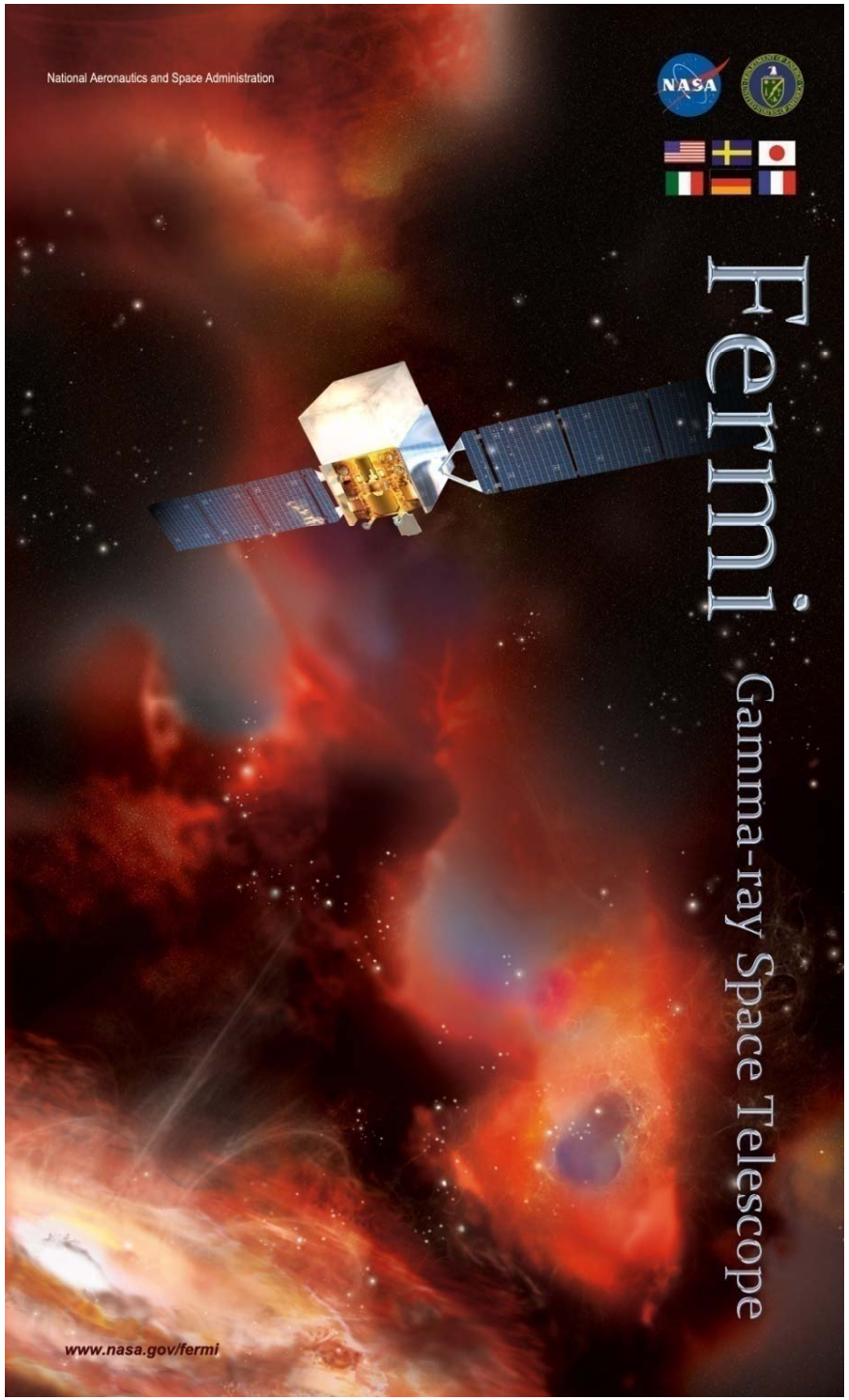


Fermi Gamma-ray Space Telescope

Studies of Gamma Ray Sources with the Fermi Large Area Telescope

Jürgen Knödlseder

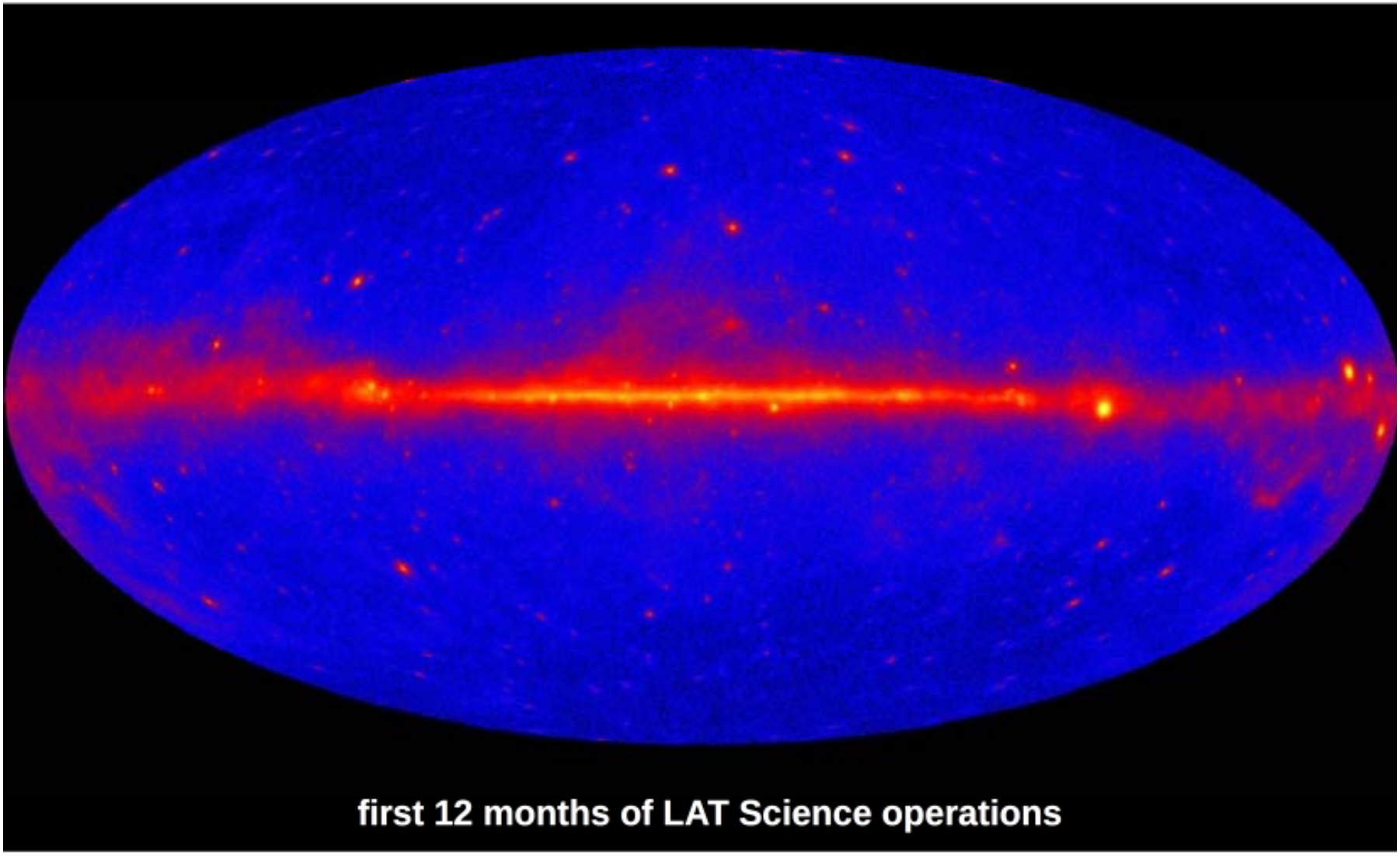
CESR-Toulouse

On behalf of the Fermi/LAT collaboration

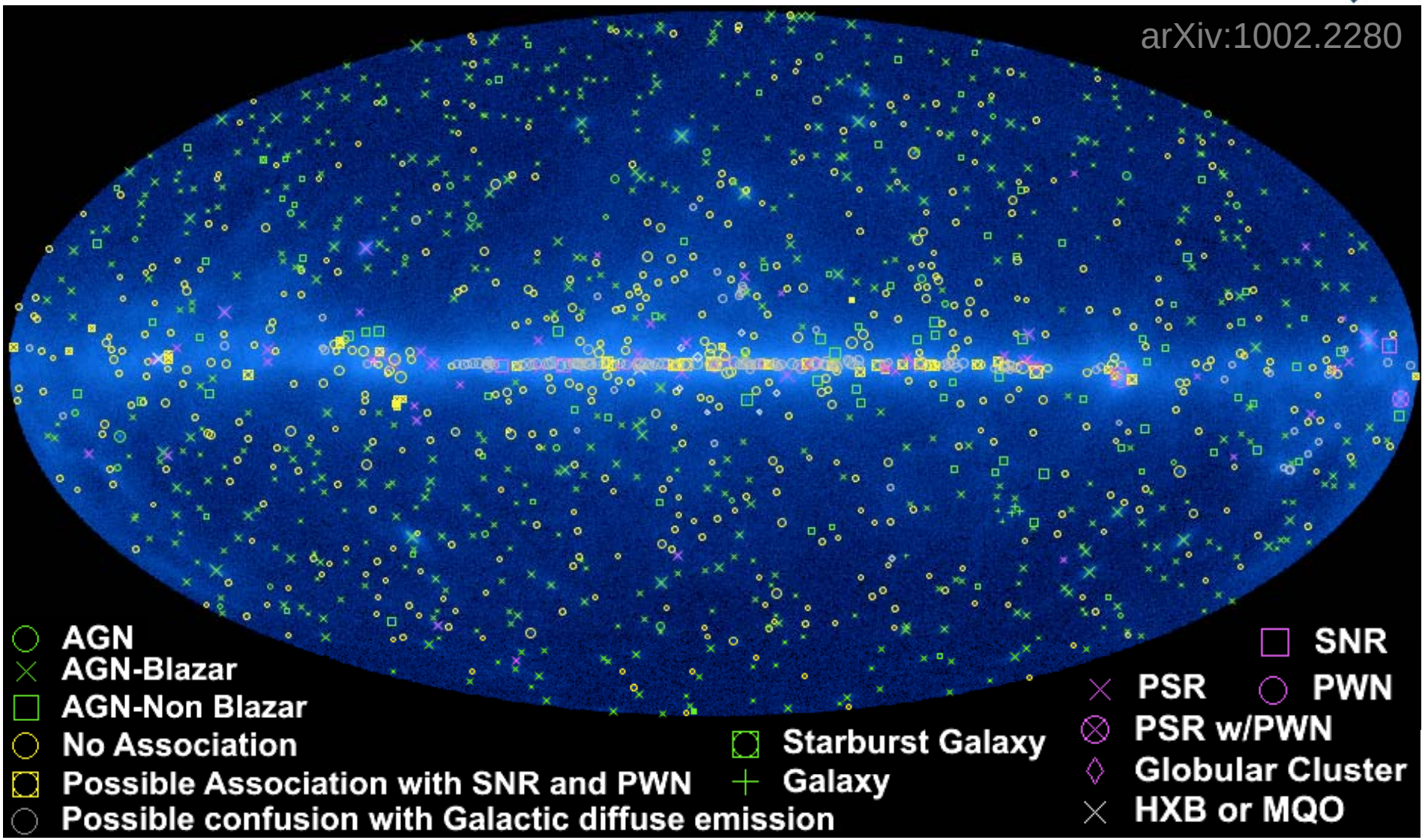
Les Rencontres de la Physique de la Vallee d'Aoste

