SPI/INTEGRAL ALL-SKY SURVEY

What we know about soft γ-rays sky emission

- The point sources emission dominates the sky emission up to 200 keV
  Diffuse continuum emission < 15 % of the total emission in the 20-200 keV (Lebrun et al., 2004; Terrier et al., 2004; Strong et al., 2005; Bouchet et al., 2005).

- GRXE between 3 and 60 keV : population of accreting white dwarfs binaries ? (Revnivtsev et al., 2006; Krivonos et al., 2007).

- Annihilation spectrum (511 keV line + positronium continuum) contributesbetween 200 and 511 keV (Knödlseder et al., 2004; Churazov et al., 2004; Jean et al., 2006) . Bulge + disk/halo emission ? (Knödlseder et al., 2005).

- Particle interactions with interstellar medium

POINT SOURCES VERSUS DIFFUSE EMISSION

“DIFFUSE” EMISSION NATURE ?

REALLY “DIFFUSE”

Inverse-Compton of GeV electrons

Bremsstrahlung of few 100 keV electrons

AND/OR UNRESOLVED SOURCES

SPI (20- 8000 keV) allows simultaneous determination of point sources and extended diffuse emissions

Presented results based on 4 years of observation : ~ 51 Ms

“Imaging” of both sources and “diffuse” emission

Survey – sources catalogue

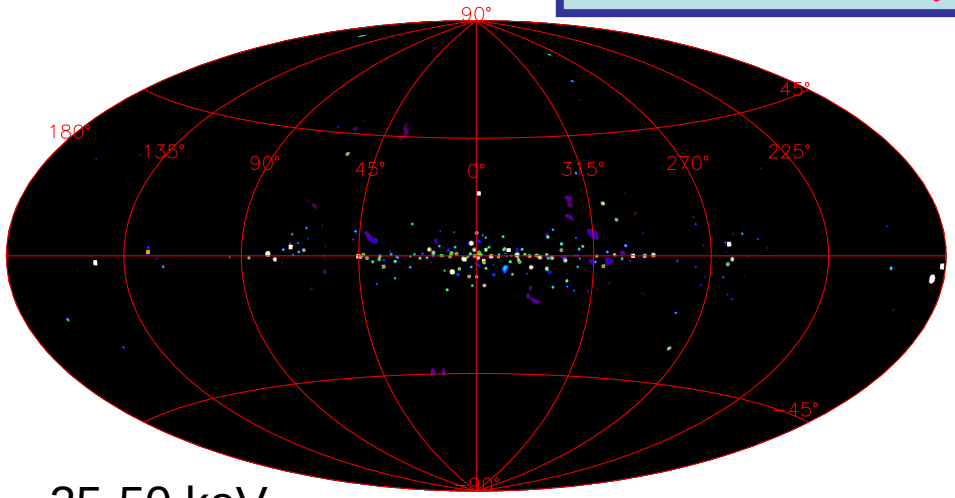
Diffuse emission “mapping” & morphology

POINT SOURCES & DIFFUSE EMISSIONS

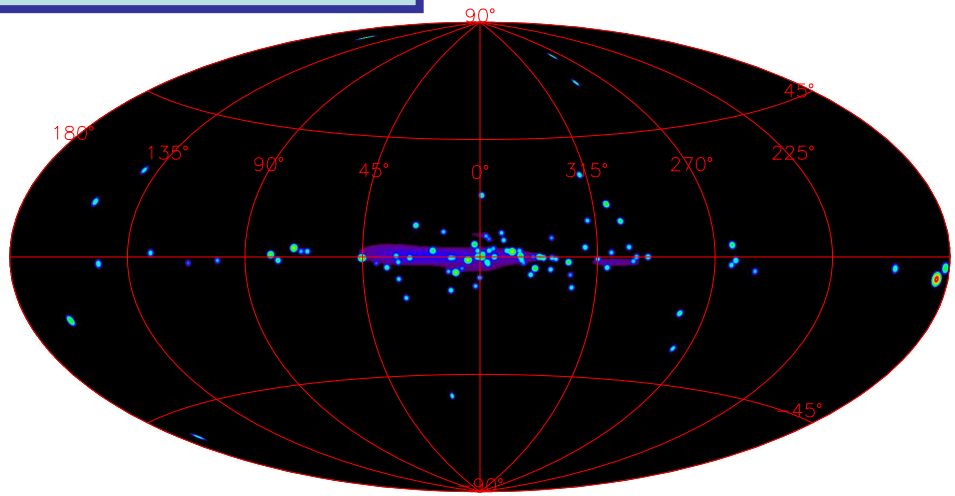
- Catalogues
  - A priori information on the diffuse morphologies
  - Search for source position
    - 25-50 keV -> 173 sources (> 3.5 σ)
    - 50-100 keV -> 79 sources (> 3.5 σ)
    - 100-200 keV -> 30 sources (> 2.5 σ)
    - 200-600 keV -> 12 sources (> 2.5 σ)

