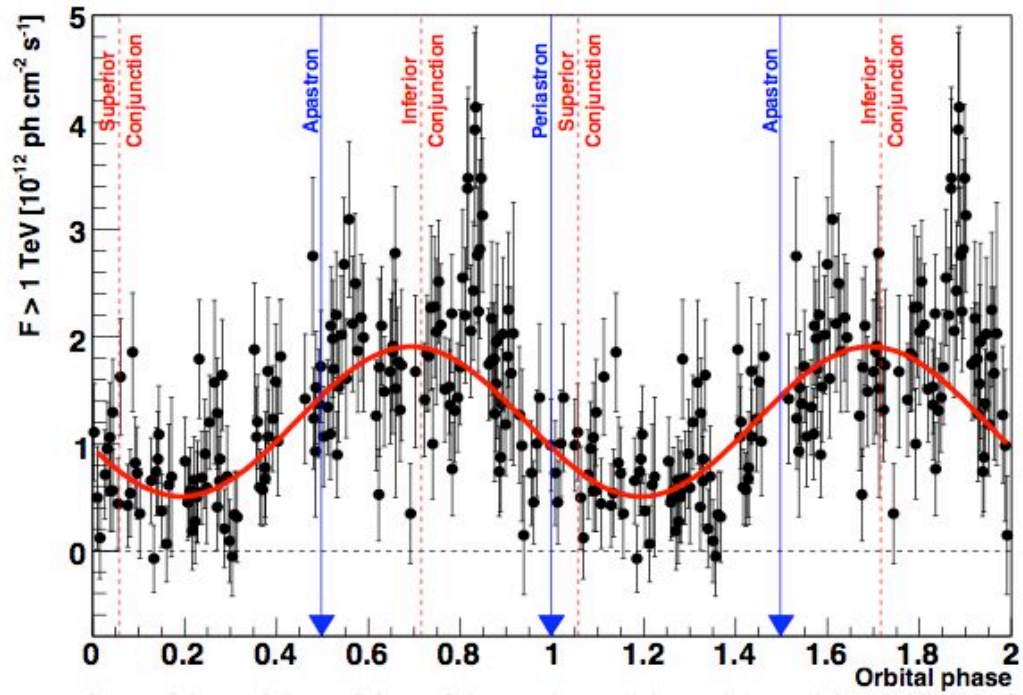
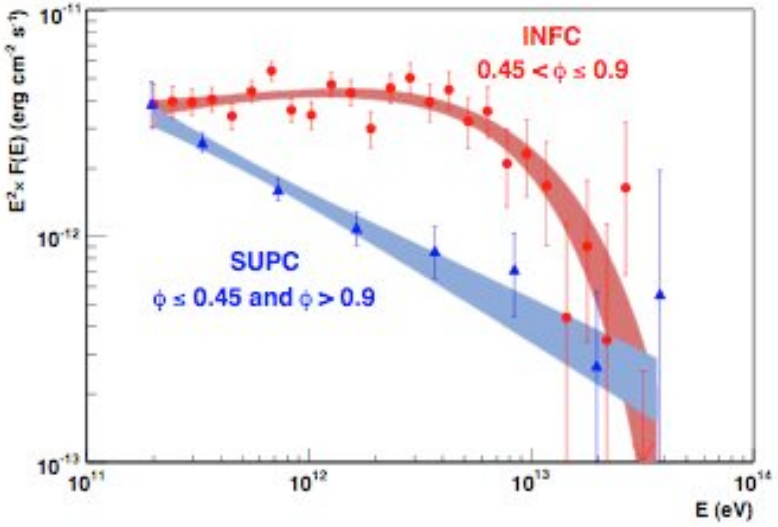
Microquasars

