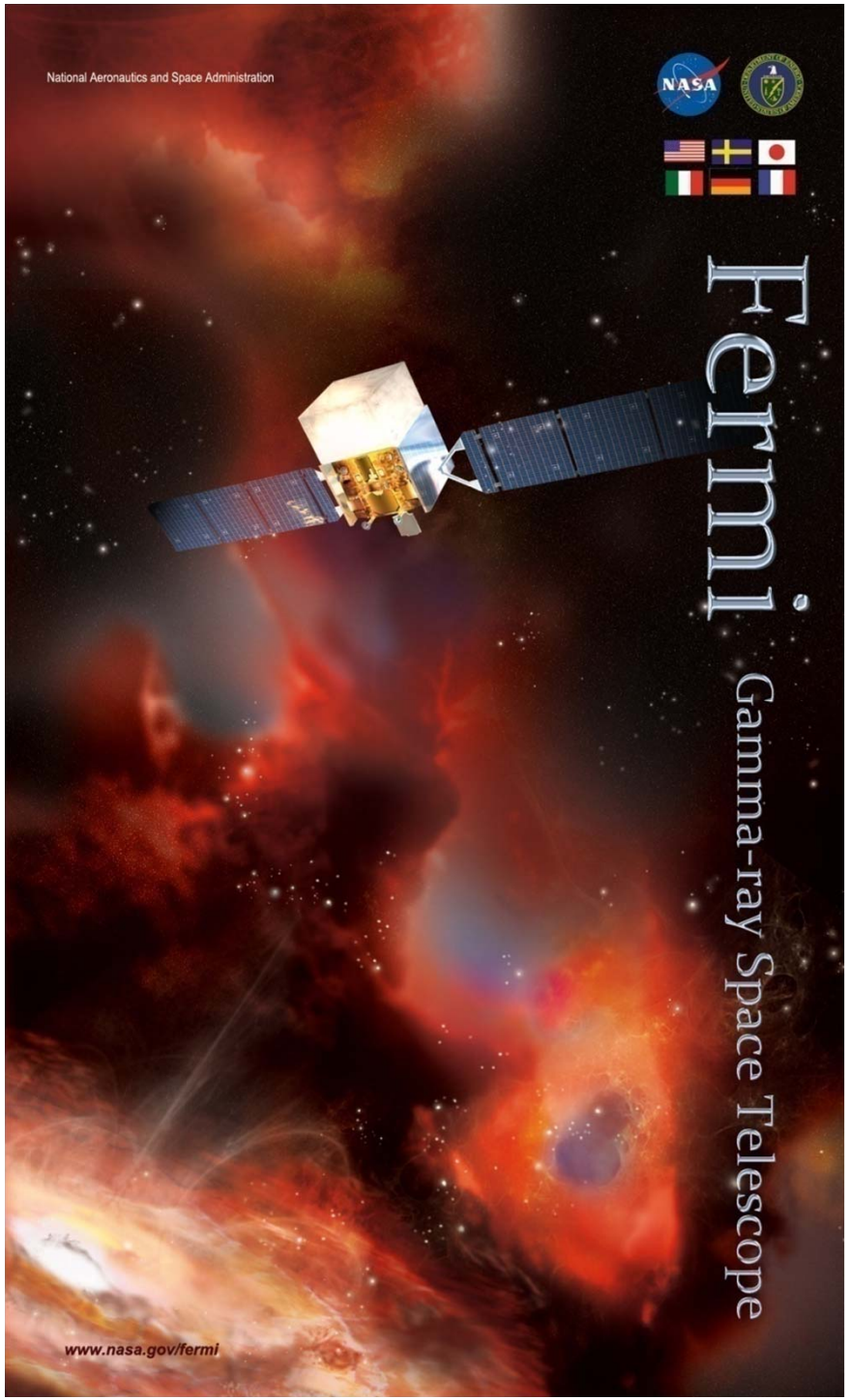


Fermi Gamma-ray Space Telescope

Young SNRs

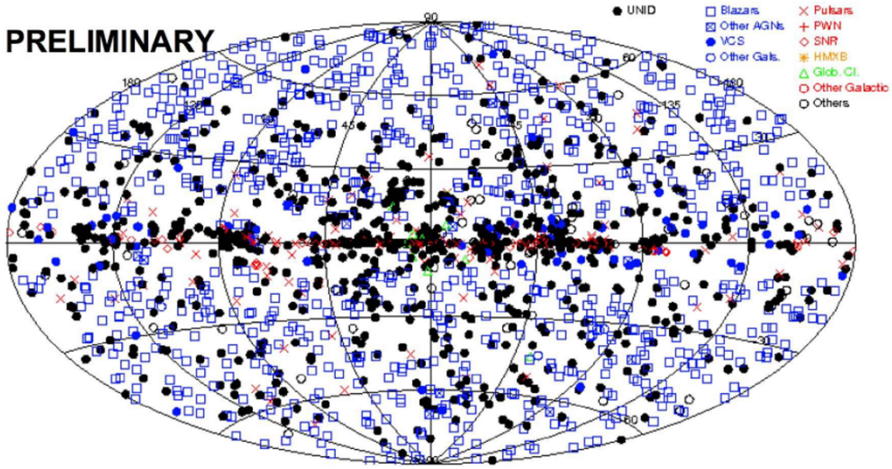
a new family of HighEnergy sources

F. Giordano*
For the Fermi-LAT Collaboration

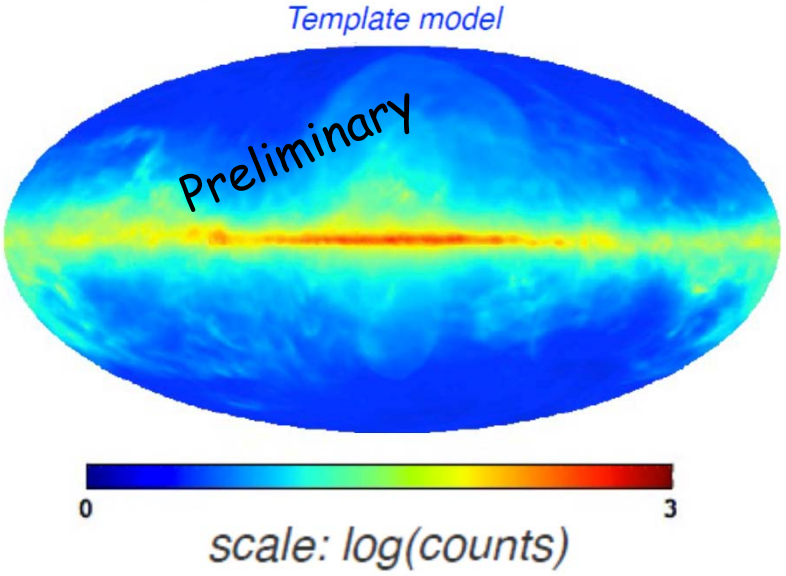
*University of Bari and INFN-Bari

The Fermi-LAT NEWS after the 3rd year