- Point sources + Diffuse emission « imaging »
  - A priori information : source positions (catalogue)
  - Diffuse mapping in pixel of $\delta l = 16° \times \delta b = 2.6°$
  - Simultaneous sources and diffuse flux extraction

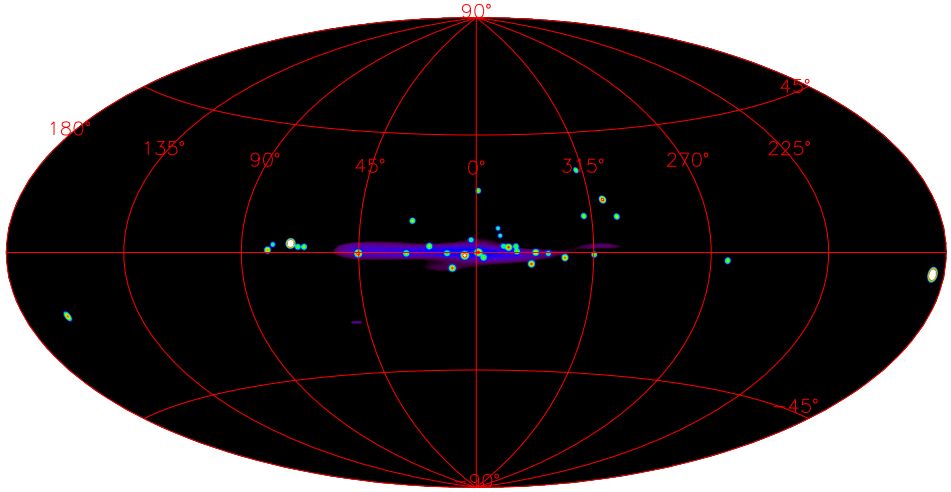
THE SOFT γ - RAYS SKY



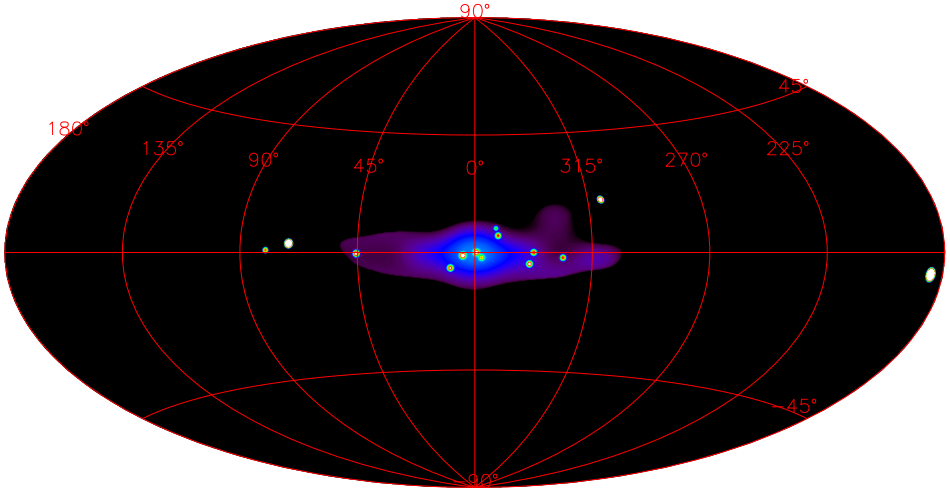
25-50 keV



50-100 keV



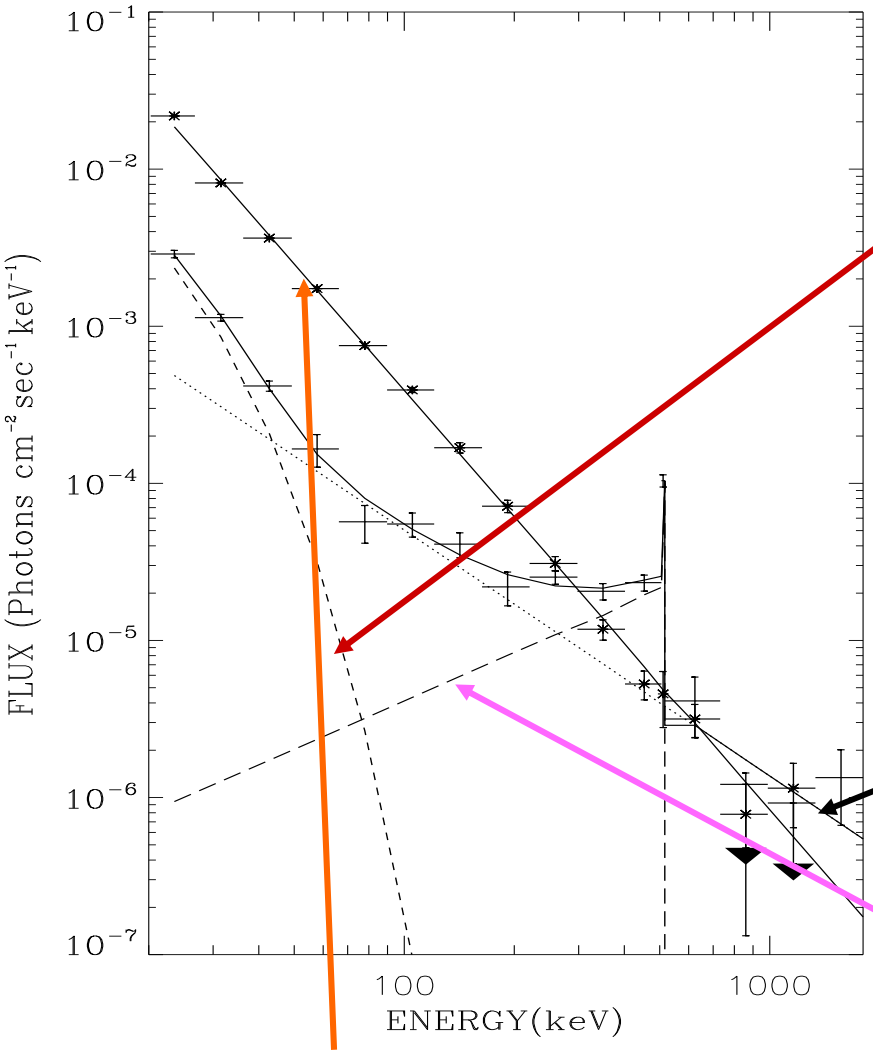
100-200 keV



200-600 keV

Below 250 keV, point sources dominate the sky emission
Between 250 and 511 keV, diffuse (annihilation radiation) dominates
Above 511 keV, emission from a few sources dominates (E > 1 MeV : Cyg X-1 and Crab Nebula)

CENTRAL RADIAN COMPOSITE SPECTRUM



20-60keV

Diffuse spatial distribution ≡ NIR 4.9 μ

Spectrum with an exponential cutoff ~ 30 keV

Luminosity ~ a few 10^{37}erg.s^{-1}

⬇

E < 60 keV dominated by a population of sources (White dwarfs, …). Krivonos et al., 2006

