Chasing unidentified EGRET sources with Neil

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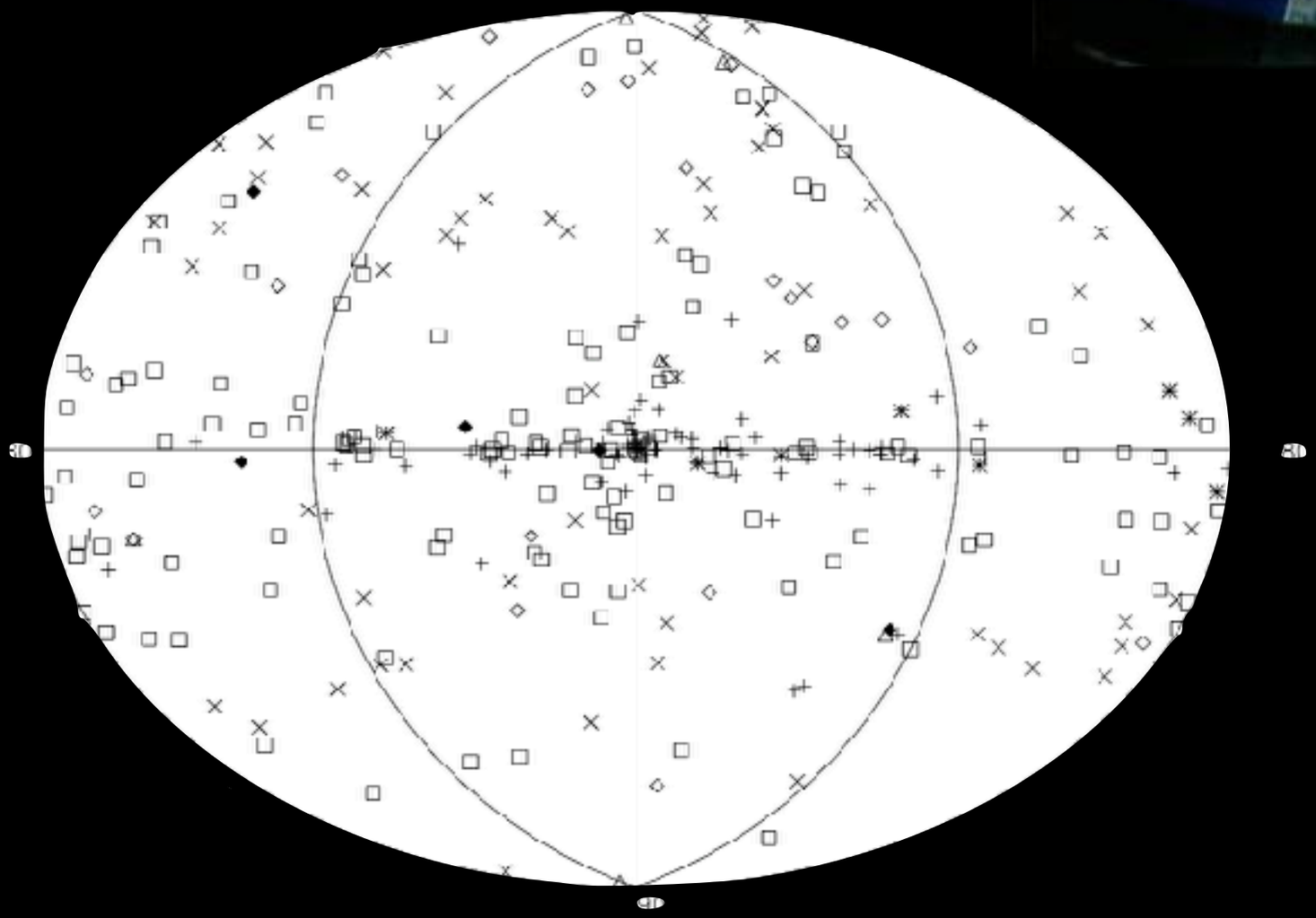
γ-ray source population studies

- Compton Gamma-Ray Observatory
  - 1991-2000 (project scientist)
  - CGRO-EGRET
    AGN populations
- Macomb & Gehrels 1999:
  - catalogue of 309 sources
  - from 50 KeV to 1 TeV