La Thuile, March 1st 2010

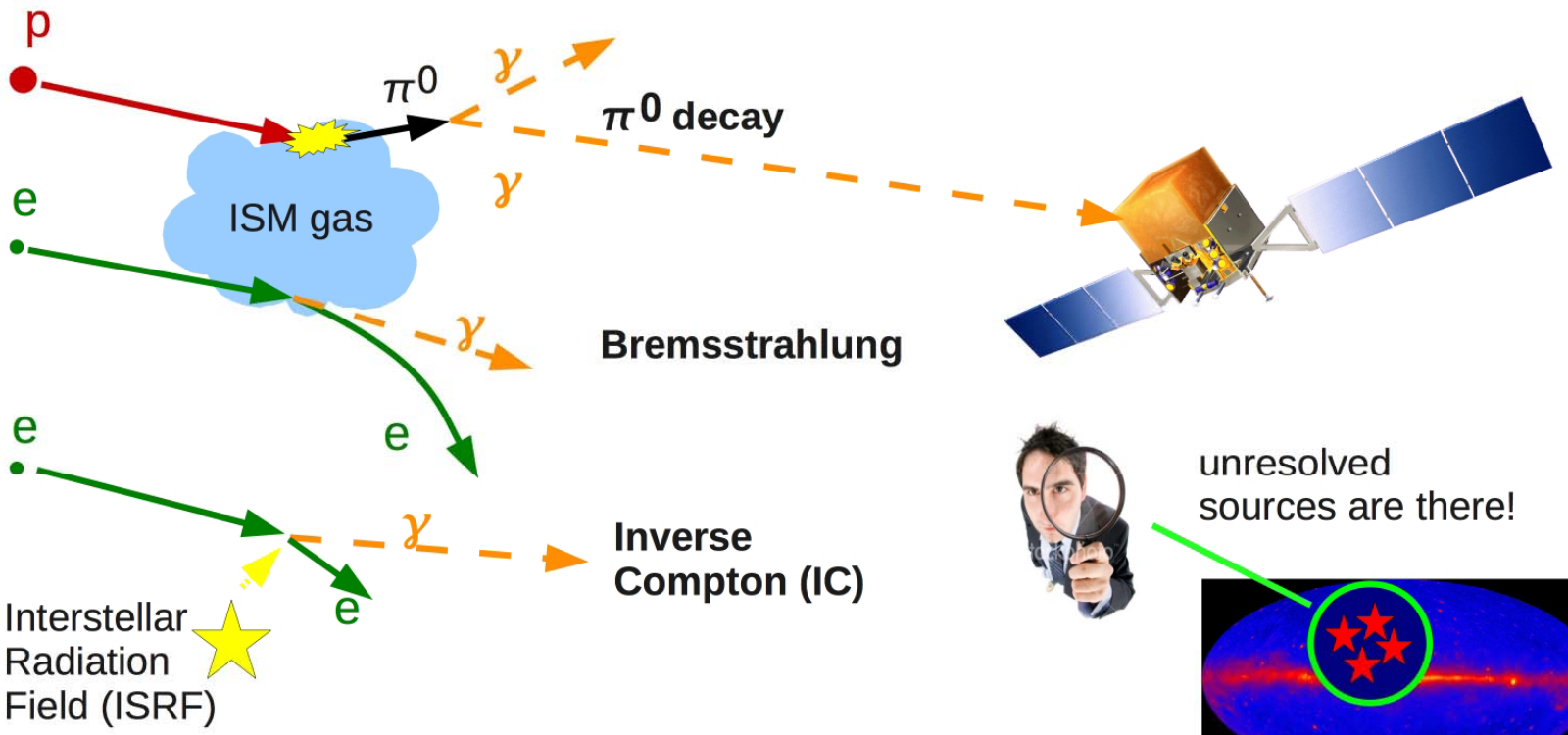
Unveiling the Gamma-Ray Sky



1451 sources in the sky … so far …



Interstellar Gamma-Ray Emission



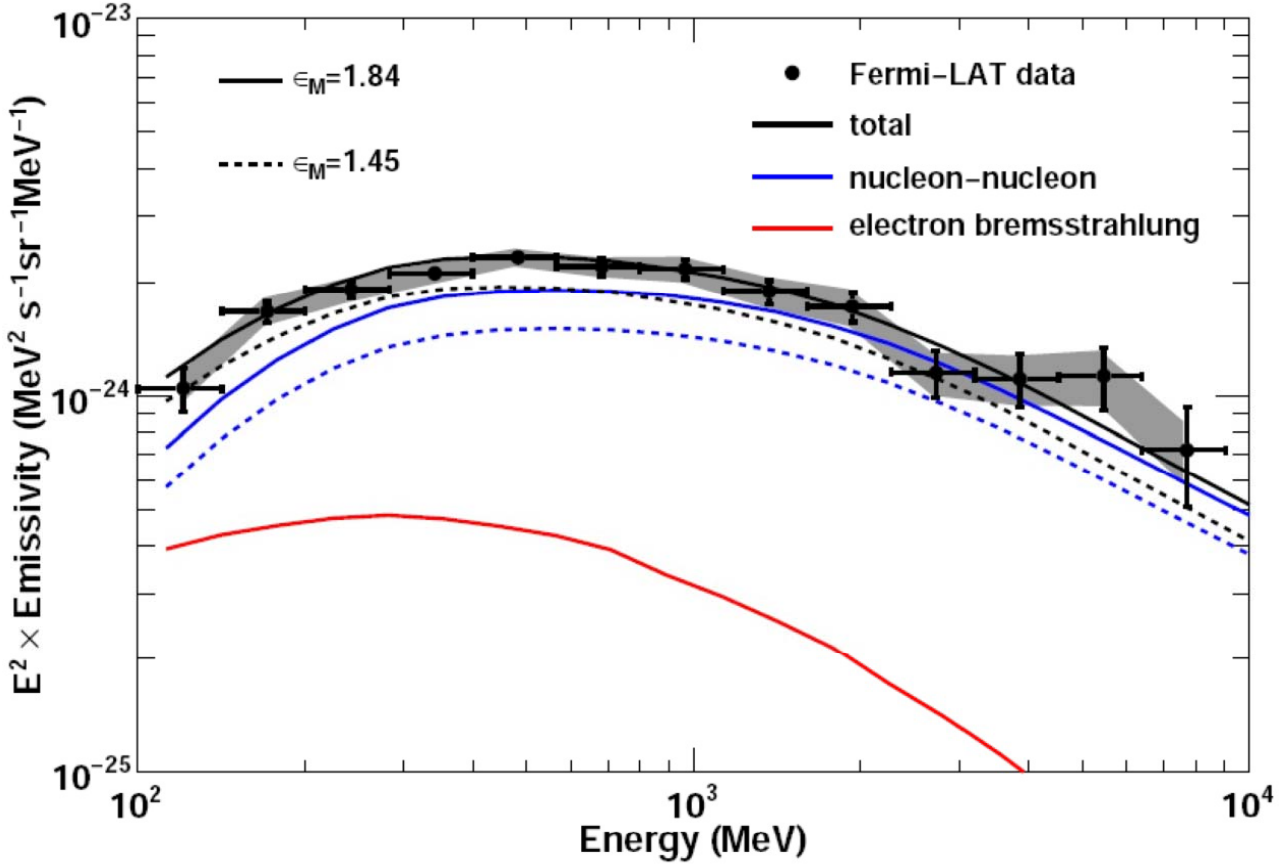
unresolved
sources are there!

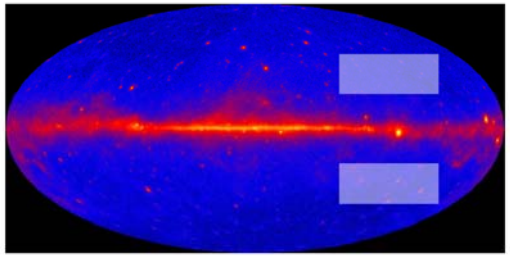
- cosmic-ray tracer
- distant locations not accessible by direct measurements