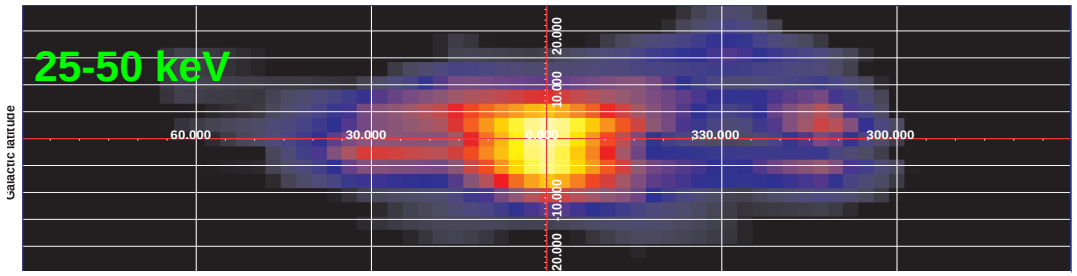
Interstellar emission (=>power law α~1.6)

Sum of sources (stars) (=> Power law α=2.67±0.04)

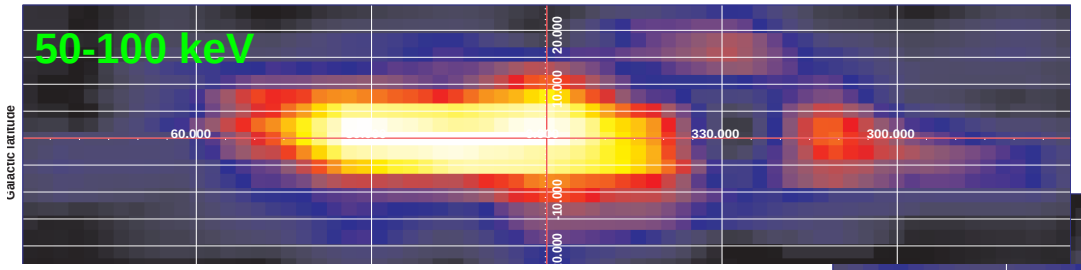
- **Positronium continuum & 511 keV annihilation line**
- **F_{511}=0.87±0.06 x 10^{-3} ph.cm^{-2}.s^{-1}**