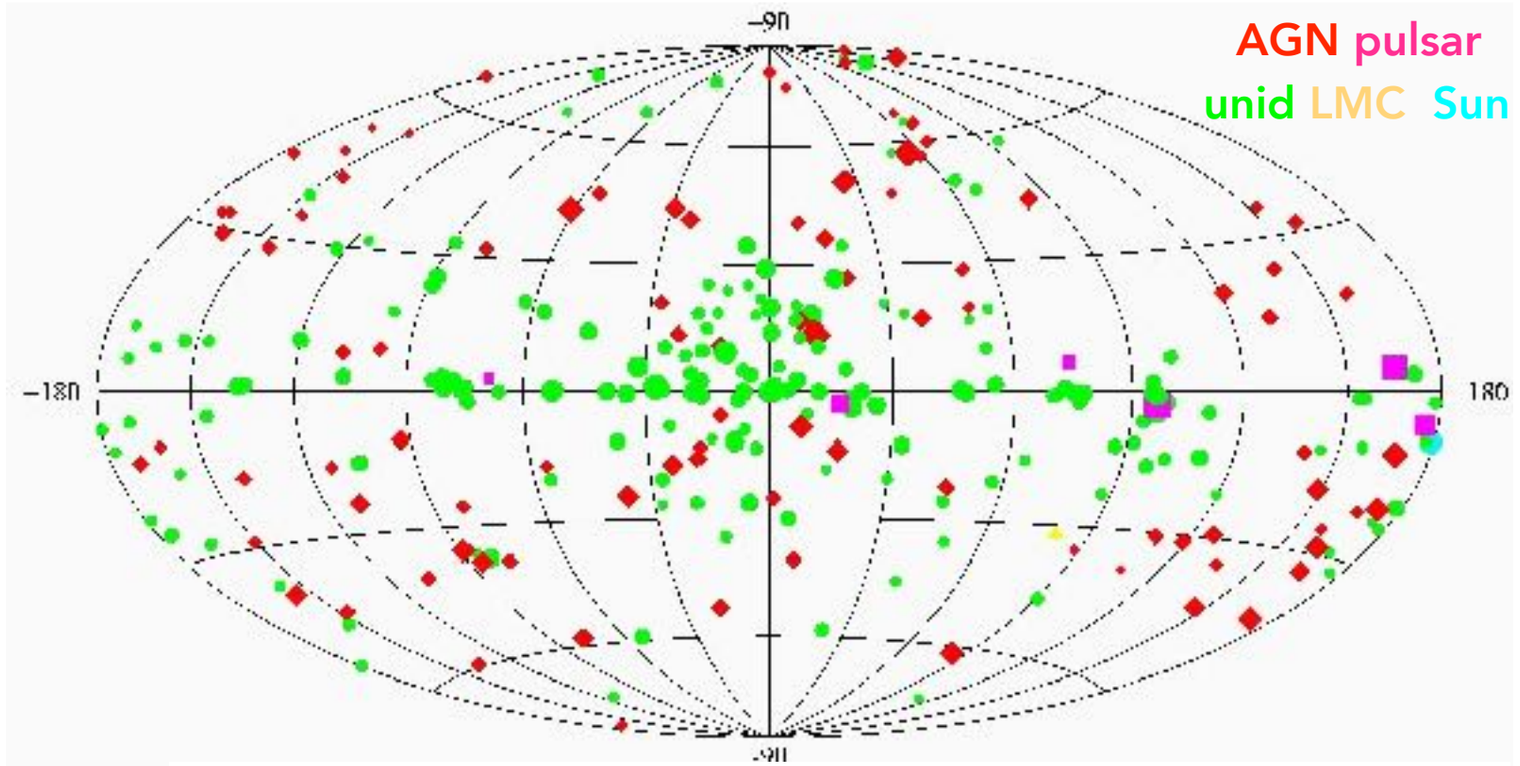


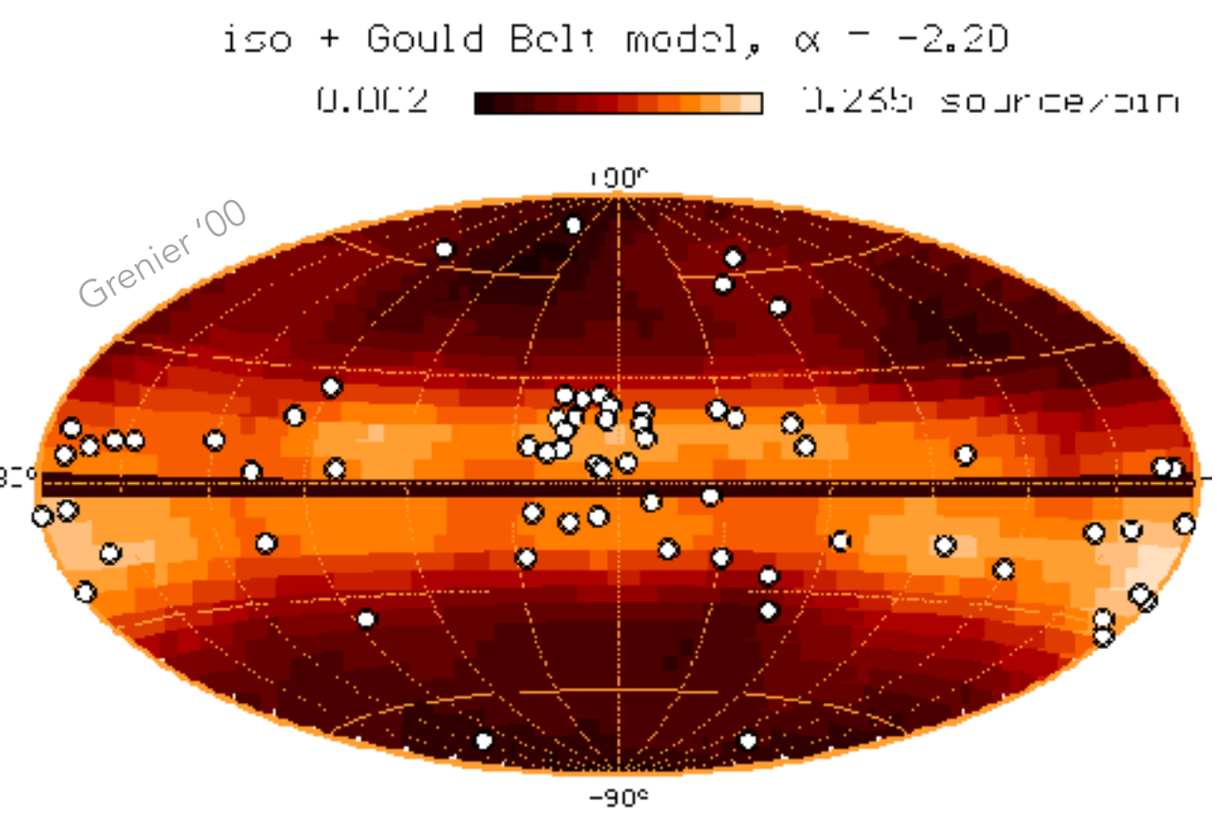
+ accreting source
* pulsar
◇ AGN Seyfert
╳ AGN quasar
△ galaxy/cluster/diffuse
□ unidentified