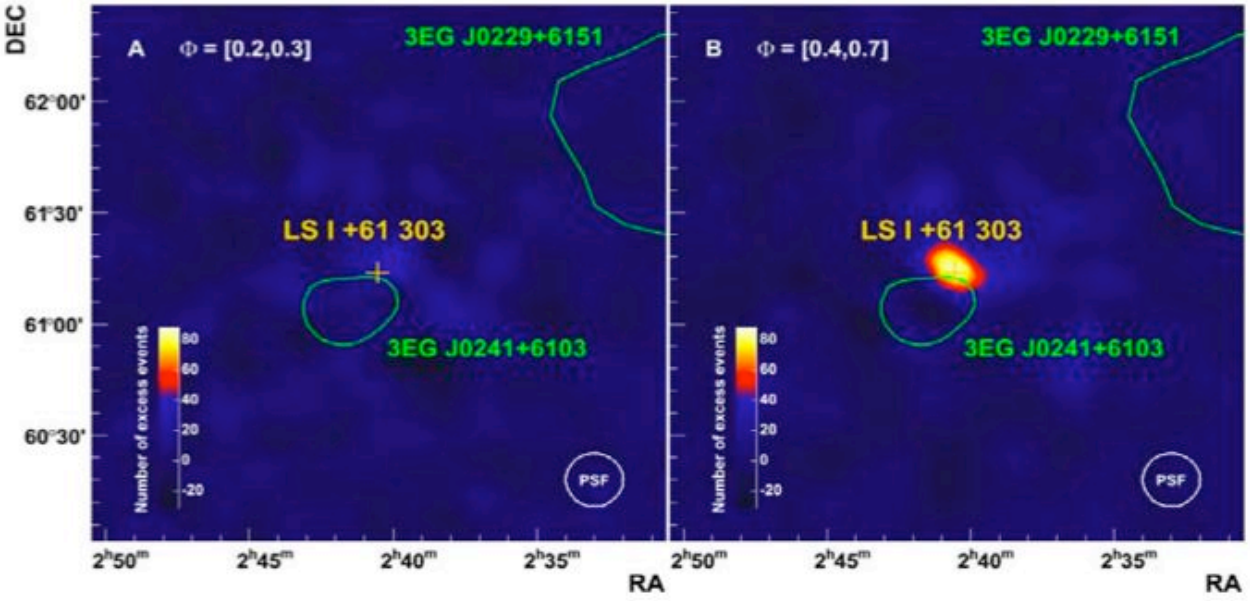
- Two HMXB seen at TeV energies; LS5039 (HESS) and LS I +61 (MAGIC).
- TeV can provide ephemerides for GLAST
- TeV/GeV comparison important for physics



4.7 Binaries, Microquasars, and GLAST - G. Dubus







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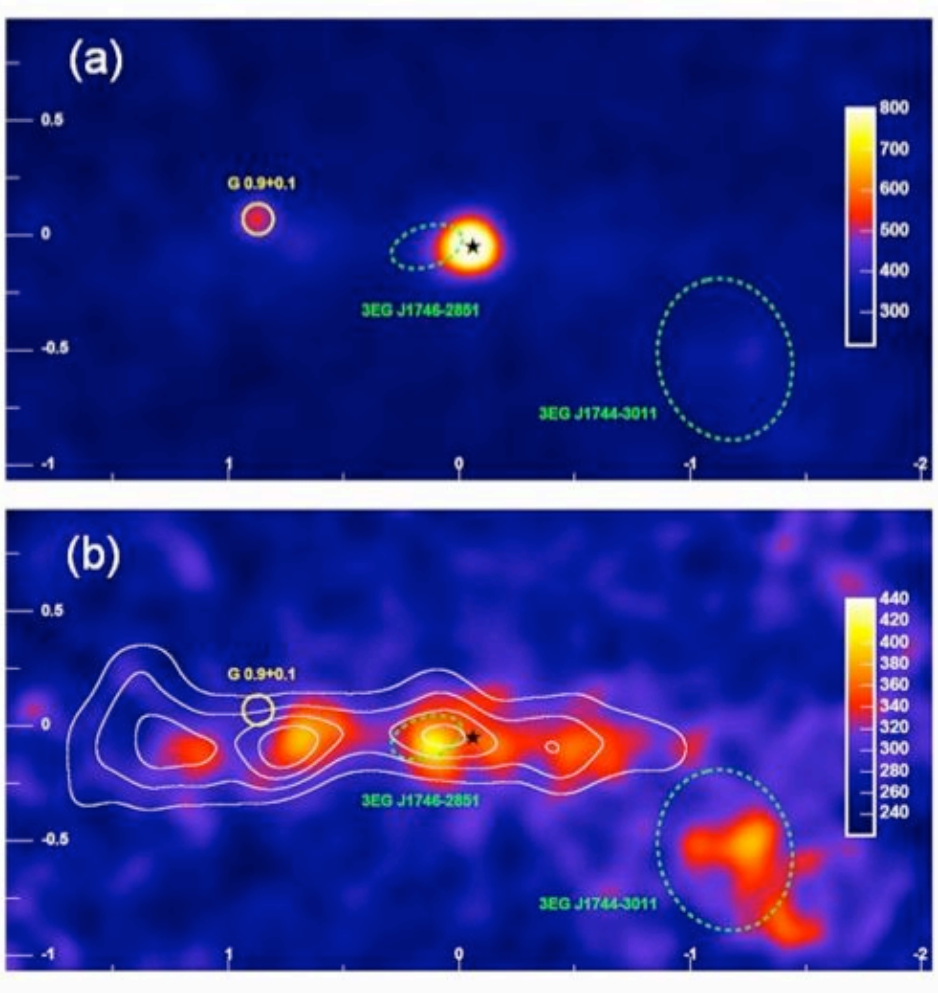
Diffuse emission