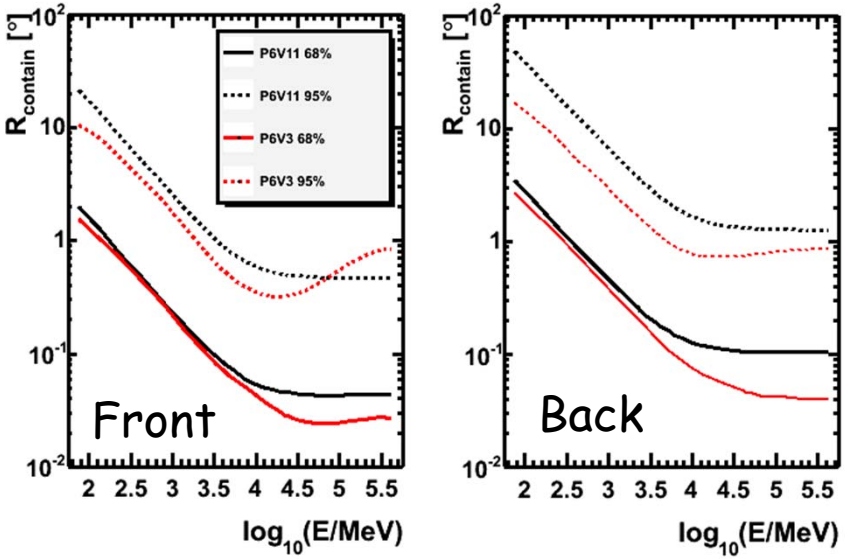
The 2FGL catalog



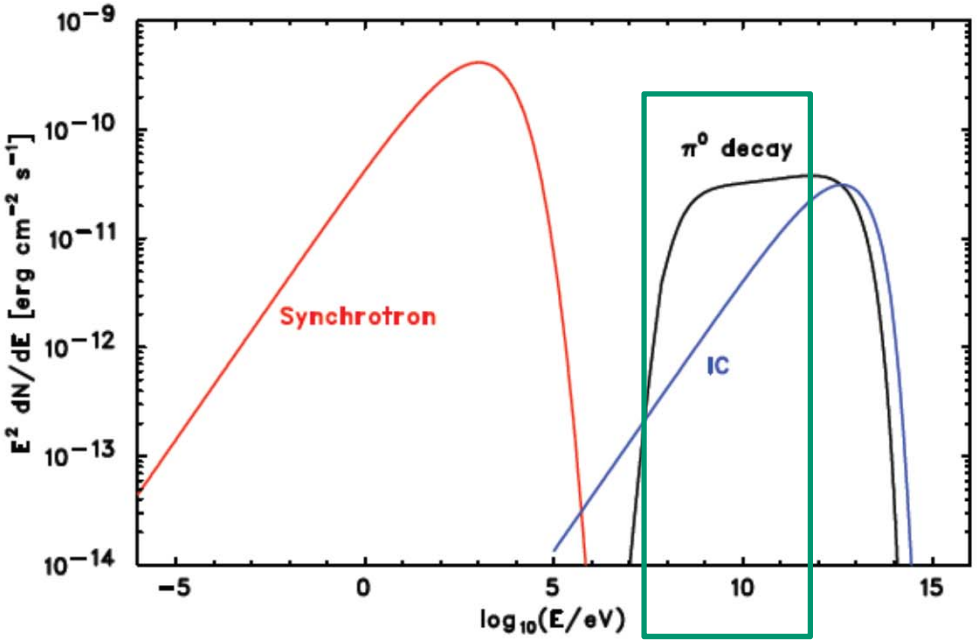
The New Diffuse Model



New PSF w/ On-Flight Corrections

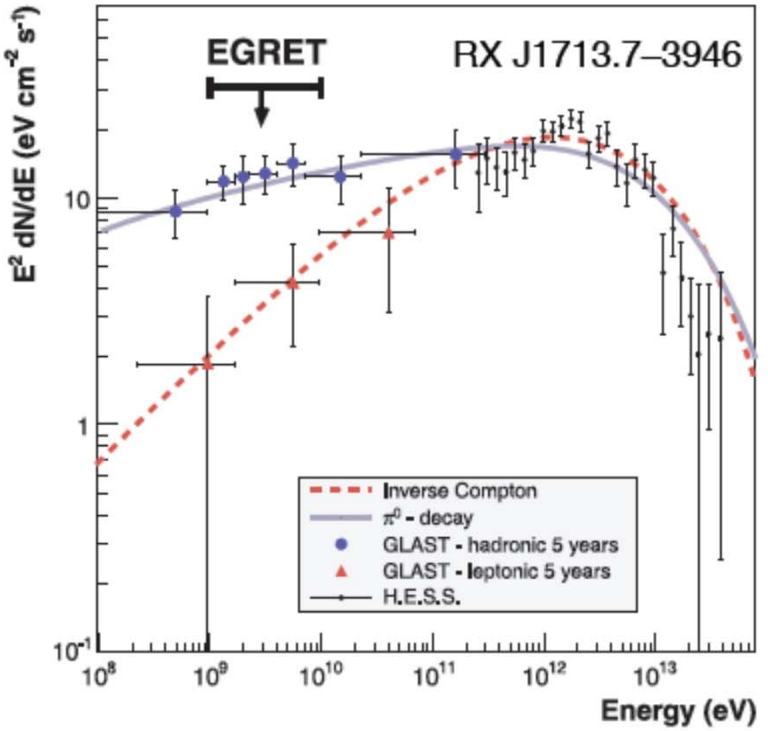


Non-thermal Radiation from an SNR

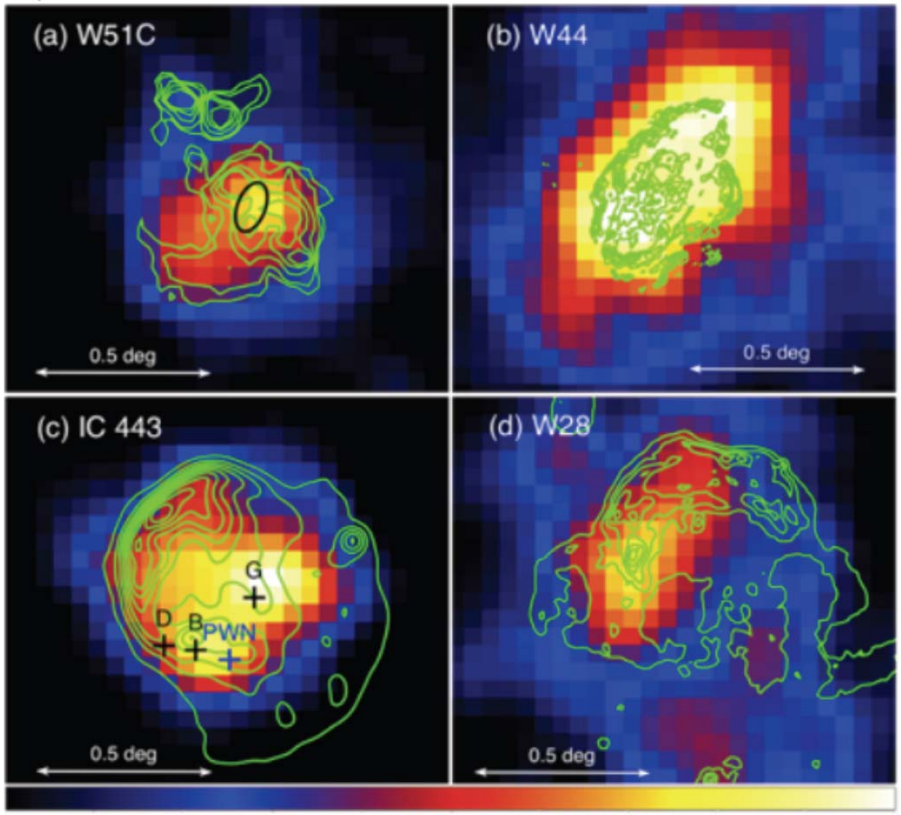


Tanaka Fermi Symp. 2011

Prelaunch Simulation (Funk+ 2008)