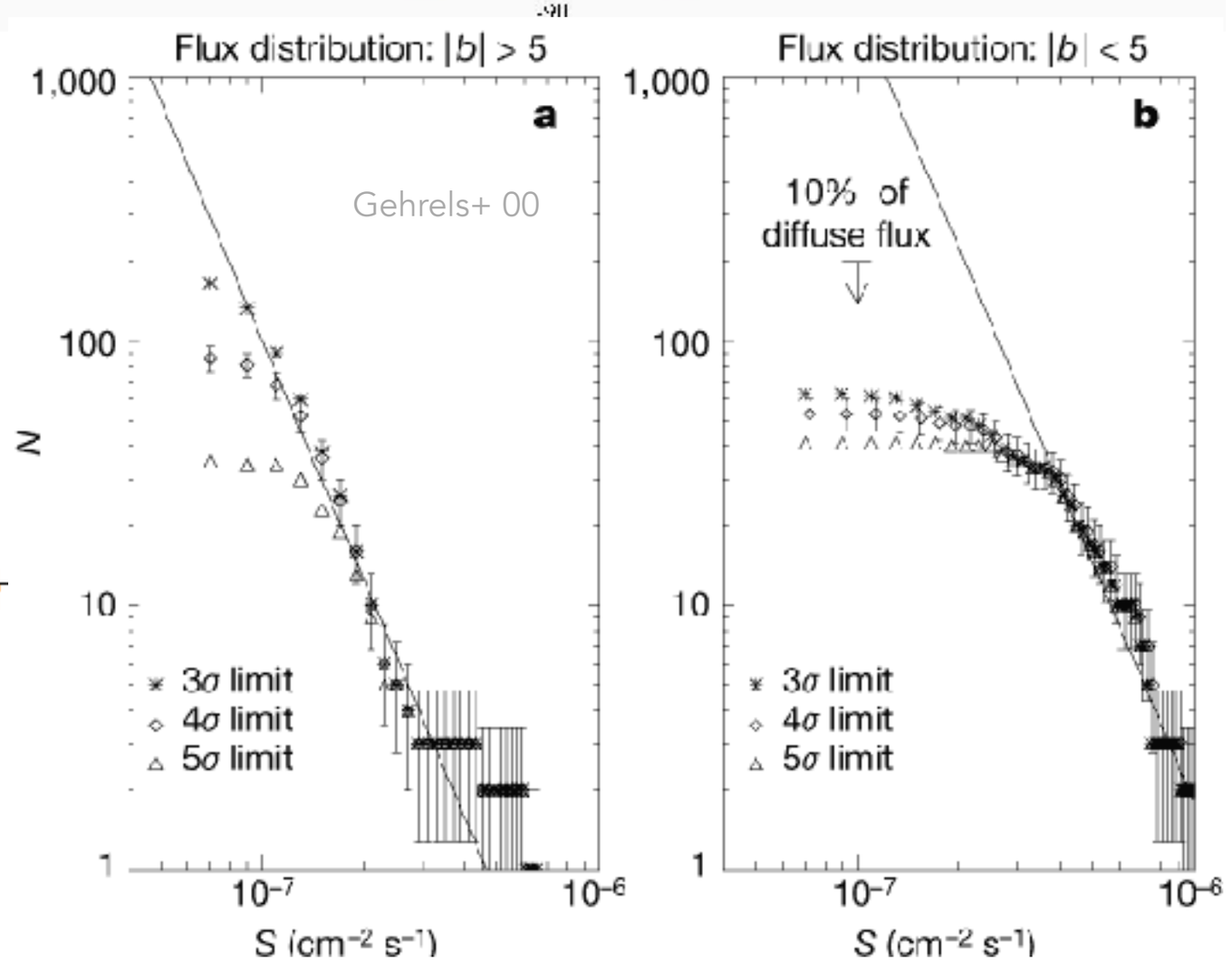
◆ SNR

EGRET unidentified sources

- 3rd EGRET catalog, > 100 MeV:
  - ✦ 170 unidentified sources
- Grenier 1997+99+00:
  - ✦ 45 ± 6 persistent sources associated with the Gould Belt
- Gehrels et al. 2000:
  - ✦ 20 mid-latitude sources
  - ✦ fainter and softer ($E^{-2.49 \pm 0.04}$) than at low latitudes ($E^{-2.18 \pm 0.04}$)