are there
contributions
from exotic
processes???

Slide from Luigi Tibaldo

Local Cosmic Ray Spectrum



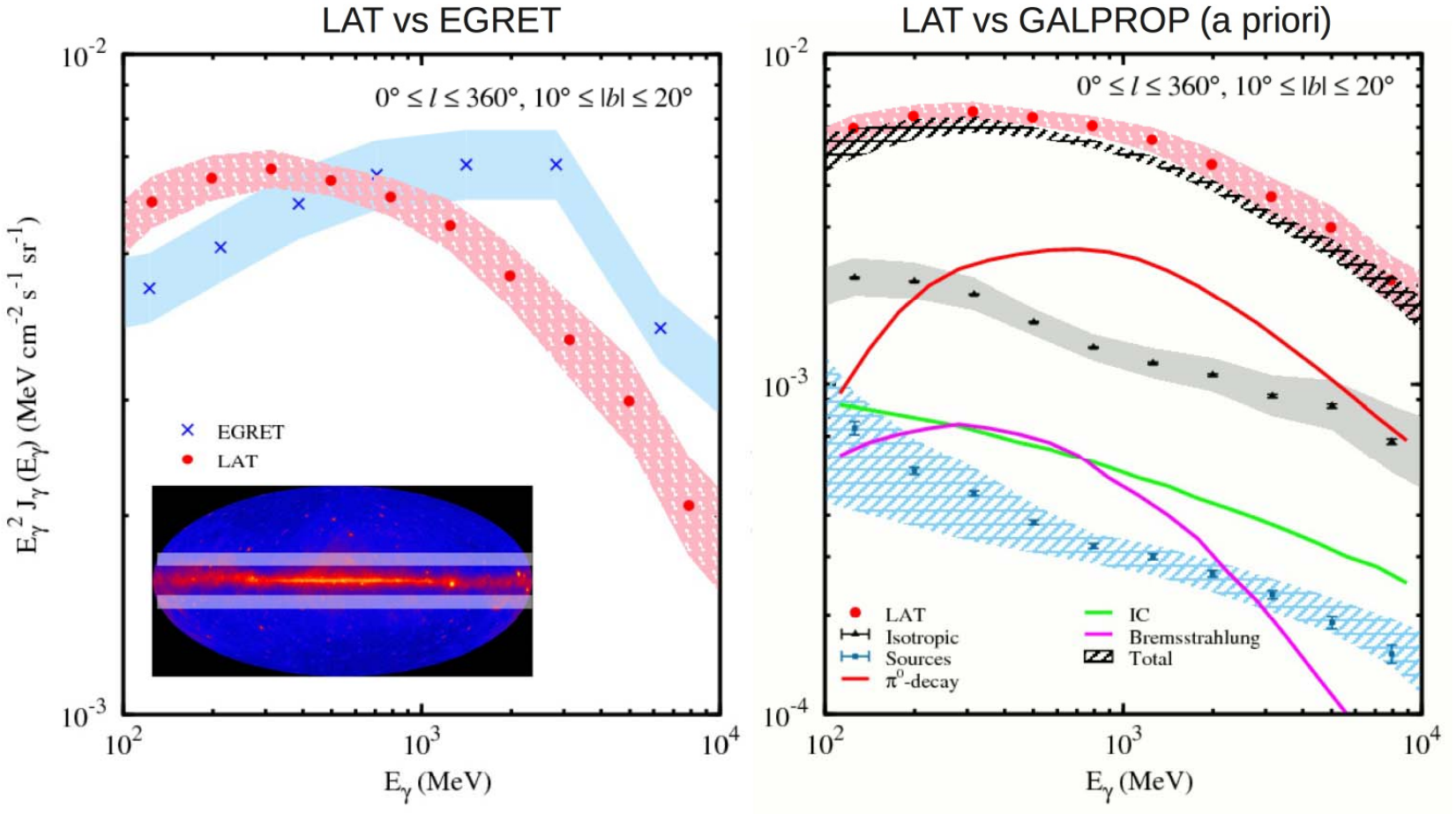


Small contributions from IC and molecular gas, correlation mainly with HI

Observed emissivity spectrum agrees well with the model prediction derived from the local interstellar medium