Fermi-Detected SNRs



Uchiyama 2011

Most are middle-aged interacting with Molecular Clouds

- Extended GeV emission has been discovered from several SNRs, with molecular cloud (MC) interactions.
- GeV extension is consistent with the size of a radio remnant (except for W28).
- Steep spectrum

High GeV luminosity up to 10^{36} erg/s
Assuming e/p ratio less than 10%, the only way to achieve the high luminosity is π0-decay γ-rays in dense gas (>10 cm^{-3}).
Spectral break in the GeV band
GeV Luminosity>>TeV Luminosity

But…

We now have Other detections: Historical (i.e. Very young), and…

SN 1006

AD 1054 - The Crab

AD 1181 and the PSR J0205+6449

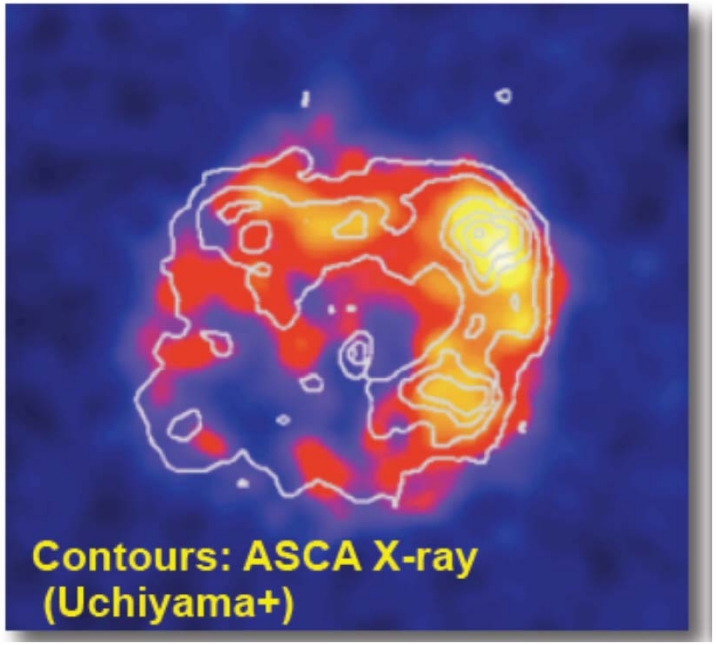
AD 1572 – Tycho SNR

SN 1604 (Kepler)