- Not easy for TeV telescopes.
- Ideal for GLAST!
- Very important for understanding distribution and propagation of cosmic rays.



Galactic centre region (a) and with point sources removed (b), from astro-ph/0603021

Nature **439** (2006) 695–698

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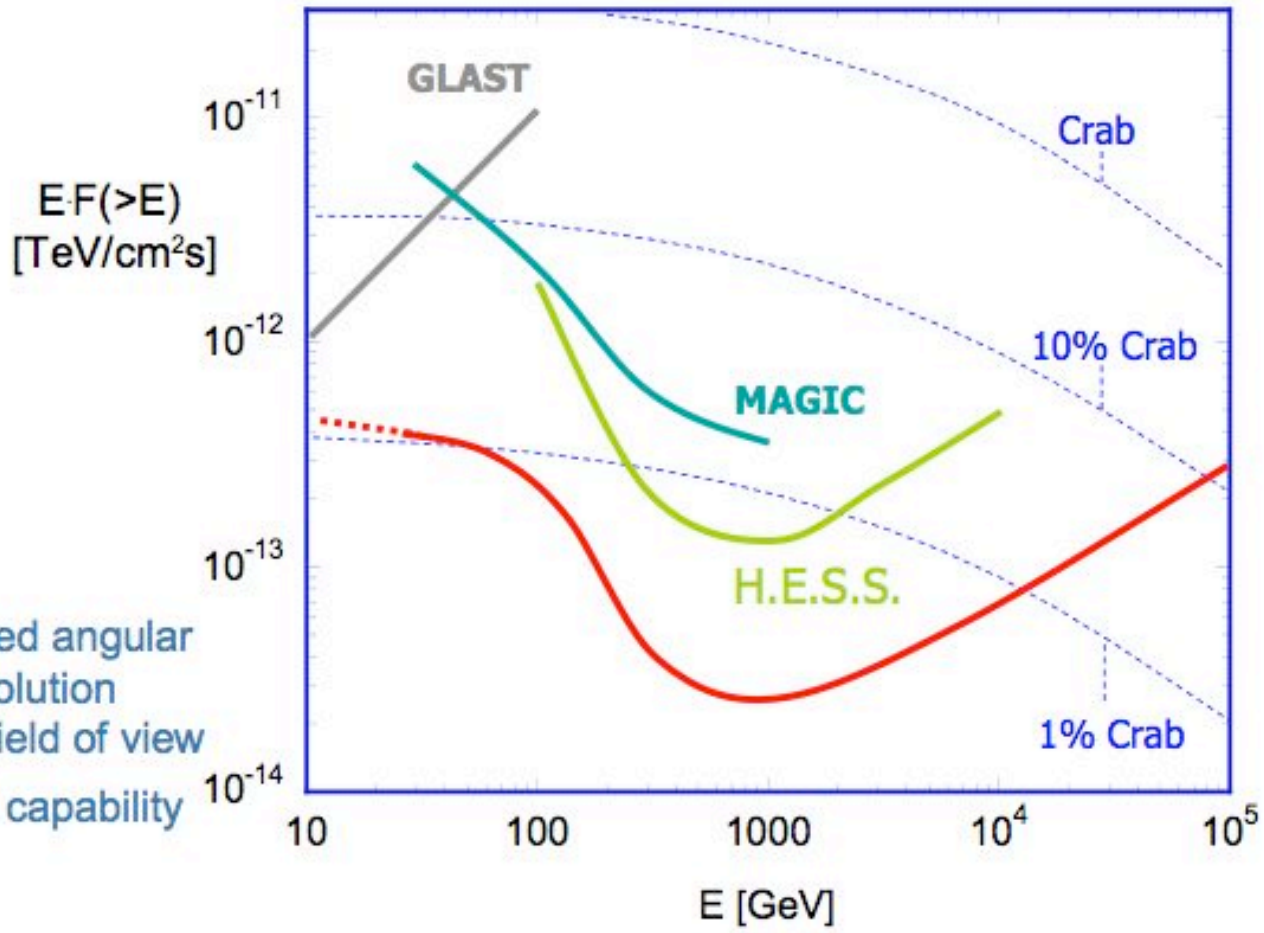
Conclusions