Abdo et al. (2009), ApJ, 703, 1249

Inconsistency with EGRET GeV excess

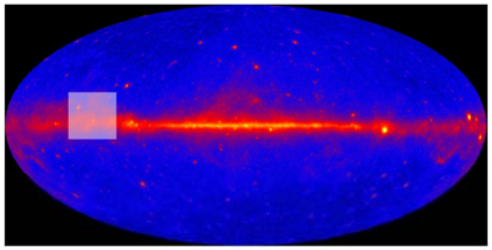


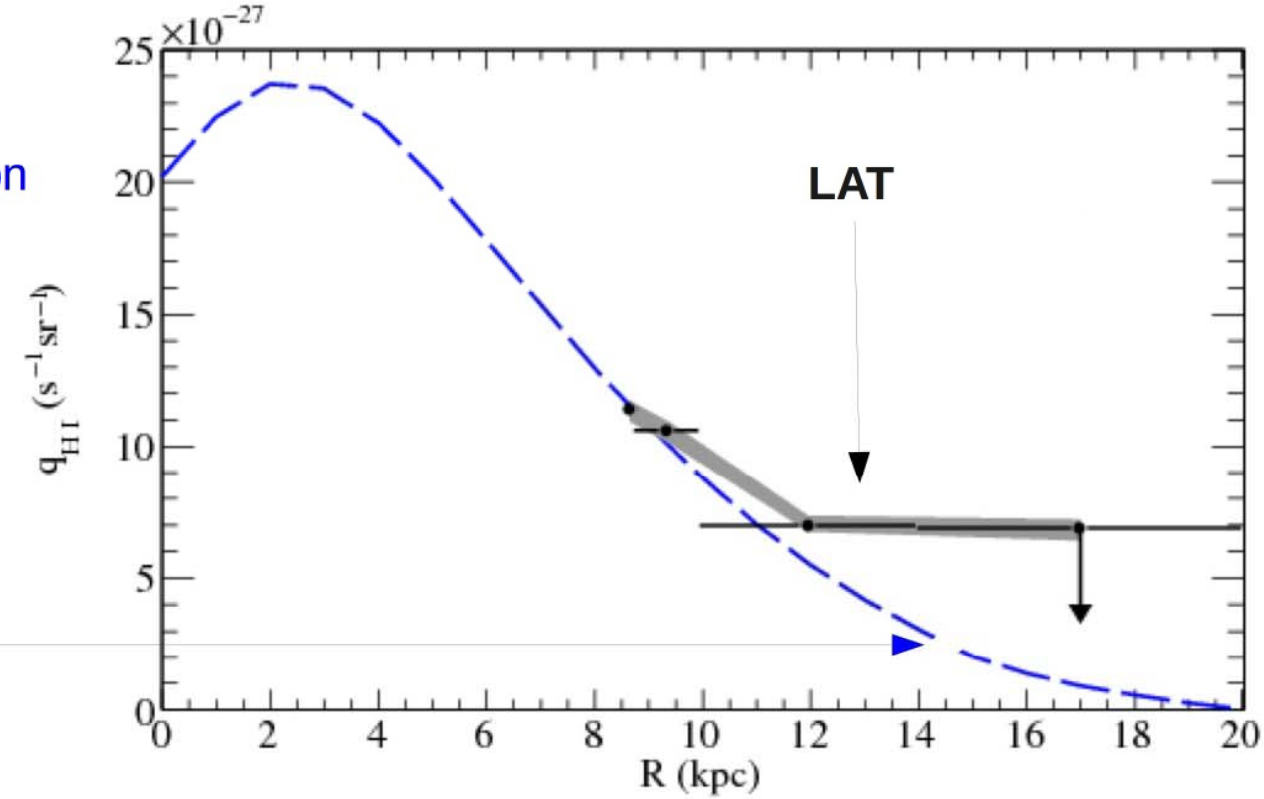
GeV excess reported by EGRET is not confirmed
Fermi/LAT data consistent with a priori GALPROP model

Abdo et al. (2009), PRL, 103, 251101

The CR gradient problem

GALPROP
based on PSR distribution





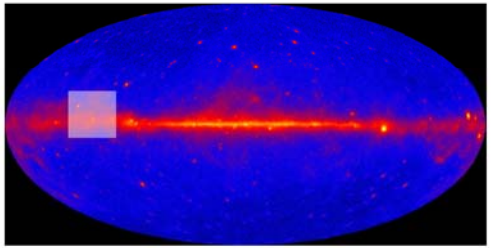
Gamma-ray emissivity
gradient smaller than gradient in (supposed) source distribution

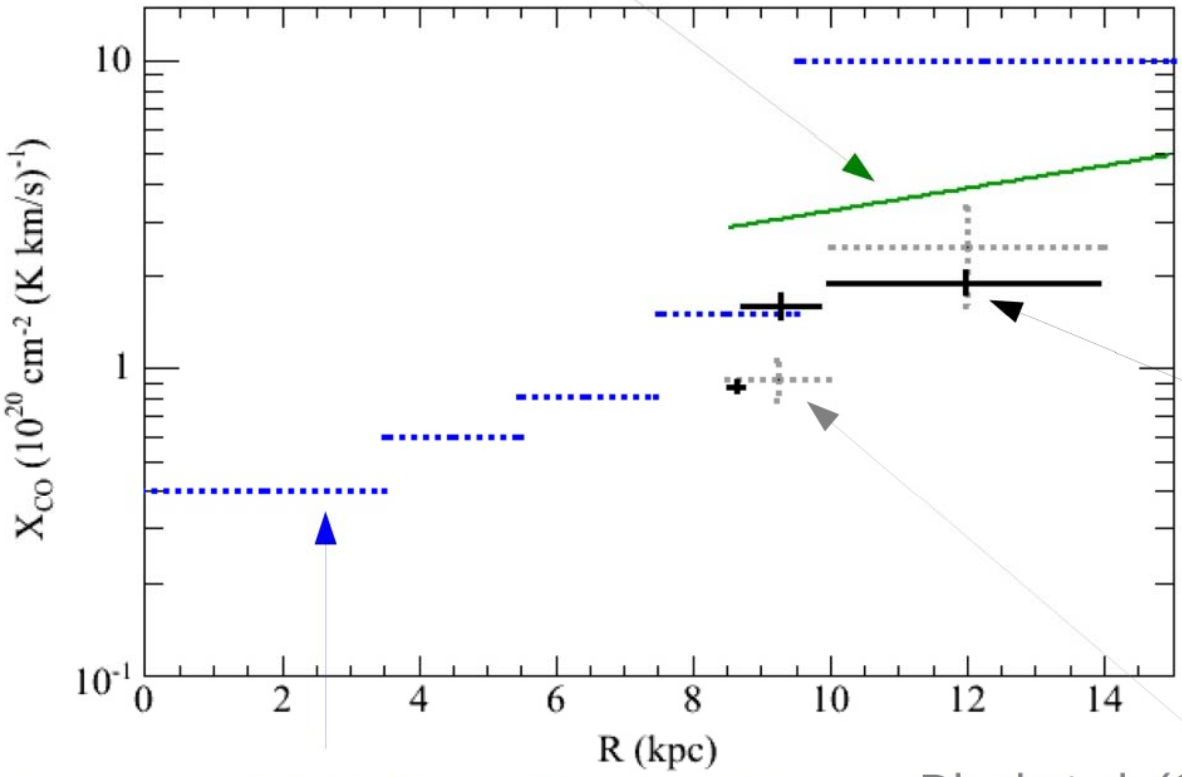
- Missing gas?
- Unresolved sources?
- CR sources in the outer Galaxy?
- CR propagation?