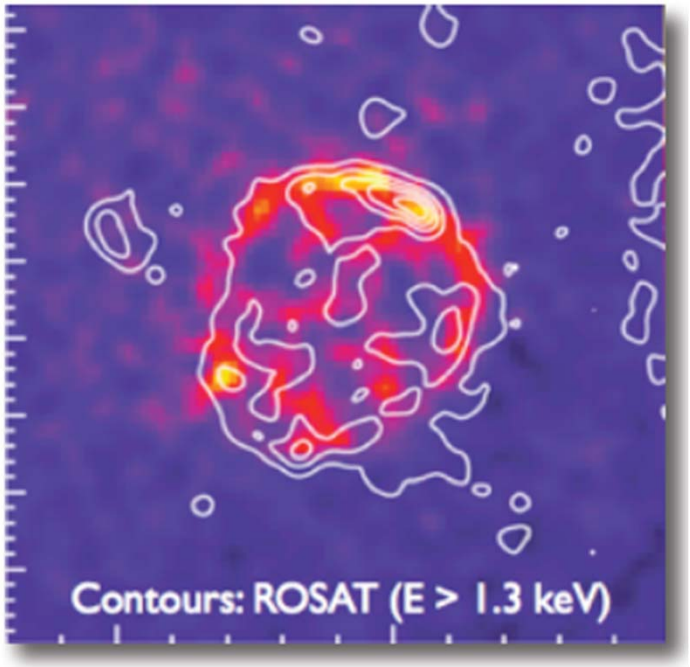
AD 1680 - Cas A

Stephenson & Green "Historical Supernovae and their Remnants" Oxford Univ. Press

RX J1713.7-3946

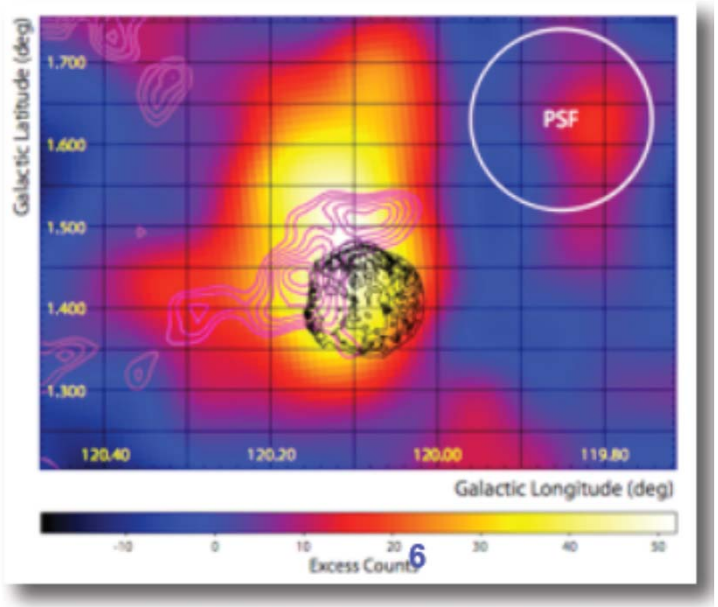


RX J0852.0-4622

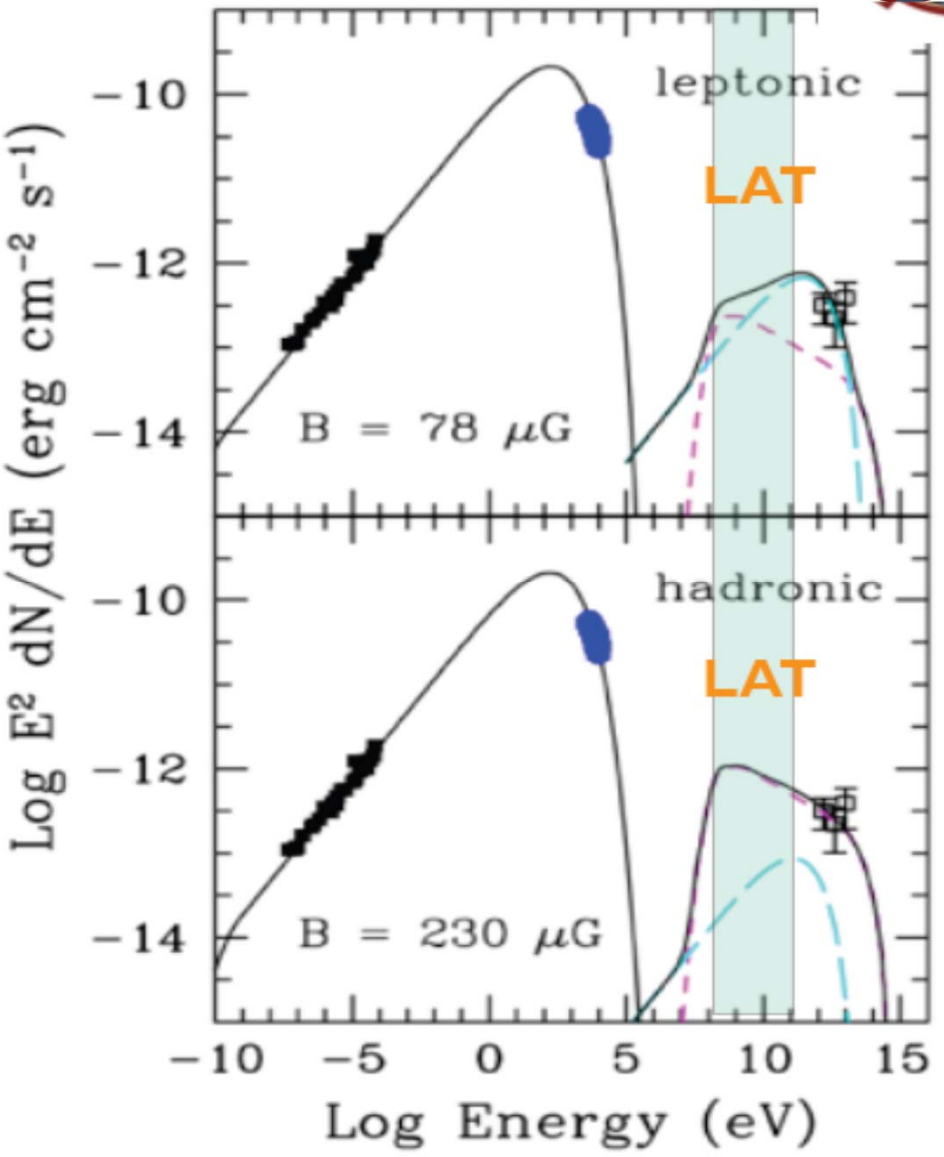


Let's start from the last arrived: TYCHO

Acciari et al 2011

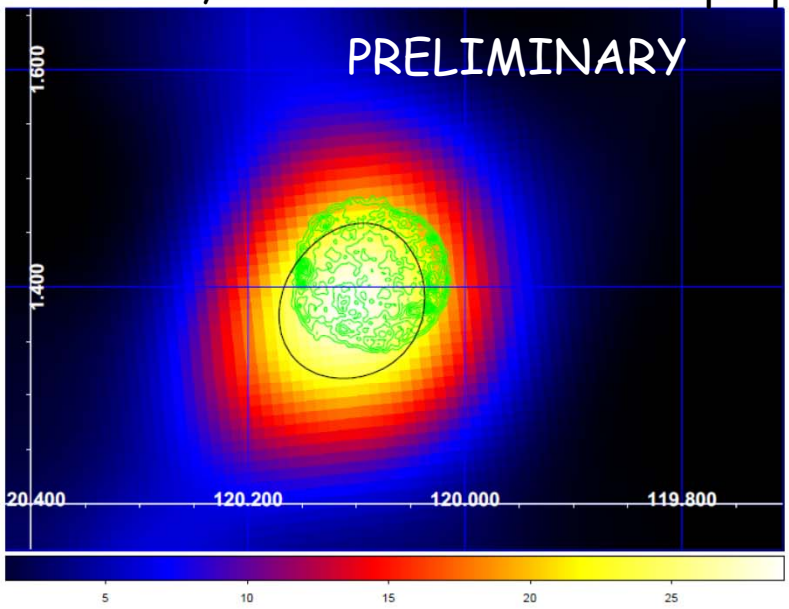


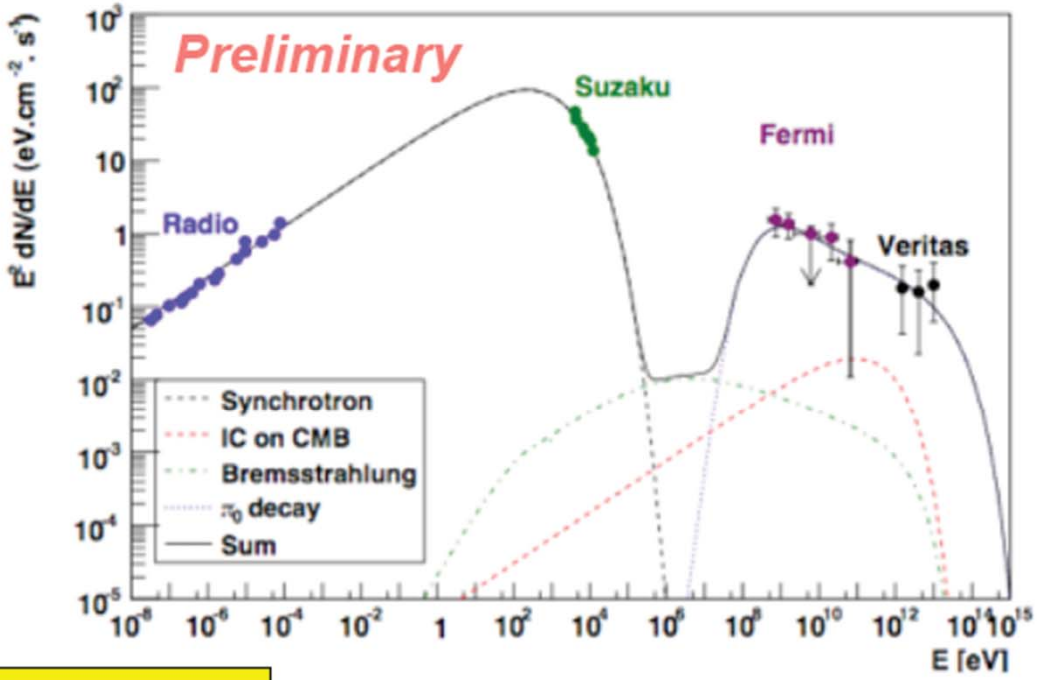
Flux(>1 TeV) ~ 1% Crab
5.0σ detection (post-trial)



Tycho with the Fermi-LAT
Hadronic or Leptonic?