Positronium fraction 0.98 +/- 0.05

MORPHOLOGY OF THE DIFFUSE EMISSION

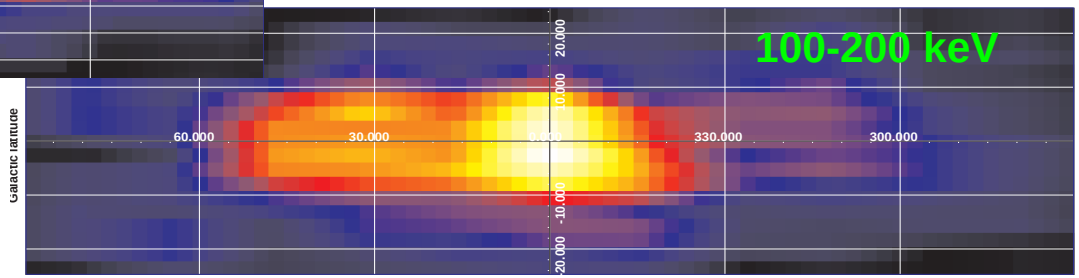


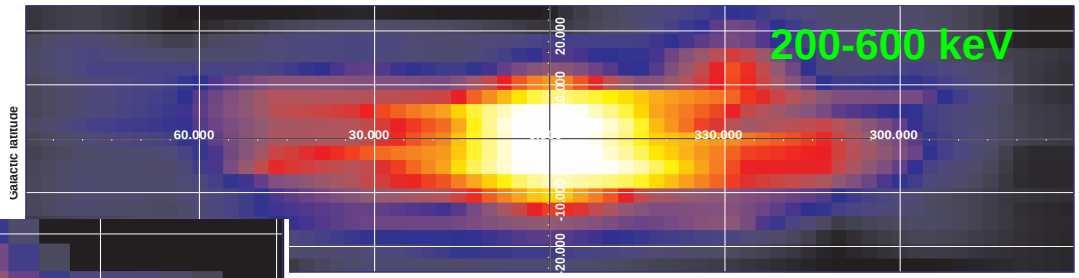
20°



-20°

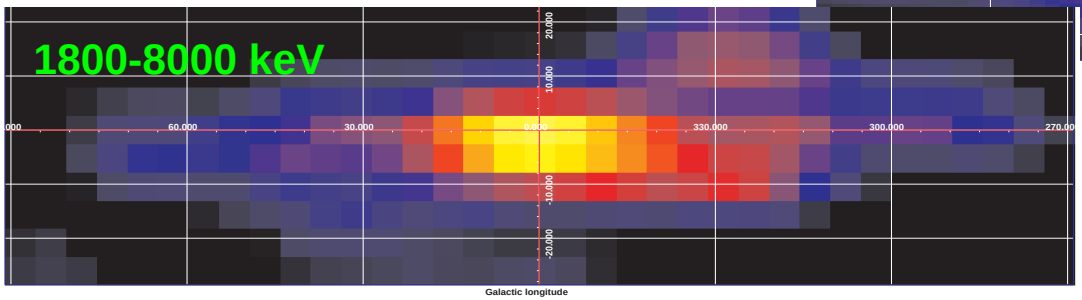