Abdo et al. (2010), ApJ, 710, 133

X_{CO} gradient in the Outer Galaxy

Nakanishi & Sofue
(2006), virial masses





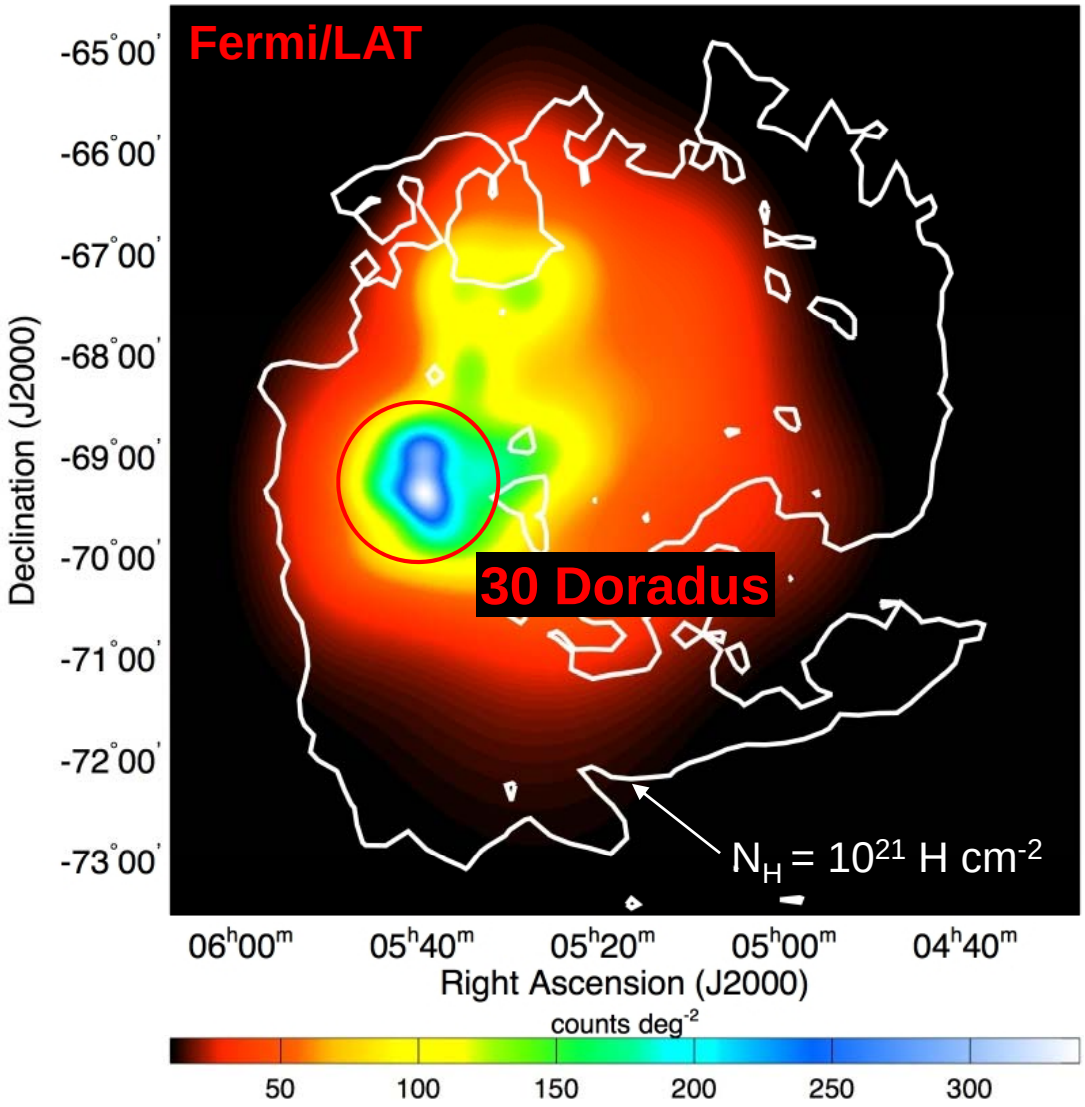
LAT

Strong et al. (2004), combined model

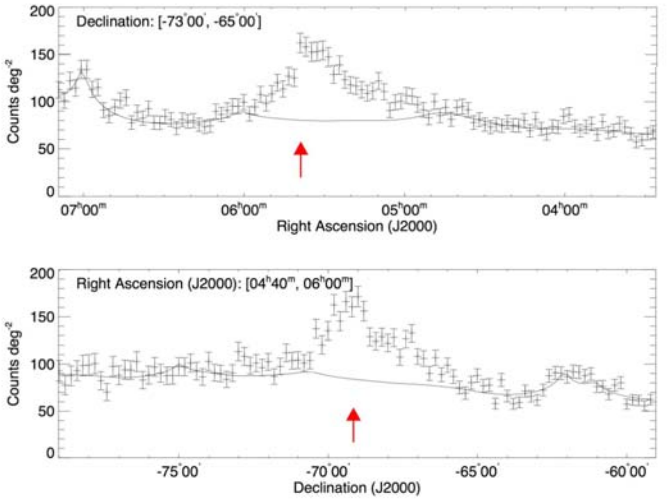
Digel et al. (1996), gamma-rays

Abdo et al. (2010), ApJ, 710, 133

Resolving the LMC in gamma rays



NASA/JPL-Caltech/M. Meixner (STScI)