Giordano, Naumann-Godo et al. in prep.





Se=2.2-2.3
Eb=6-7TeV
B~200uG

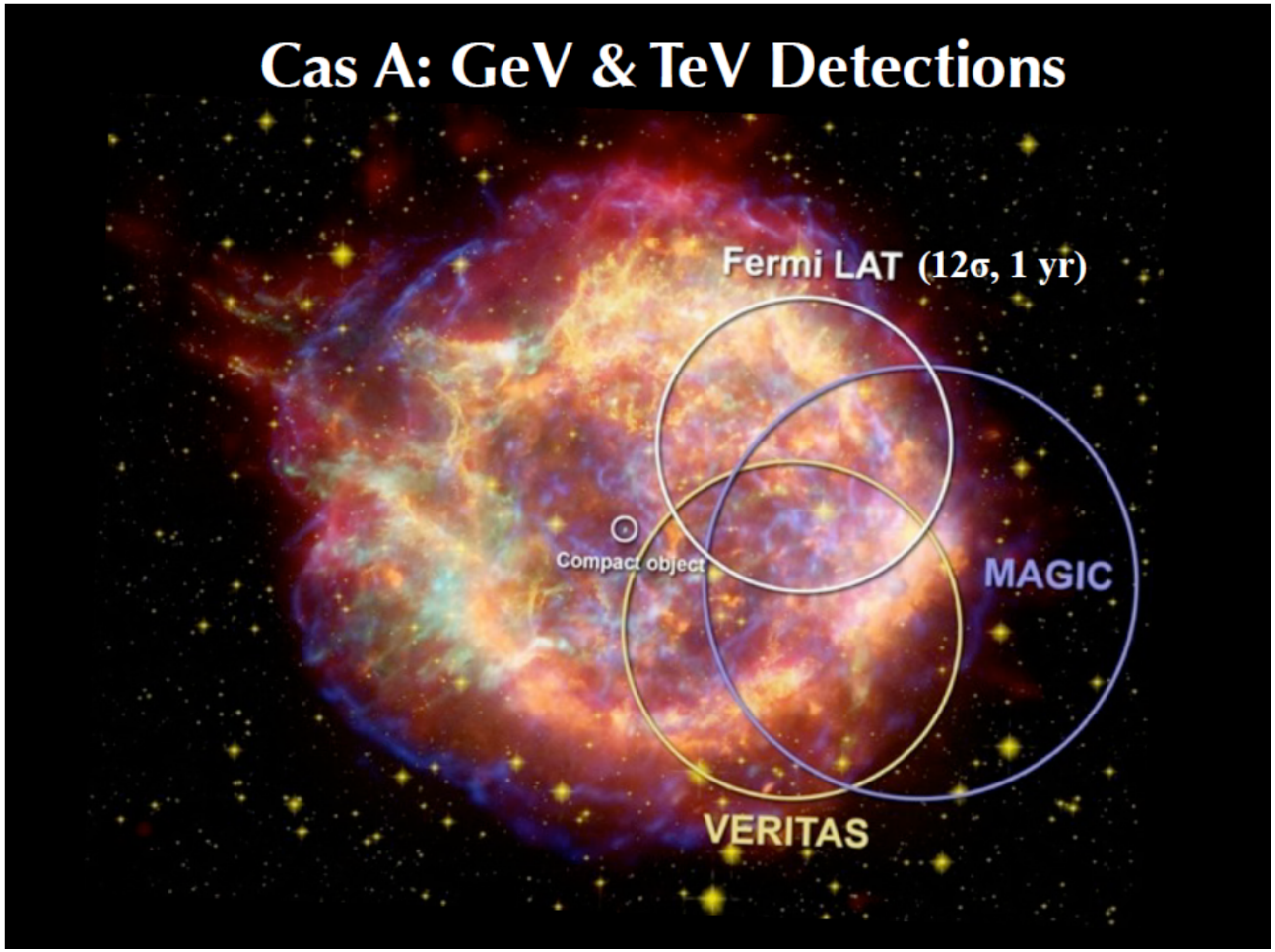
~6-8% of E_{SN} transferred to CRs.

Case	D_{kpc}	n_H [cm^{-3}]	E_{SN} [10^{51}erg]	$E_{p,tot}$ [10^{51}erg]	K_{ep}
Far	3.50	0.24	2.0	0.150	4.5×10^{-4}
Nearby	2.78	0.30	1.0	0.061	7.0×10^{-4}

Leptonic not-favoured for:

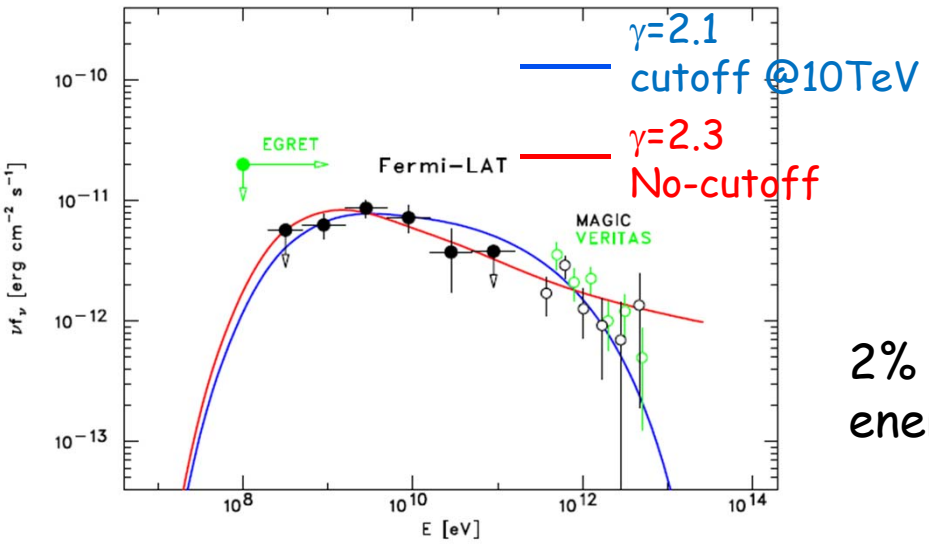
- IC does not fit the data
- Bremss
  - N_e fixed by IC
  - $n_H \uparrow$ up to $10cm^{-3}$
  - $B \downarrow$ down to 65uG
- Kep~0.1

CasA: Just few years older



Hadronic or Leptonic??