- Good complementarity between TeV ground-based observations and GLAST/LET
- The Galaxy is rich in high-energy gamma-ray sources - exciting prospects!
- Need cooperation agreements between GLAST and the various TeV communities.
- Need to start planning for a next-generation TeV observatory - eg CTA.

Sensitivity aimed for

An advanced Facility for ground-based gamma-ray Astronomy



+ Improved angular resolution
+ Large field of view
+ all-sky capability

+6 Parallel Talks

- P2.1 Gamma-Rays Produced in Cosmic-Ray Interactions and the TeV-band Spectrum of RX J1713-3946 - C. Huang
- P2.2 Survey of the Galactic Plane at 12 TeV with Milagro - C. Lansdell
- P4.4 HESSJ1023-575: Non-thermal Particle Acceleration Associated with a Young Stellar Cluster - O. Reimer
- P4.5 Discovery of a Pulsar Candidate Associated with TEV source HESS J1813-178 - E. Gotthelf
- P7.3 How to unravel the nature of dark TeV gamma-ray sources - G. Puehlhofer
- P7.7 X-ray observations of unidentified H.E.S.S. Gamma-ray sources - S. Funk

+14 Posters

- P13.1 - Funk, Stefan; The connection between the LAT and VHE gamma-ray instruments
- P13.3 - Kieda, David B.; GeV/TeV source population statistics extrapolated from the HESS galactic plane survey
- P13.5 - Walker, Gary P.; A milagro sky survey optimized for soft-spectrum sources
- P14.1 - Djannati-Atal, Arache; Relic electron glow in middle-aged pulsar wind nebulae: a new class of VHE sources revealed by HESS
- P14.6 - Funk, Stefan; Future GLAST observations of Supernova remnants and Pulsar Wind Nebulae
- P14.11 - Lemiere, Anne; Time dependent modeling of the archetypal middle-age gamma-ray PWN HESS J1825-137
- P14.12 - Lemoine-Goumard, Marianne; Observations of the shell-type supernova remnants RX J1713.7-3946 and RX J0852.0-4622 with H.E.S.S.
- P14.14 - Otte, Nepomuk; Pulsars and plerions observed with the MAGIC telescope
- P14.28 - Boettcher, Markus; Implications of the VHE gamma-ray spectral variability of LS 5039
- P14.29 - Butt, Yousaf M;. A radio shell counterpart of TeV J2032+4130?
- P15.2 - Dingus, Brenda L.; HAWC (High Altitude Water Cherenkov) obervatory for surveying the TeV sky
- P16.3 - Bastieri, Denis; MAGIC upper limits on the high energy emission from GRBs
- P17.3 - Grasso, Dario; TeV gamma-ray and neutrino diffused emission from the galaxy
- P18.6 - Stark Schneebeli, Luisa Sabrina; Indirect dark matter search with the MAGIC telescope