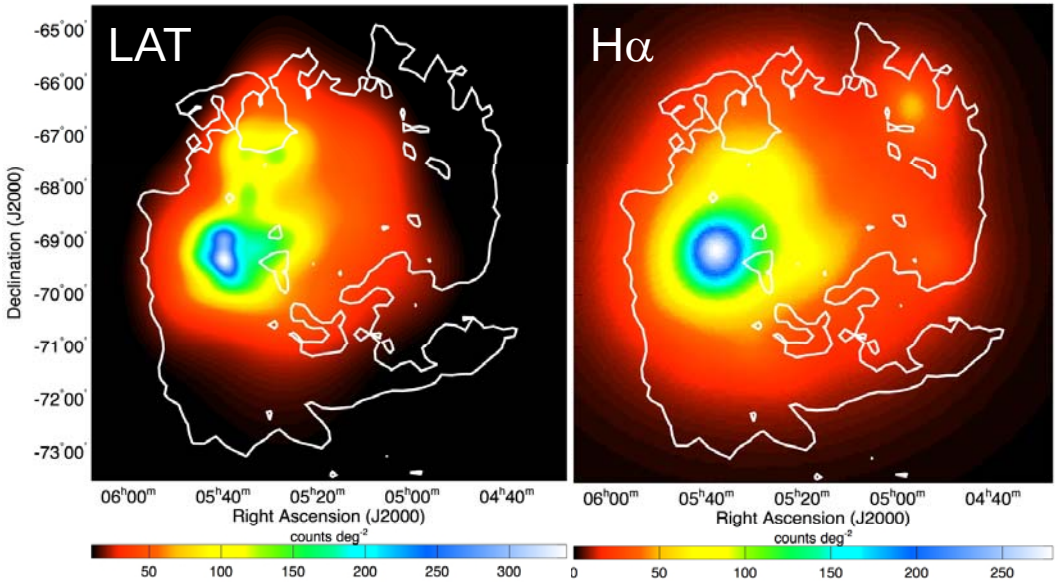
Mapping CR acceleration in the LMC

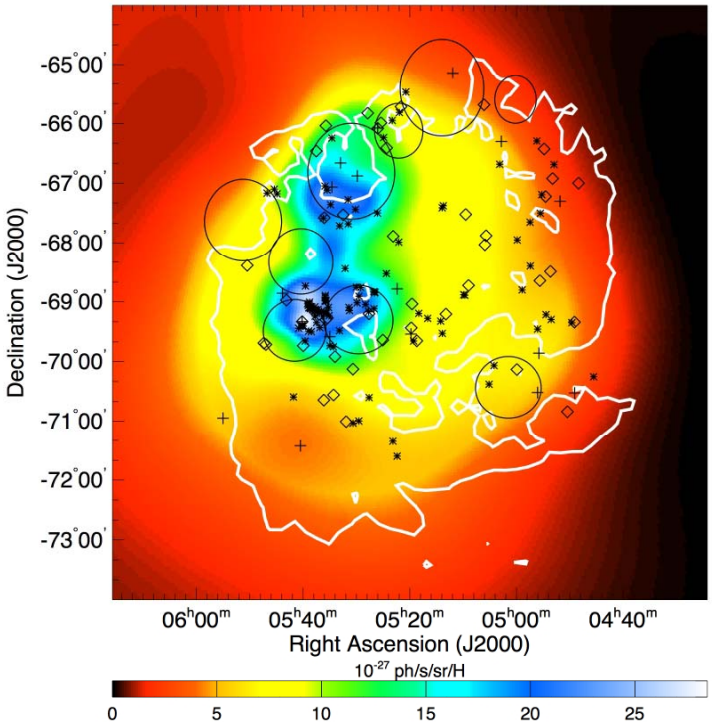
30 Doradus bright in gamma-rays; powerful CR accelerator

Gamma rays trace star formation (Hα) rather than interstellar mass (HI)

Average CR density ~0.2-0.3 local Galactic CR density

Small CR diffusion length (or non steady state?)





gamma-ray emissivity
[gamma-ray flux/N(H)]

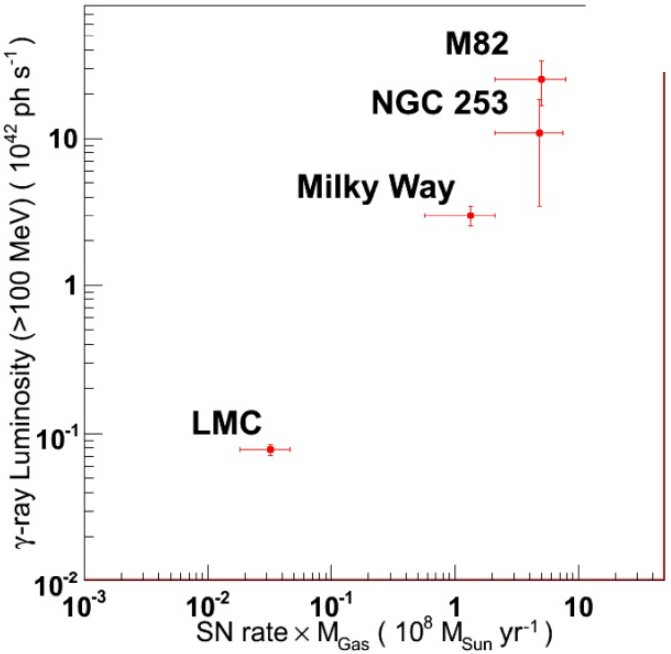
Abdo et al. (2010), A&A, in press

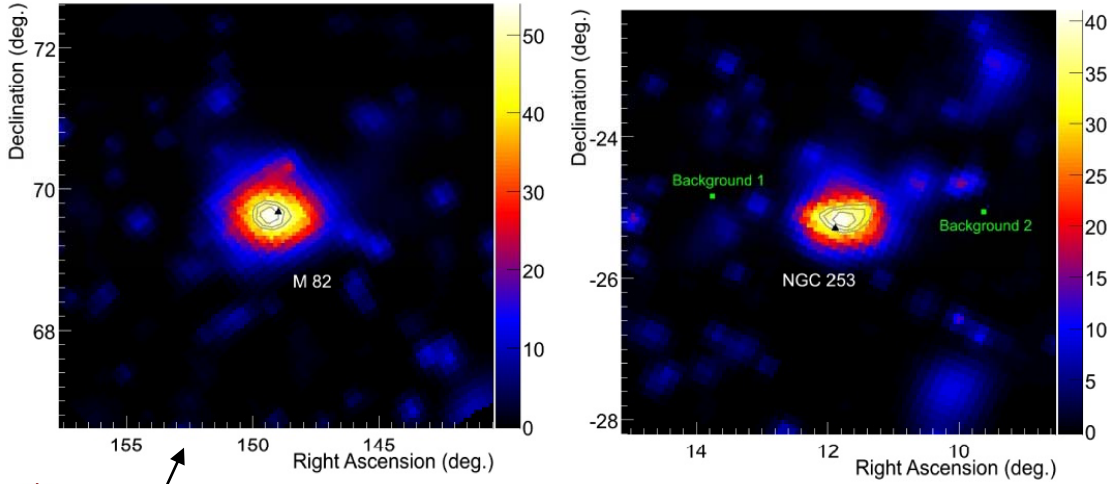
arXiv: 1001.3298

Starburst galaxies: M 82 and NGC 253

Gamma-ray luminosity scales with SN rate times gas mass

Recall: spatial variations may be important (LMC)