Abdo et al., 2010 ApJL 710



Hadronic model

Wp(> 10 MeV/c)=3.8 × 10^{49} erg

nH=10cm^{-3}

2% of the estimated explosion kinetic energy of Esn = 2 × 10^{51} erg

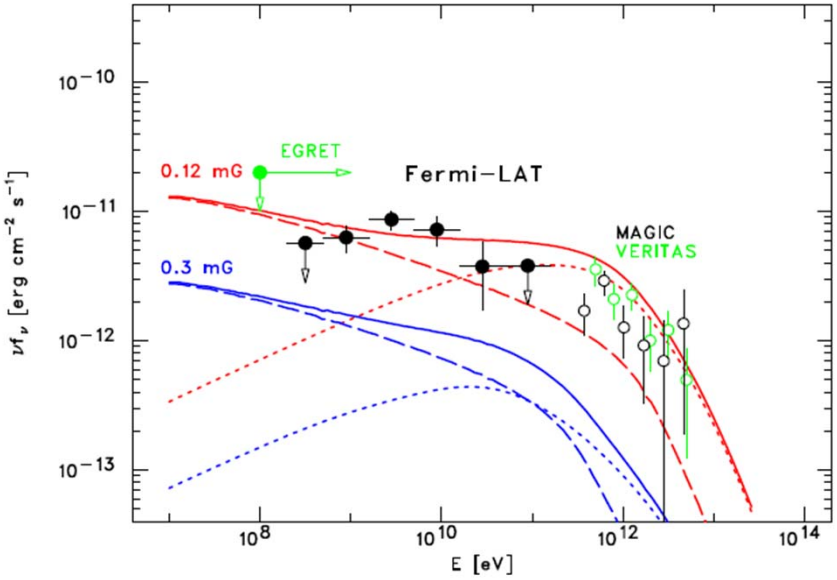
Leptonic model

IC on FIR emission from the Cas A ejecta,
T ~ 100 K - energy density ~2 eV cm−3

neff=26cm^{-3}

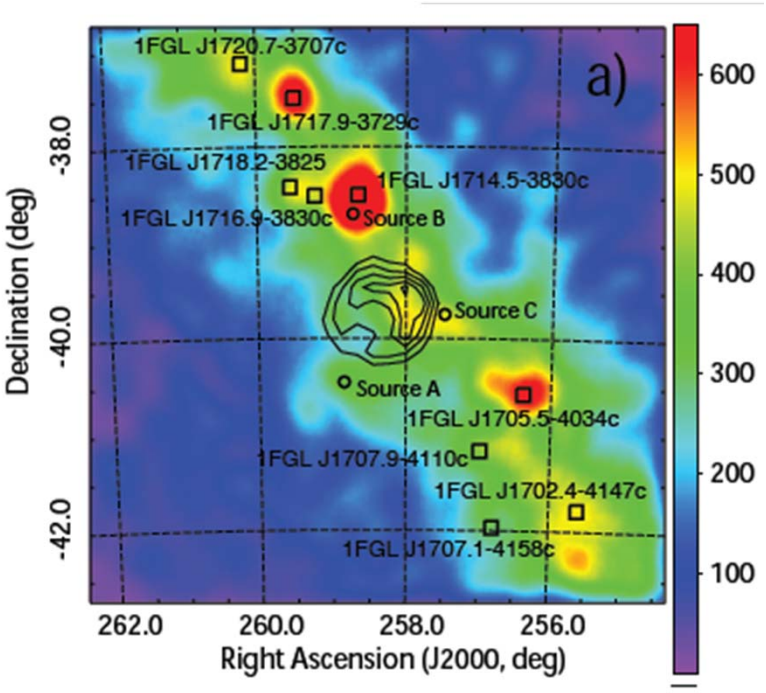
Se=2.34

We(> 10 MeV) = 1 × 10^{49} erg

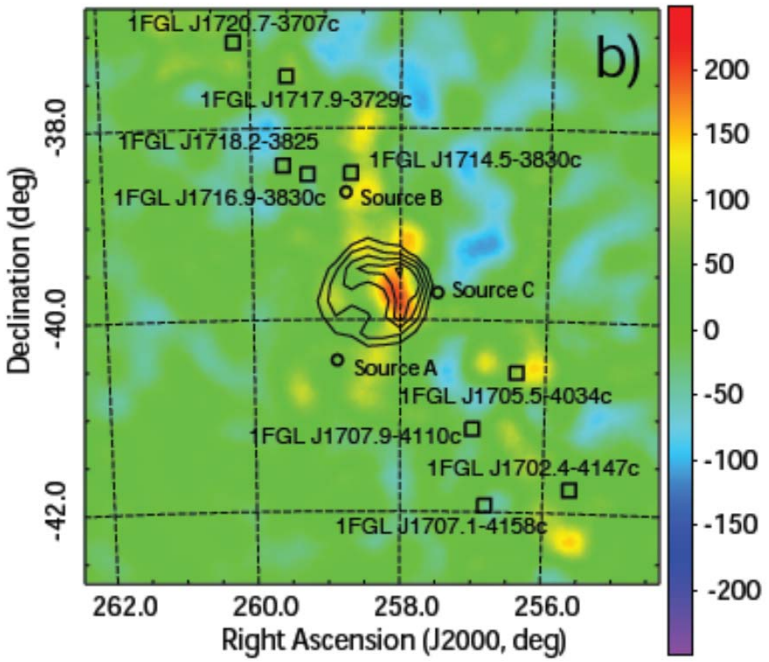


Older & older…
RXJ1713 G347.3-0.5 - AD393

Very complex region, not far form the Galactic center



Before background subtraction

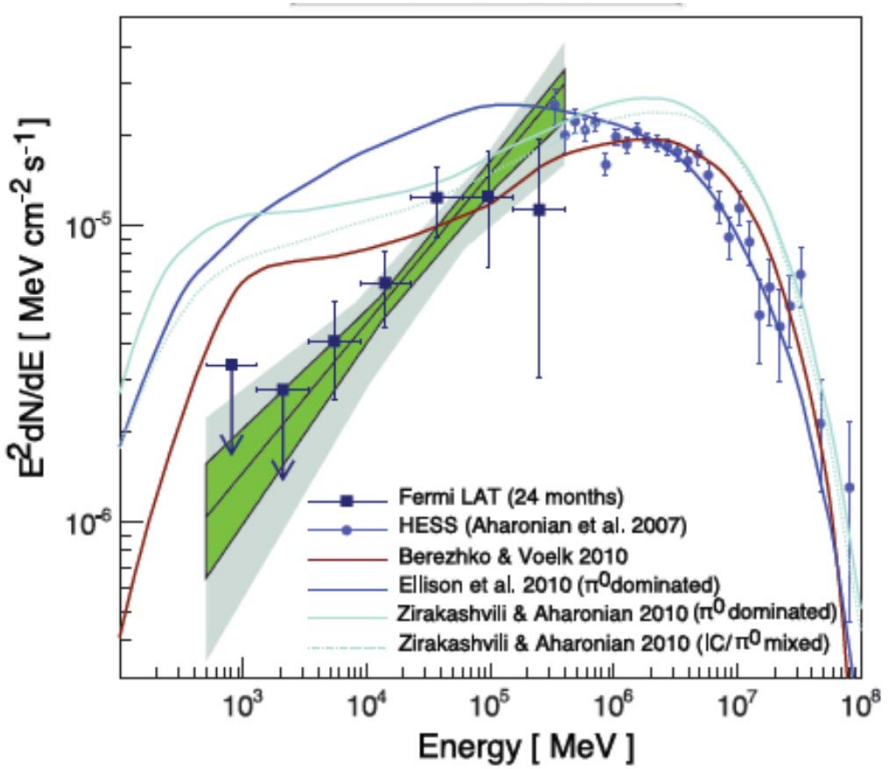


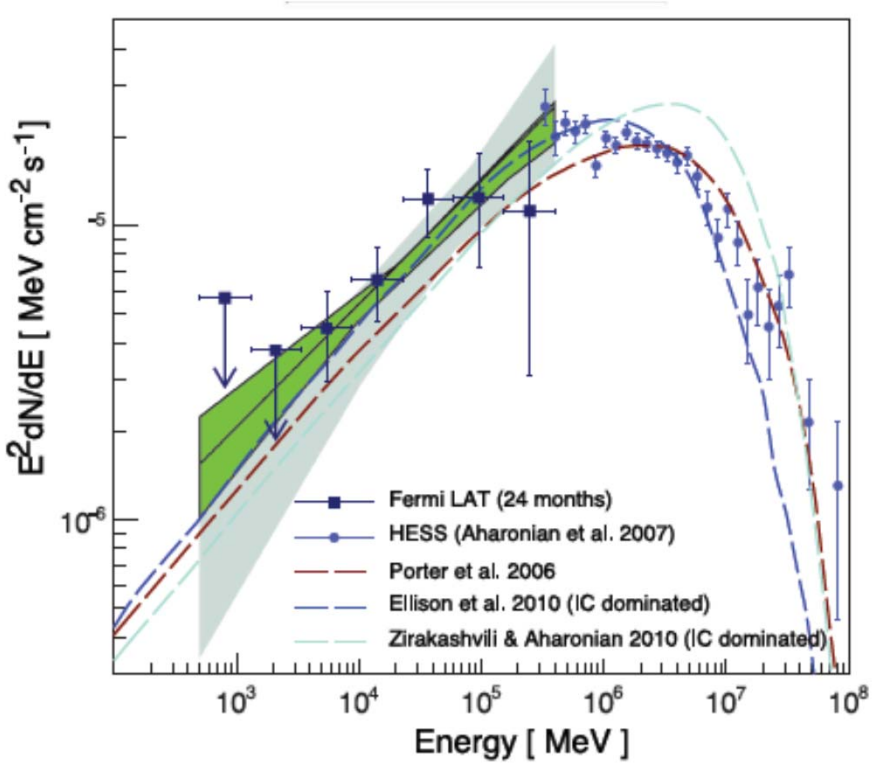
After background subtraction (contributions from the diffuse backgrounds + nearby sources)