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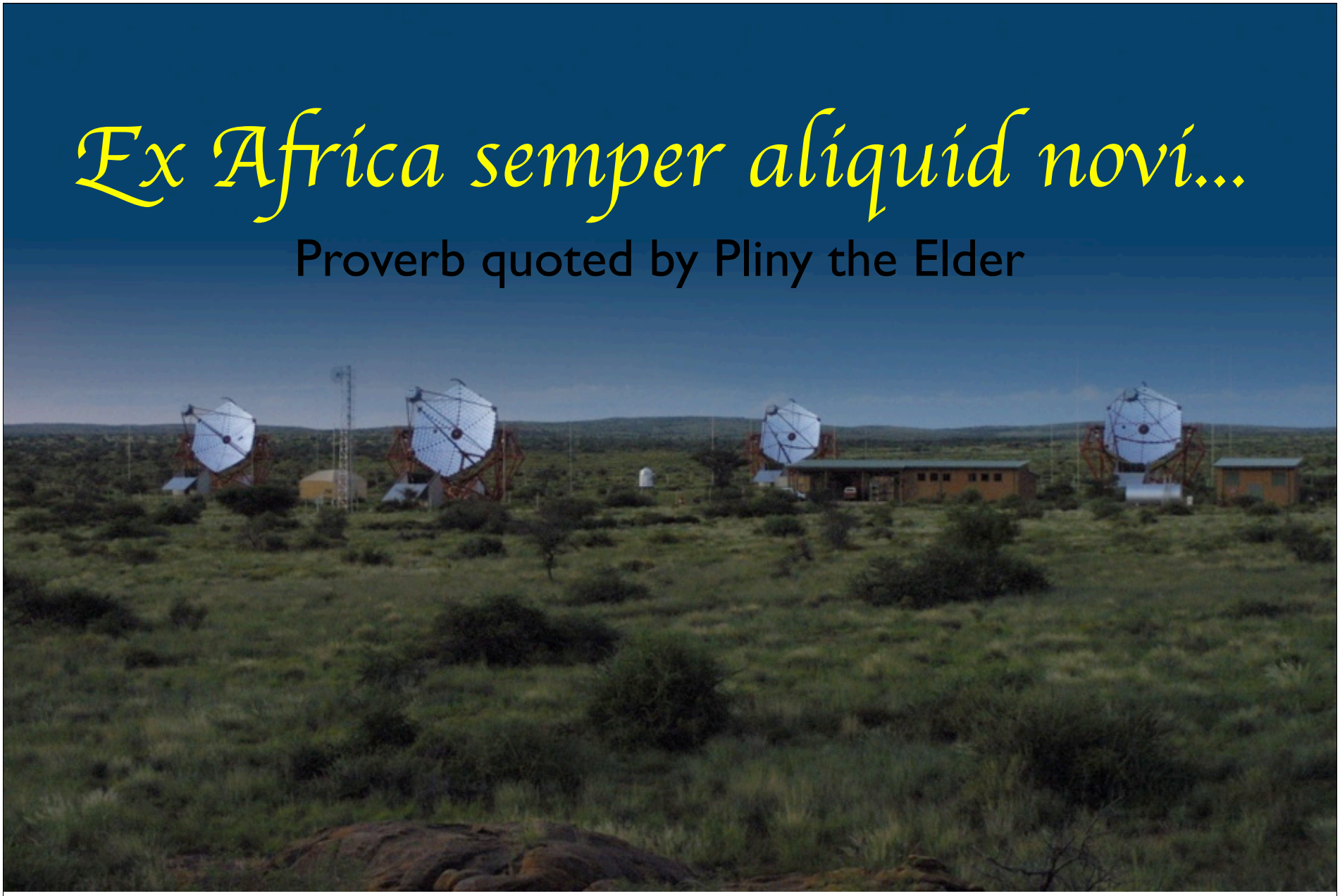
Ex Africa semper aliquid novi...

Proverb quoted by Pliny the Elder



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