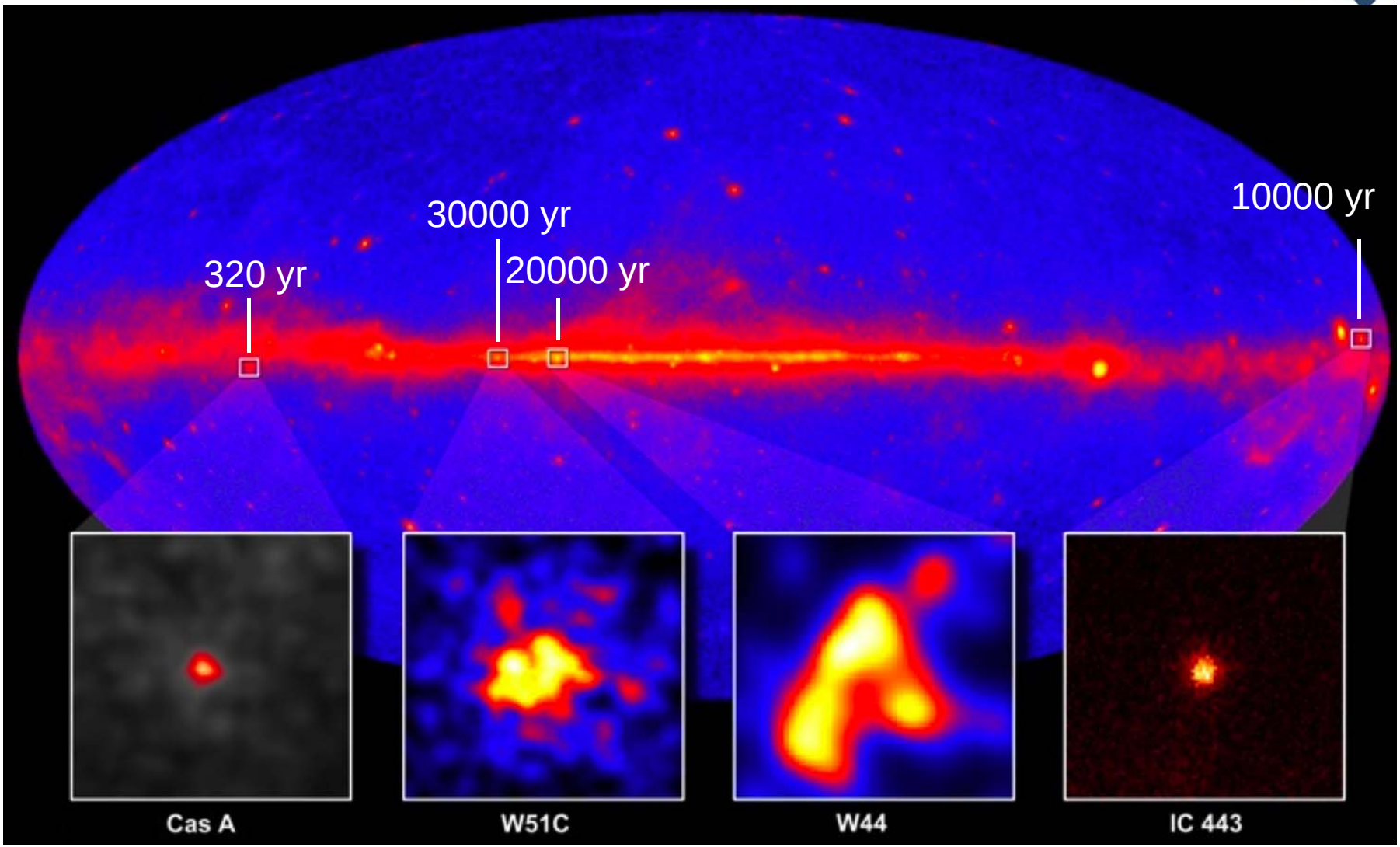
LAT TS maps > 200 MeV

M 82
- Detected at 6.8σ
- Detected at VHE by VERITAS

NGC 253
- Detected at 4.8σ
- Detected at VHE by HESS

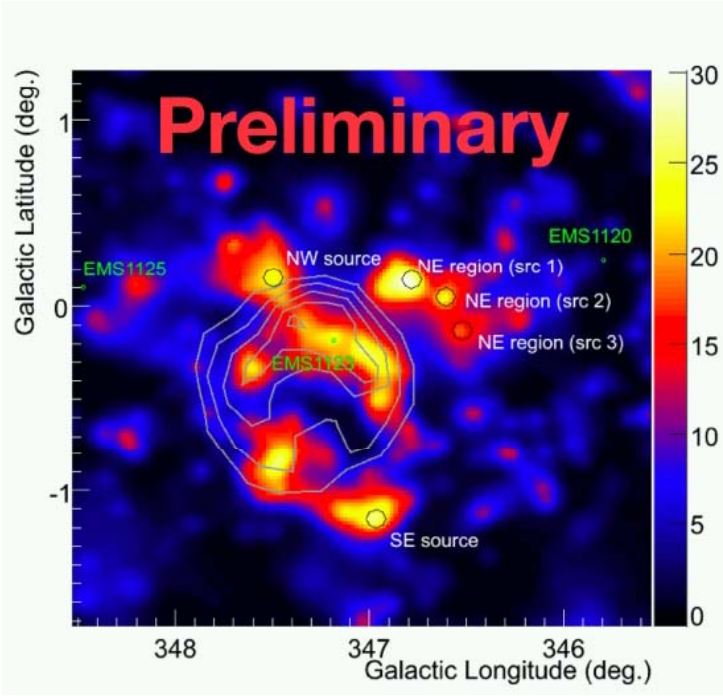
Abdo et al. (2010), ApJ, 709, L152

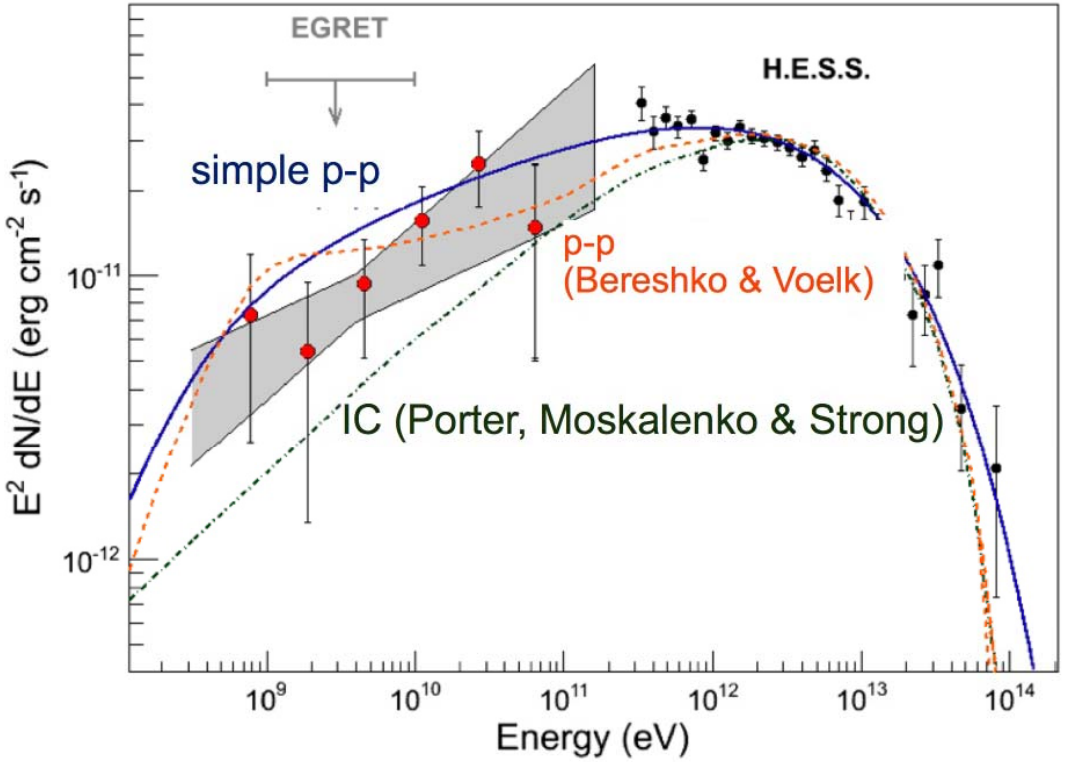
Resolving Supernova Remnants with Fermi



Young (historical) SNRs

Example: RX J1713.7-3946



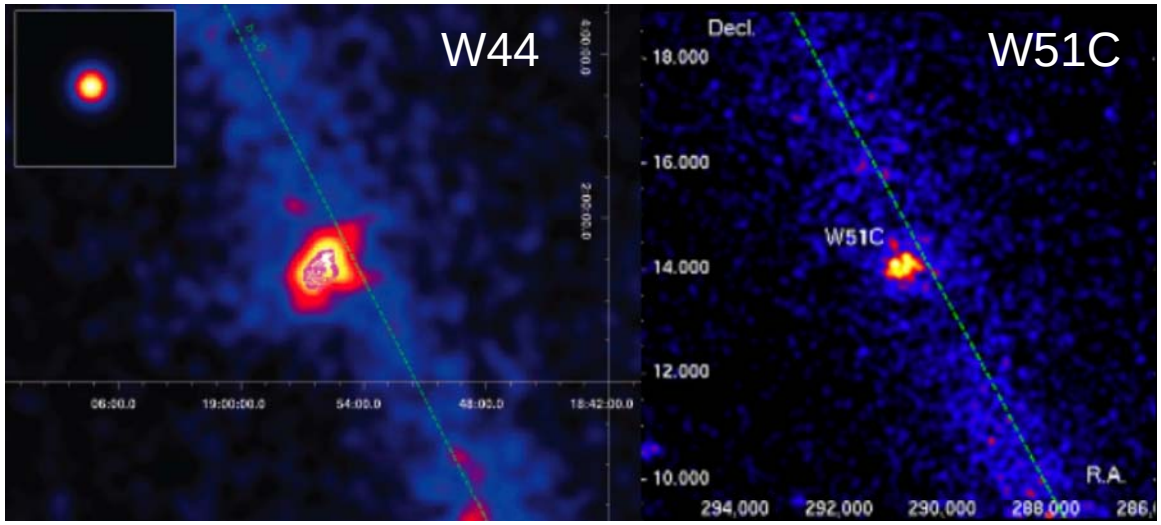


Faint source in a complex region

Sources to the north coincide with molecular material (CO/HII)