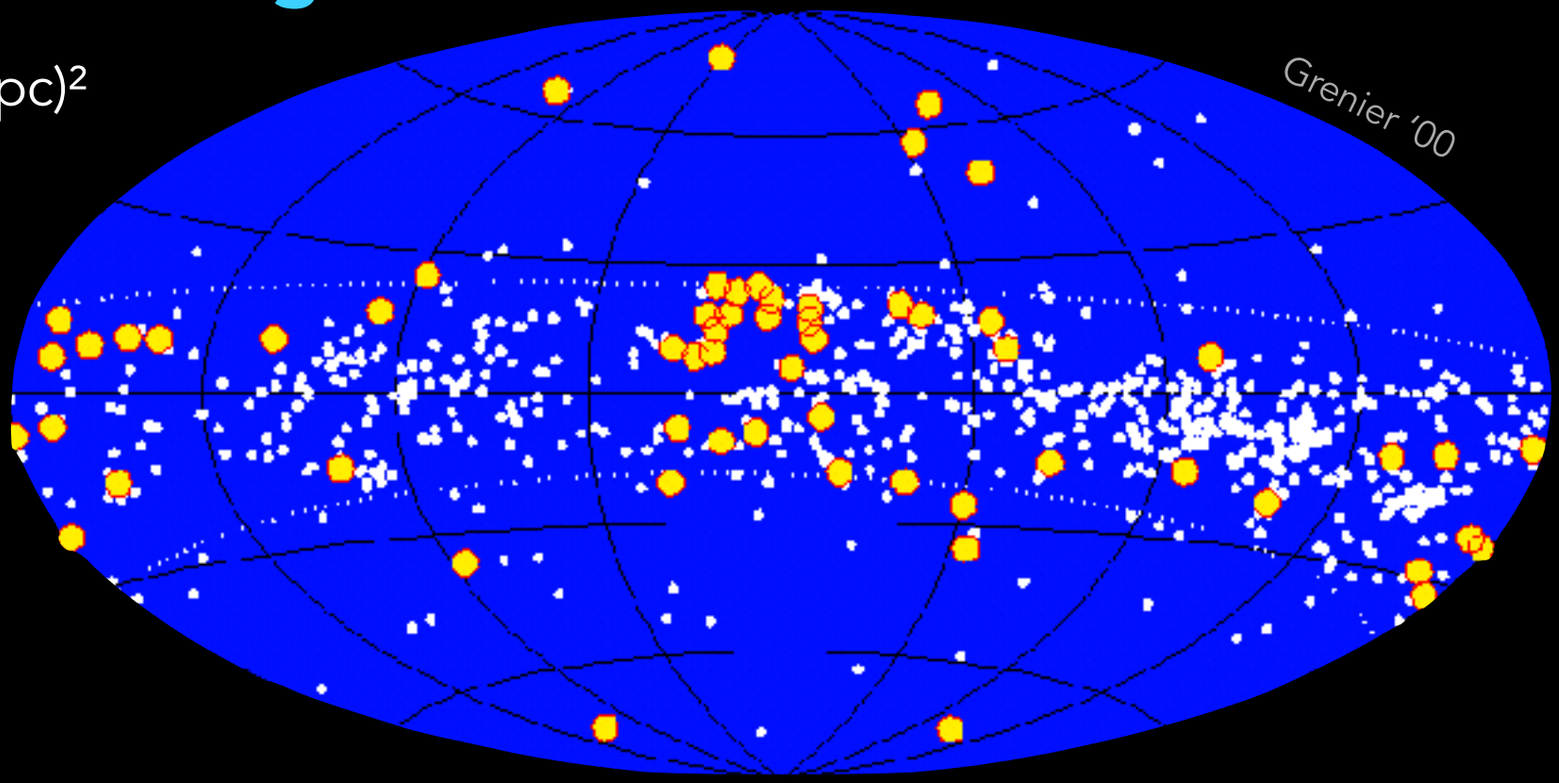




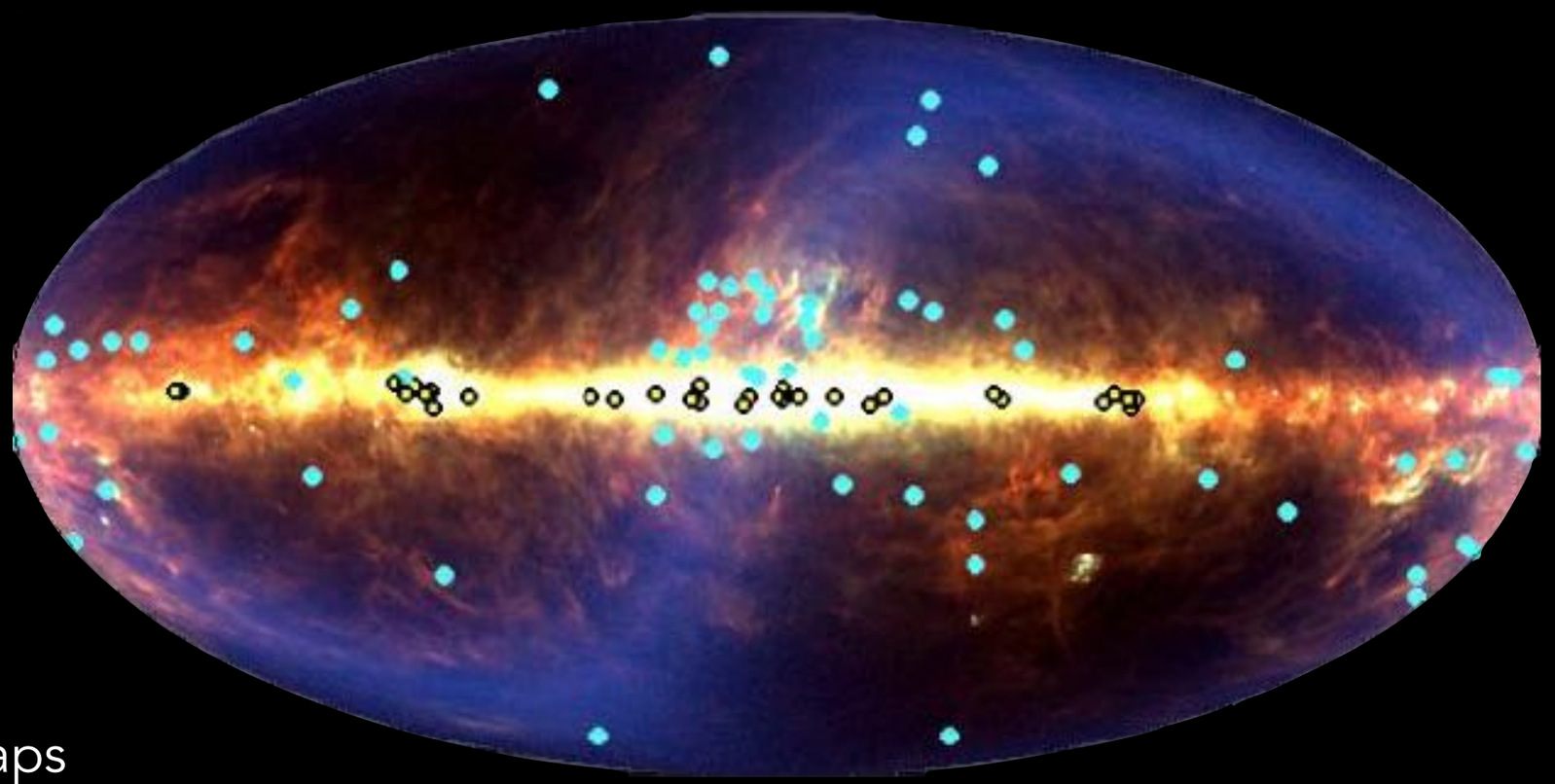
origins?

- $L_{iso,\ >\ 100\ MeV} \sim 0.2\text{-}8\ 10^{26}$ W (D/300 pc)²

3EG unidentified
young O-B3 star



- Belt supernova relics ?
  - 75 to 95 $Myr^{-1}\ kpc^{-2}$ Grenier '00
    = 3 to 5 times local Gal. rate
  - SN remnants,
    but too extended
  - off-beam pulsars ~ 20 over 5 Myr Harding & Zhang '01
    but bright enough?
  - BHoles accreting gas Dermer '01
    but 3 to 9 times fewer than NS
  - micro-quasars Kaufman Bernado+02
    but too few



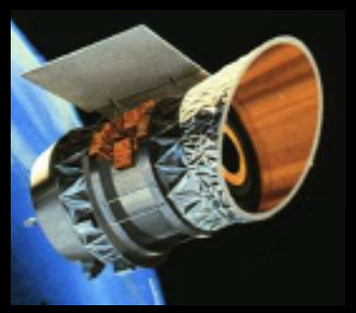
- hidden gas clumps ?
  - but not resolved in HI & CO maps