60° 30° -30°





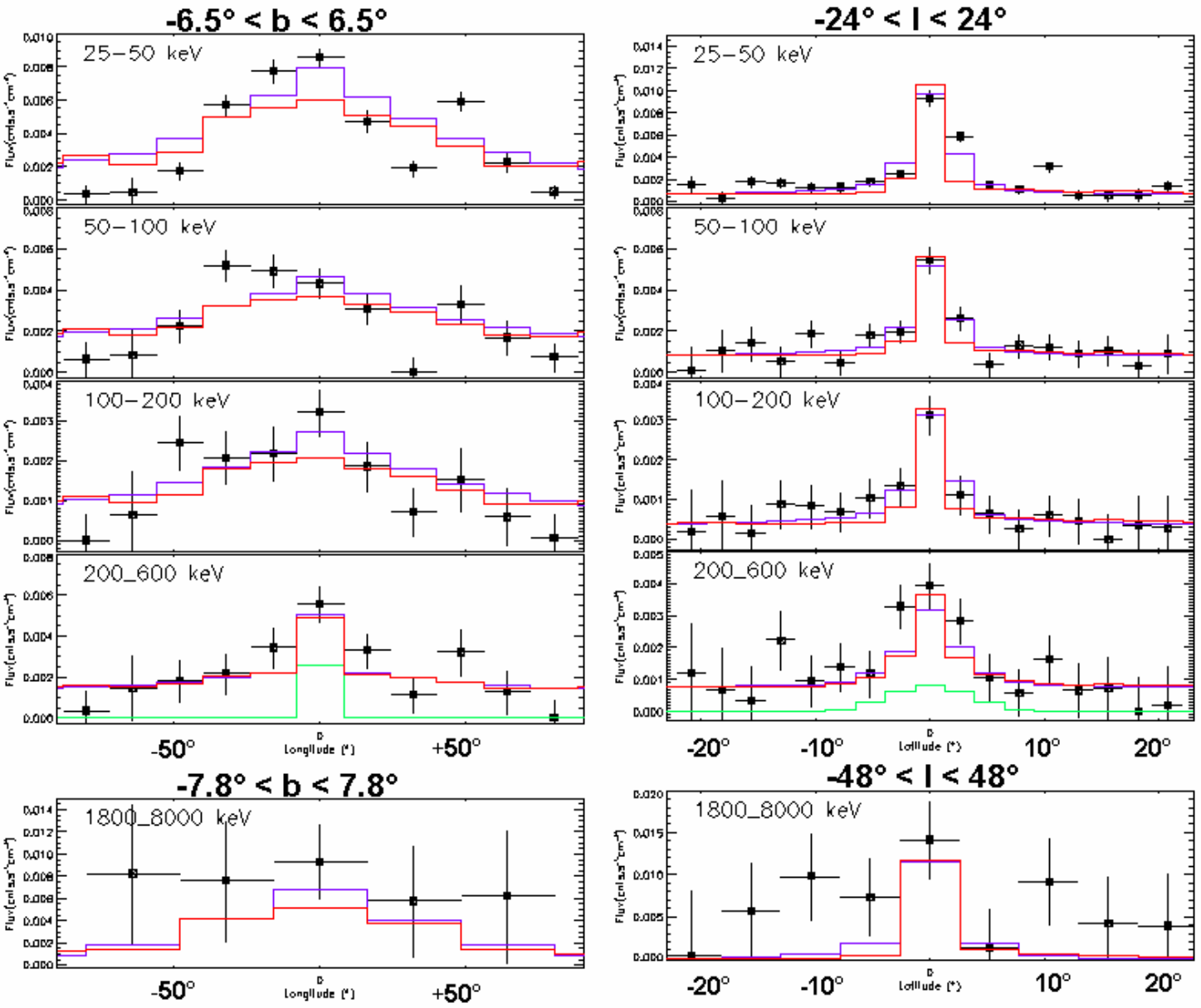
-60°

IMAGE IN THE MeV REGION



60° -60°

« DIFFUSE » PROFILES

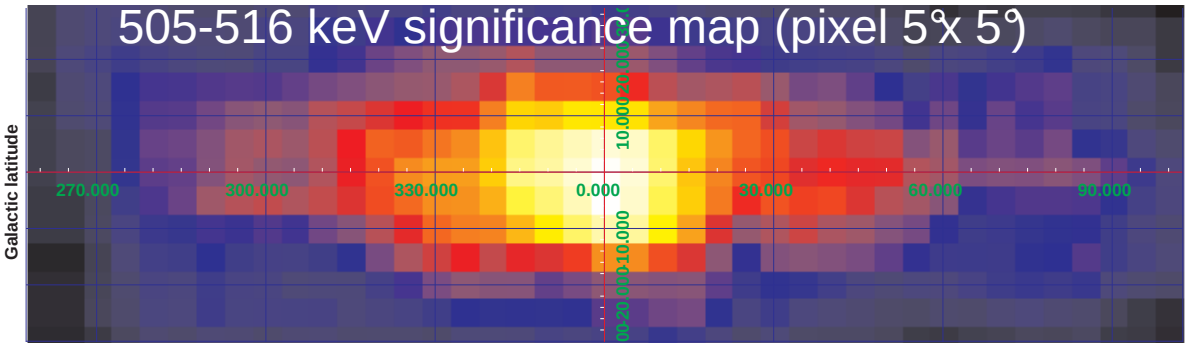