Hard spectrum in the Fermi/LAT band connects to HESS VHE spectrum

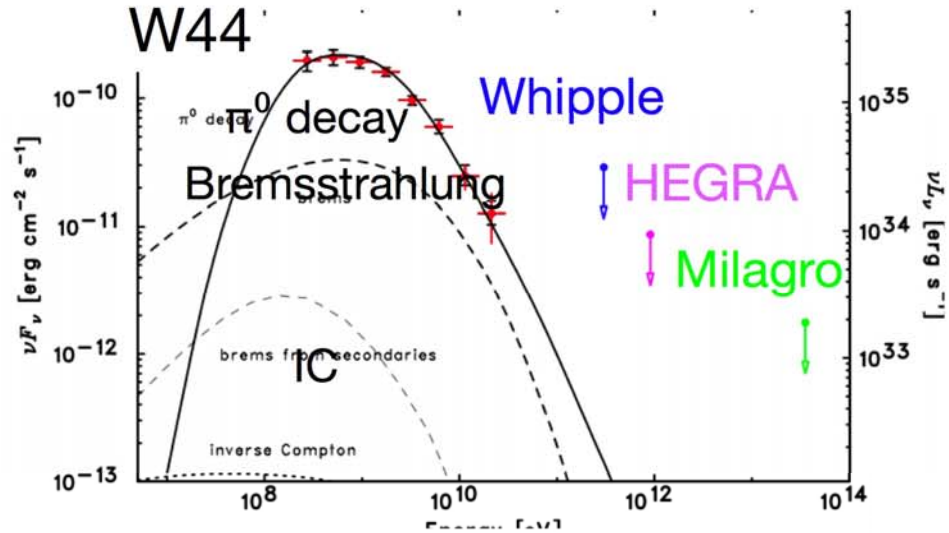
Mid-aged SNRs

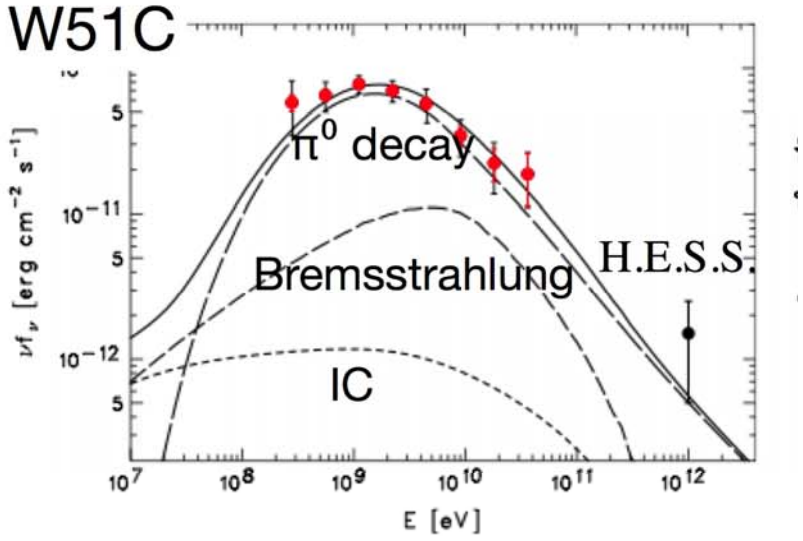


Typical rather steep spectrum compared to young SNRs

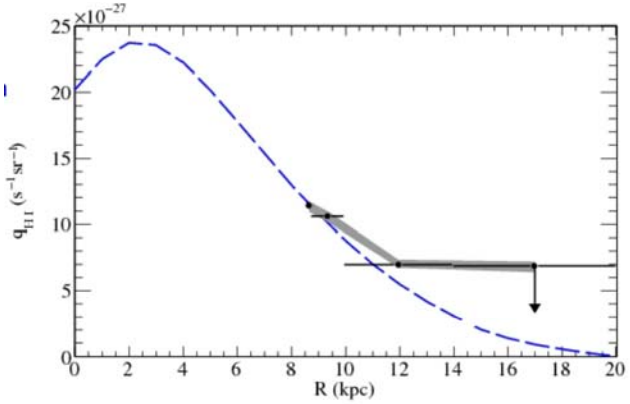
Extremely luminous

Detection of SNRs interacting with molecular clouds favoured



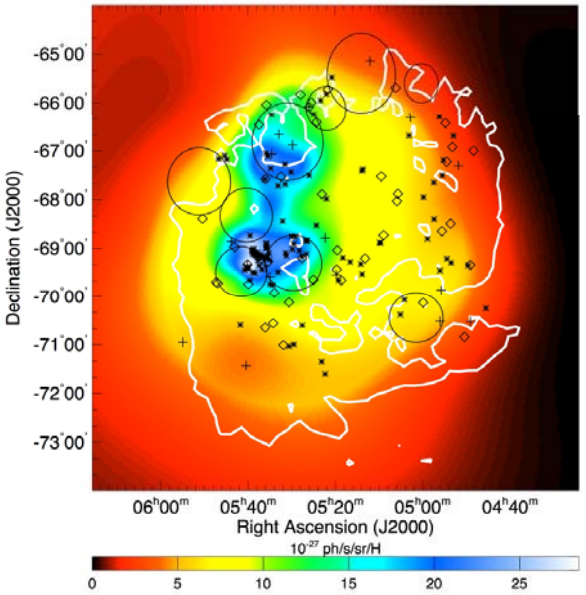


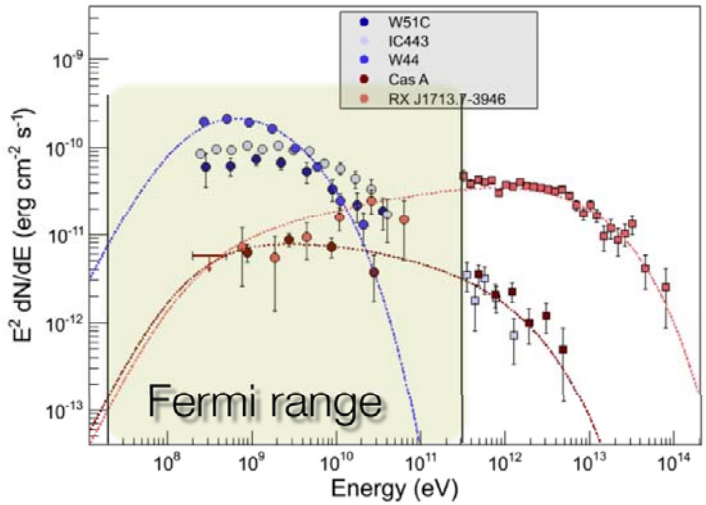
Summary



Fermi/LAT determines cosmic ray properties throughout our Galaxy

Fermi/LAT maps cosmic particle acceleration sites in nearby galaxies





Fermi/LAT probes different evolutionary stages of SNRs constraining particle acceleration and release in our Galaxy