the dark neutral gas

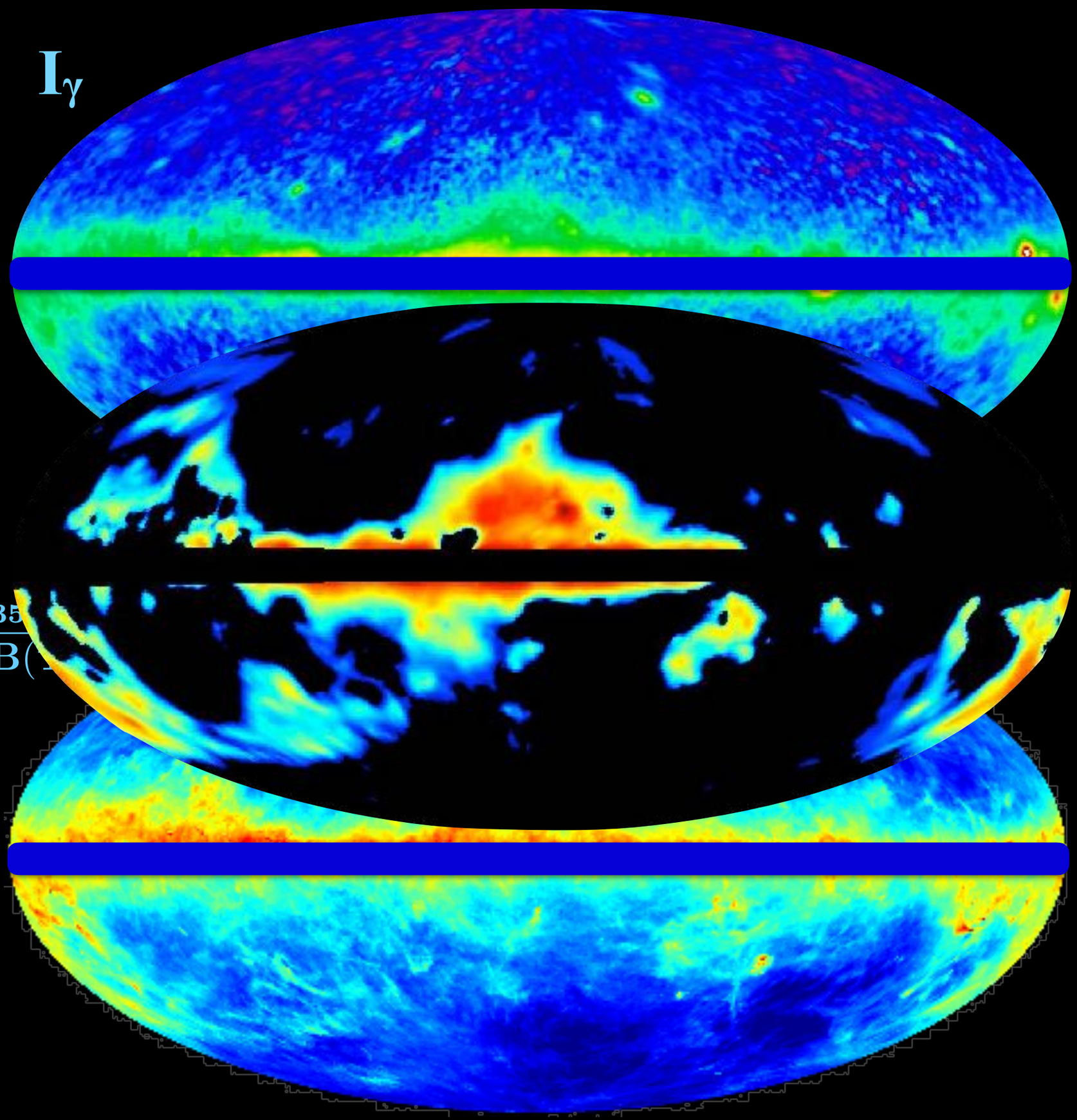
- EGRET > 100 MeV

$$\text{diffuse intensity} \propto \int n_{gas}\, n_{CRs}\, dl$$

- IRAS + DIRBE

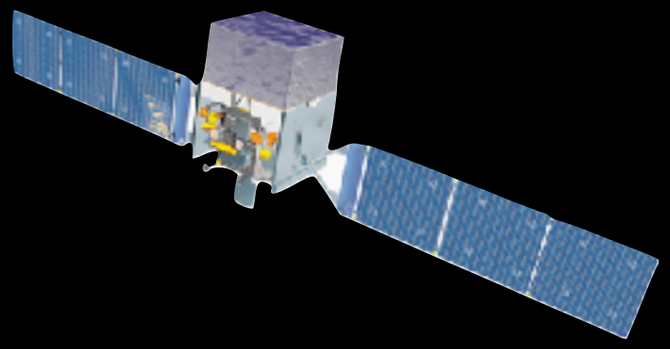


$$\text{thermal intensity} \overset{\propto}{\int} \frac{M_d}{M_g} n_g \kappa_0 \left(\frac{\nu}{\nu_0}\right)^{\beta} B_\nu(T_d)\, dl$$