Blue : NIR 4.9 μ map stellar emission

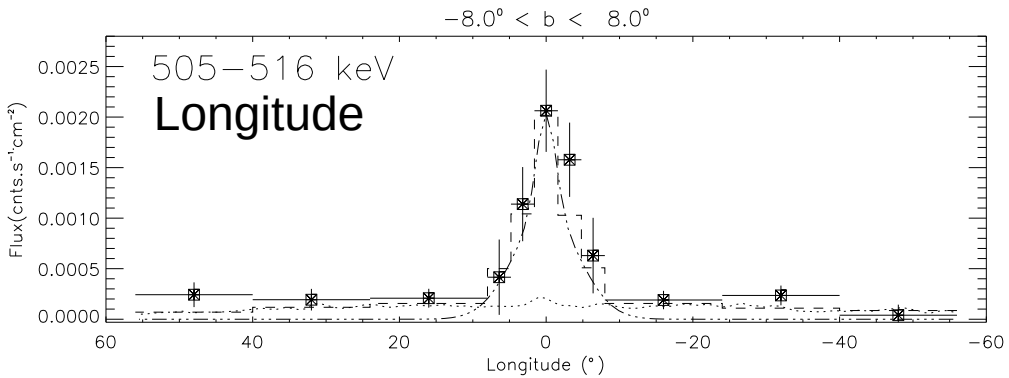
Green: 8° Gaussian annihilation spectrum

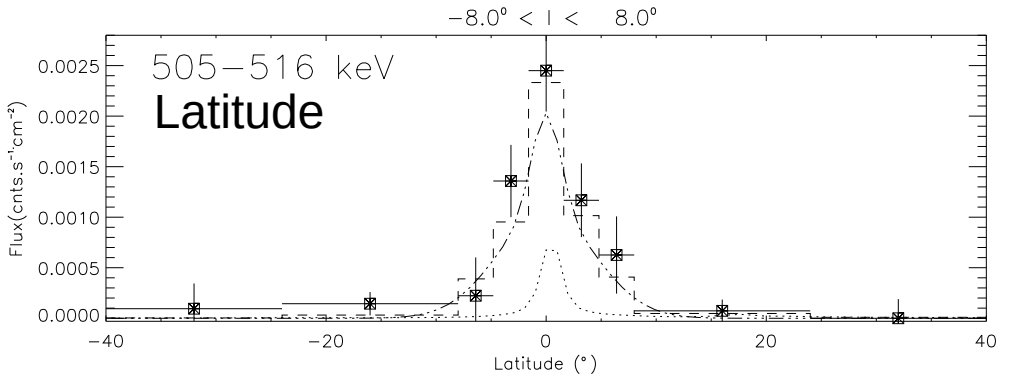
Red : CO map interstellar particle interaction