Abdo et al 2011, ApJ 734

Hadronic or Leptonic???

$\Gamma = 1.5 \pm 0.1$,





se = $2\,\Gamma - 1 = 2.0 \pm 0.2$

Eemax = 20-40 TeV

Kep~10^{-2}

nH<01

Proton content in leptonic model

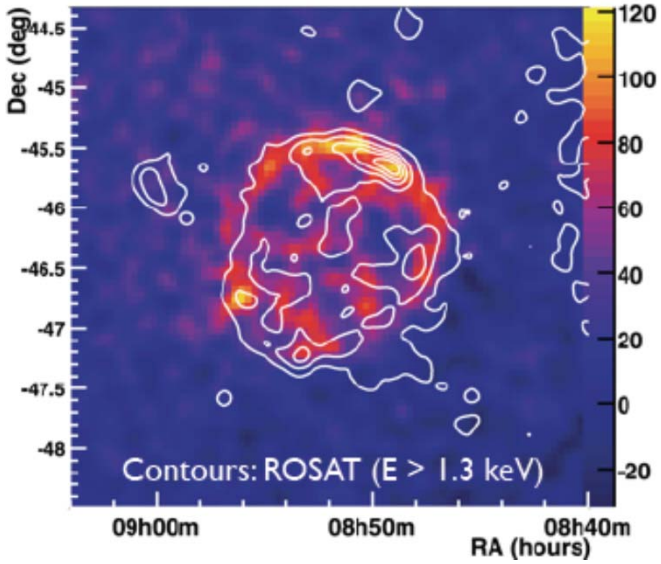
X-ray emission and the gamma-ray emission imply that the average B ~10uG

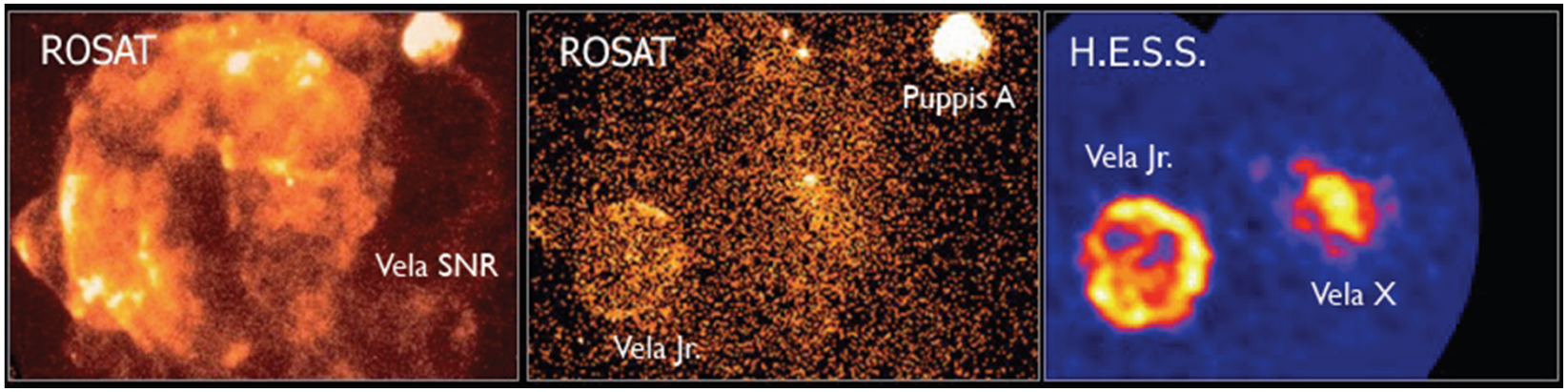
Wp < $0.3 \times 10^{51} (nH/0.1\ cm^{-3})^{-1}$erg

d = 1 kpc

VelaJr

Similar source to RX J1713.7–3946
Discovered by ROSAT (Aschenbach 1998)
Non-thermal X-rays (Slane+ 2001)
Detected in TeV
CANGAROO: Katagiri+ (2005)
Spatially resolved image by H.E.S.S.
(Aharonian+ 2005, 2007)
Latest estimate of age & distance (Katsuda+ 2008):
τ = 1700–4300 yr, D ~ 750 pc
(Further away than Vela SNR)