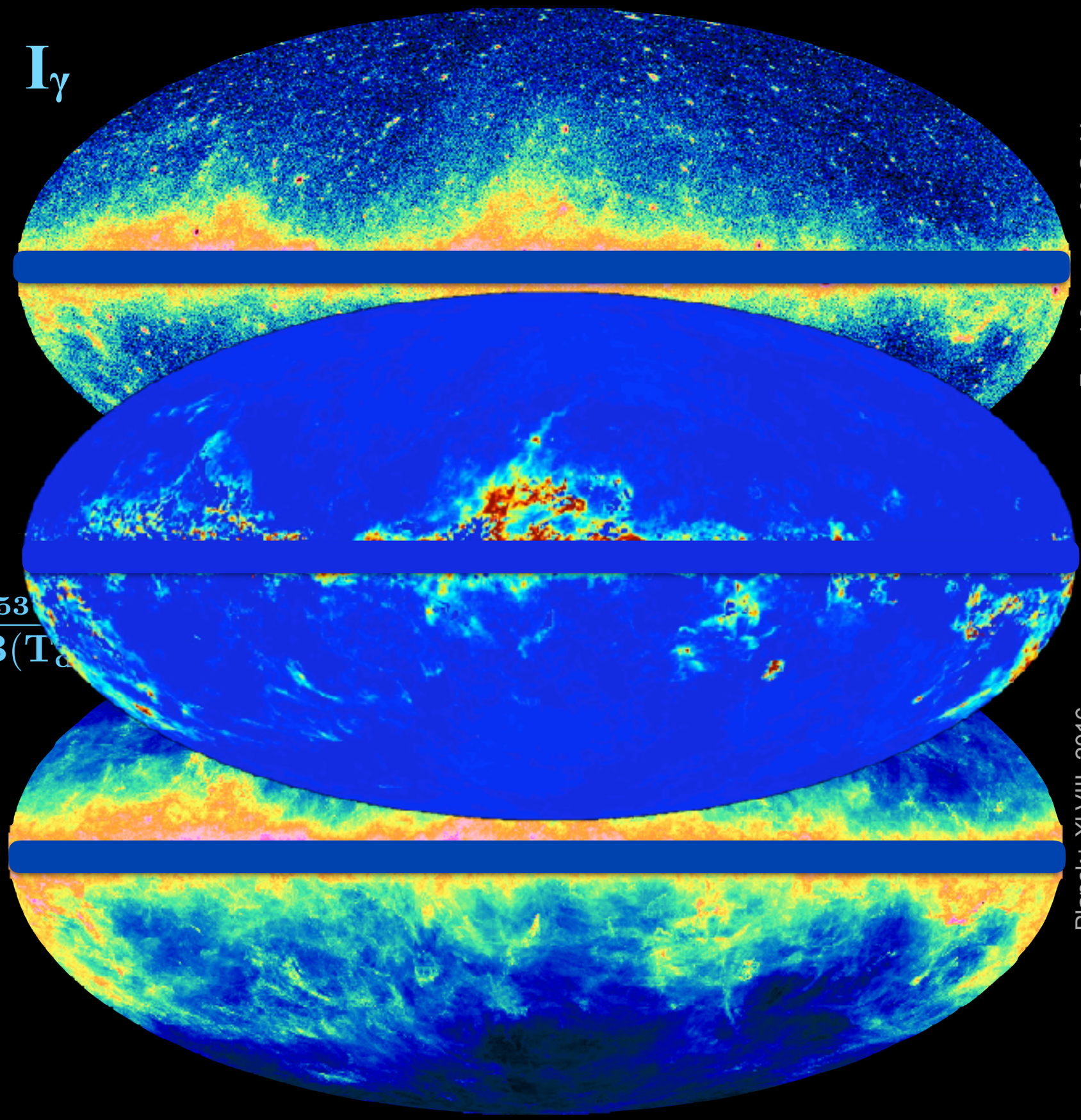
the dark neutral gas

- Fermi-LAT > 0.6 GeV



$$\text{diffuse intensity} \propto \int n_{gas}\, n_{CRs}\, dl$$

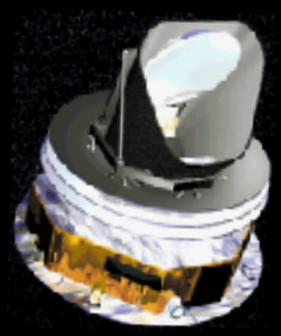
I_γ



Fermi 8 years > 0.6 GeV

- Planck + IRAS

$$\tau_{353} = \frac{I_{353}}{B(T_d}$$



thermal intensity

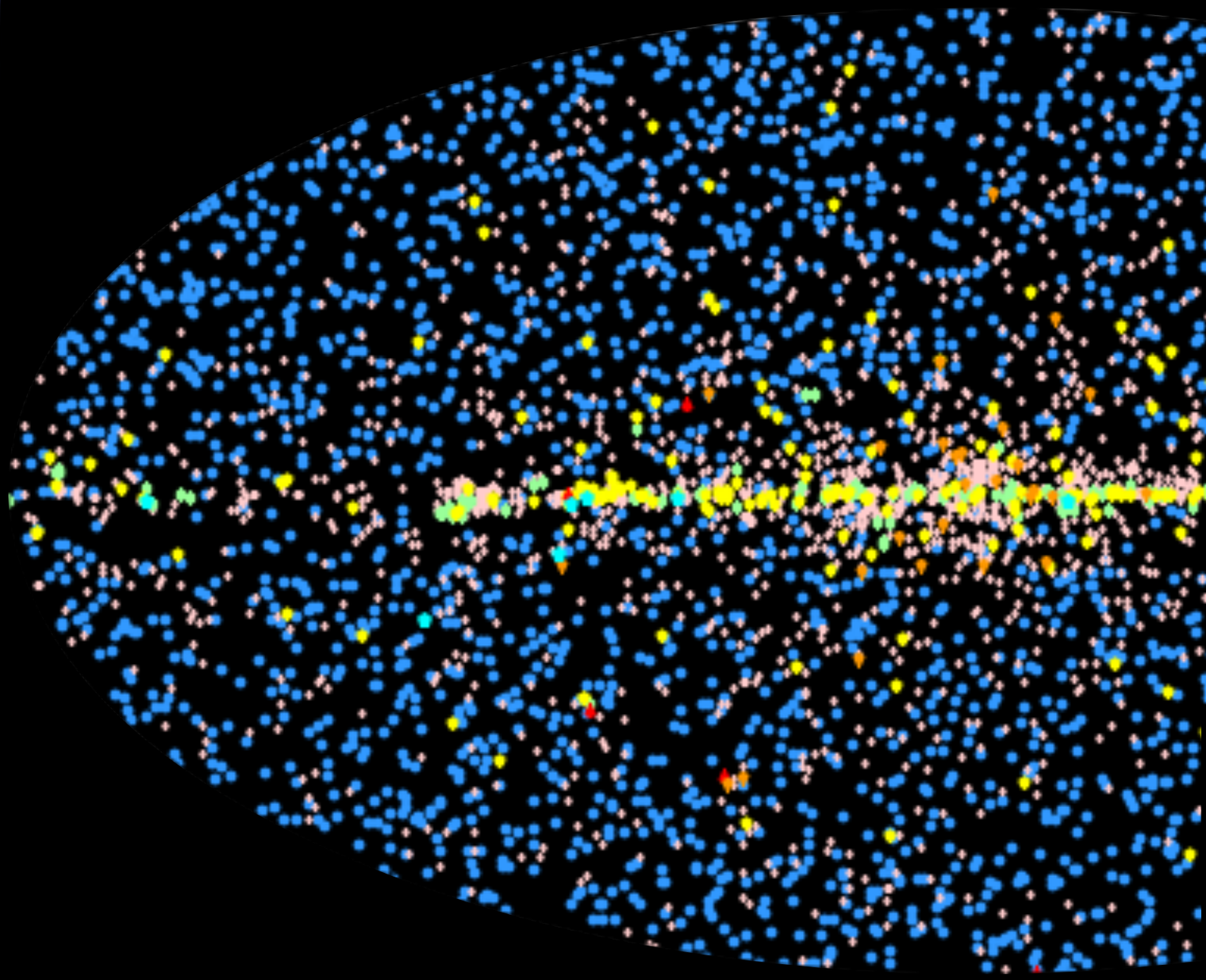
$$\int \frac{M_d}{M_g} n_g \kappa_0 \left(\frac{\nu}{\nu_0}\right)^{\beta} B_\nu(T_d)\, dl \propto$$