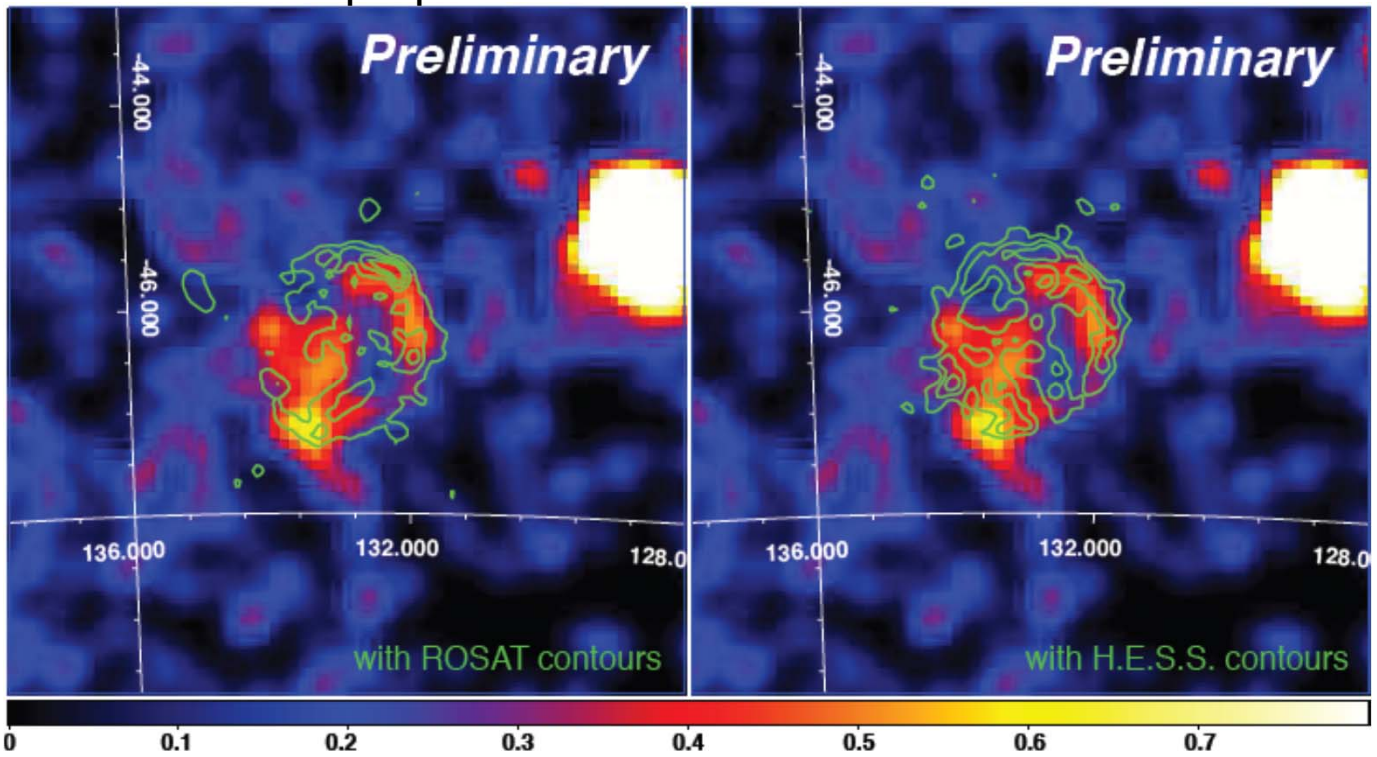




0.1 keV < E < 2.4 keV E > 1.3 keV TeV

Extension and Background

Tanaka et al. in prep.

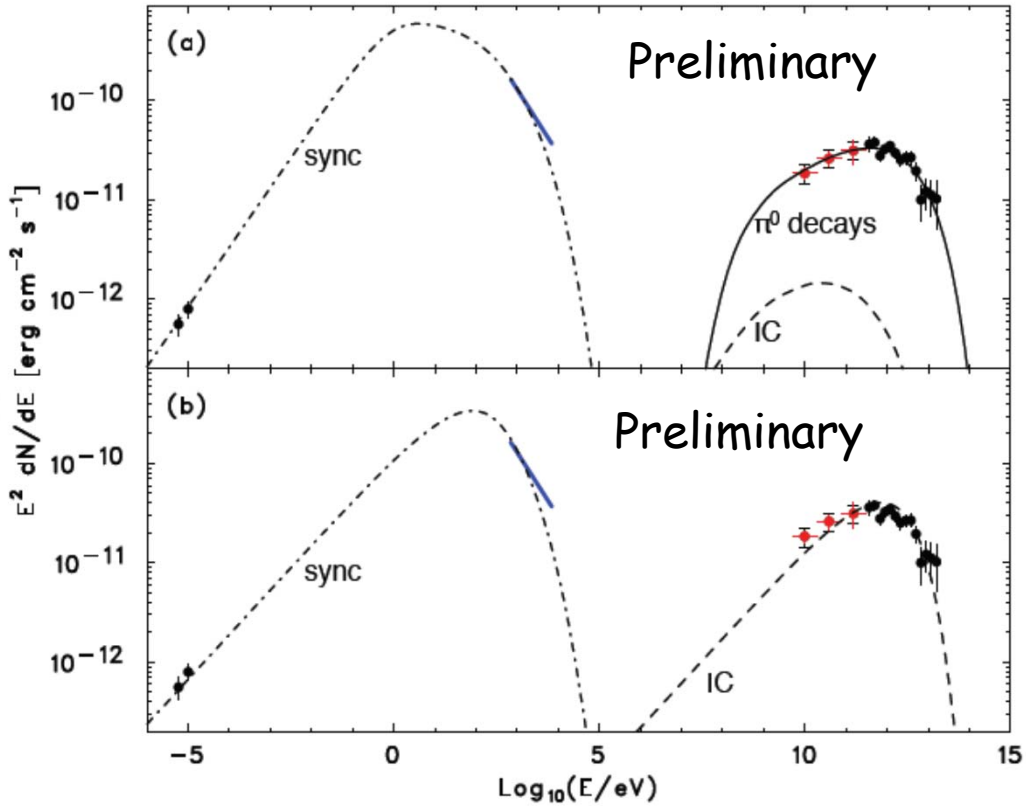


Spatially extended source at the location of the SNR RX J0852.0–4622
The emission clearly detected in the high energy region (E>5GeV)
TS = 221 with the H.E.S.S. image used as a spatial template
Using a uniform disk as a spatial template, we obtain a radius of 1.12 (+0.07, –0.06) deg, which is consistent with the extent observed in radio, X-rays, and TeV gamma rays

Hadronic or Leptonic????

Hadronic

sp = 1.8, se = 1.8
B = 50-100 μG
Wp = 5.2 × 10^{50} (n/0.1 cm^{-3})$^{-1}$ erg
We = 3.9 × 10^{46} erg
P_bp=50TeV
P_be=10TeV



Leptonic

IC on CMB, IRF in IR and optical

se = 2.1
B = 12 μG
We = 6.9 × 10^{47} erg
P_be=25TeV

SUMMARIZING…

1) Two Historical - SOFT ~2.0-2.2
2) Two young &TeV Bright - HARD ~1.5-1.7
3) Middle aged are much steeper GeV Luminosity >>TeV Luminosity

What we should wait for…

1) More statistics at High energy
   - better connection with TeV data
2) More Statistics AND Better Fit Quality at Low energy
   - go below 1GeV with new IRF and a New Diffuse!!!
   - Better discrimination Hadronic vs Leptonic scenarios