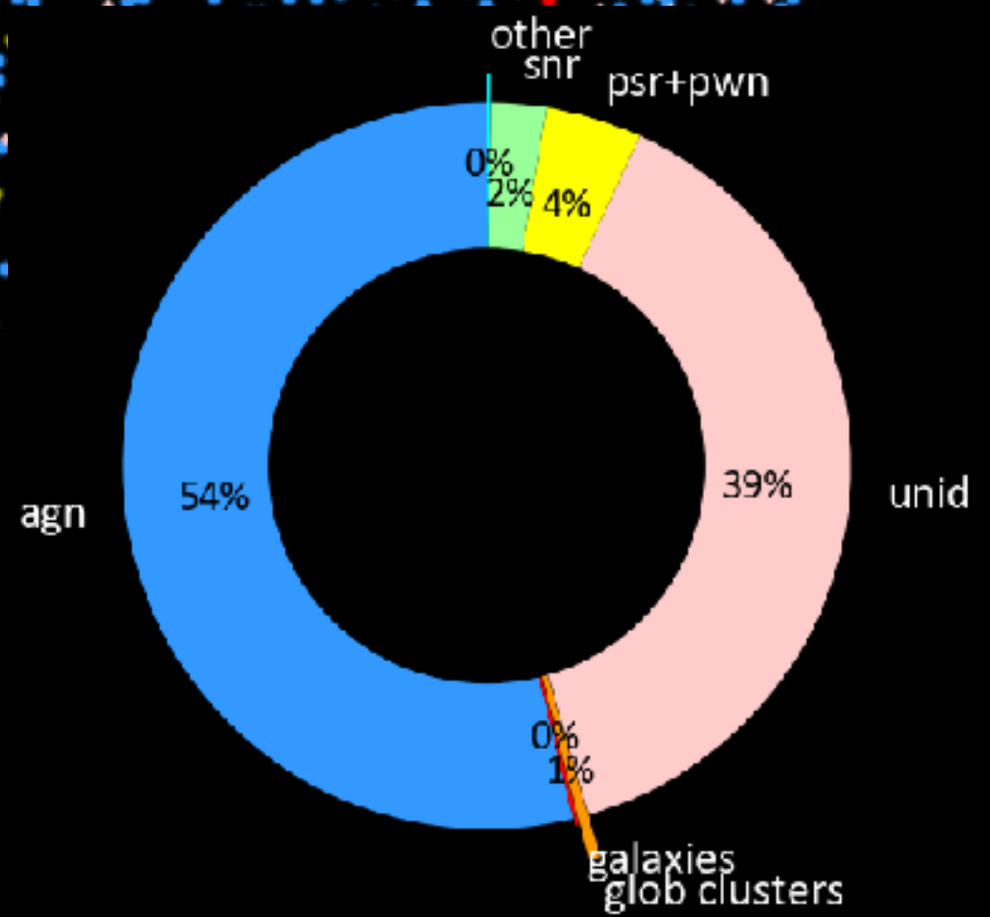
Planck+.XLVIII, 2016

setting GLAST on the right track

- chair of the Gamma Ray Astrophysics Program Working Group (GRAPWG) 1999
- led the GLAST project science requirement document (2000)
- helped with the science case for LAT, data right policy, deputy project scientist …

more unidentified puzzles





- FL8Y source list = 5523 sources
  - localization ≈ 4.5’

the efficiency of a broad smile, boldly looking forward

Neil 1952 - 2017

- graduated from University of Arizona
  majored in music, then in physics
- PhD Cal'Tech 1982 with Ed Stone
  - ✦ Voyager 1 + 2, Jupiter
  - ✦ data analysis from cosmic-ray detectors
  - ✦ O+S energetic ions (10-20 MeV/n) from Io
    accelerated at r > 17 R_{Jup} in magnetosphere

Ed would say that Neil was incredibly gifted