ELECTRON-POSITRON ANNIHILATION LINE



Significant emission outside the bulge





- Large scale (disk/halo) distribution

2D fit to the raw data with Tracers

➡240 μ DIRBE map

- Central bulge :

G=8.0±0.9°
F=0.87 ±0.06 ph.cm^{-2}.s^{-1}
$F_{240\mu}$=(1.8±0.3) x 10^{-3} ph.cm^{-2}.s^{-1}

or

G1=3.0°
G2=10.4°
$F_{240\mu}$=(1.7±0.3) x 10^{-3} ph.cm^{-2}.s^{-1}

Disk/Halo flux : 3-5 x 10^{-4} ph.cm^{-2}.s^{-1} (20 -30 %) explained by ^{26}Al decay chain,
~ 5% by Diffuse continuum, **~ 65 % another origin(s)**

SUMMARY

Imaging of resolved and unresolved emission

- **Point source survey**

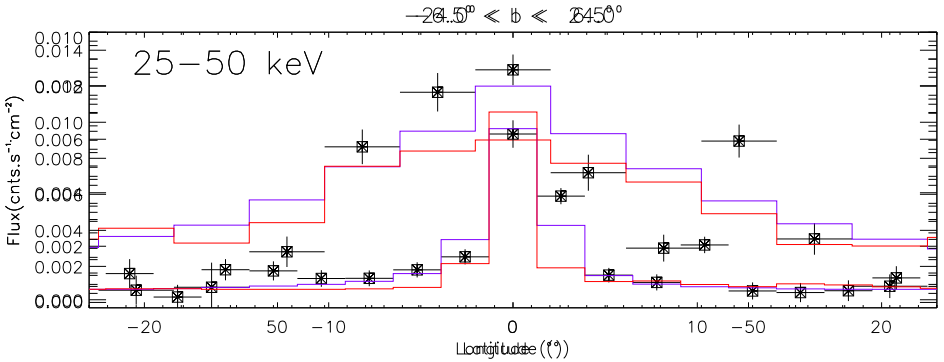
- **Unresolved/ Extended emission**

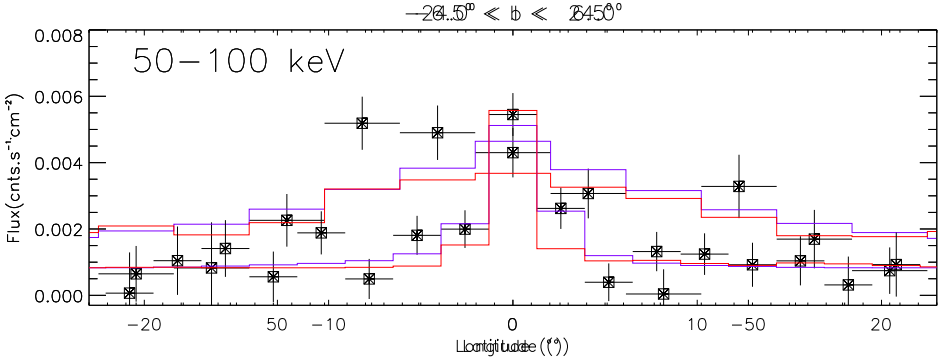
  - **Detection of a < 50 keV component**
    - **Luminosity for the central radian ~ 1.10^{37}erg.s^{-1}**
    - **Spectrum with a cutoff around 30 keV (70% of the “diffuse” emission between 20 and 60 keV).**
    - **Corroborates GRXE interpretation in terms of the population of accreting white dwarfs binaries (Revnivtsev et al., 2006, Krivonos et al., 2007).**

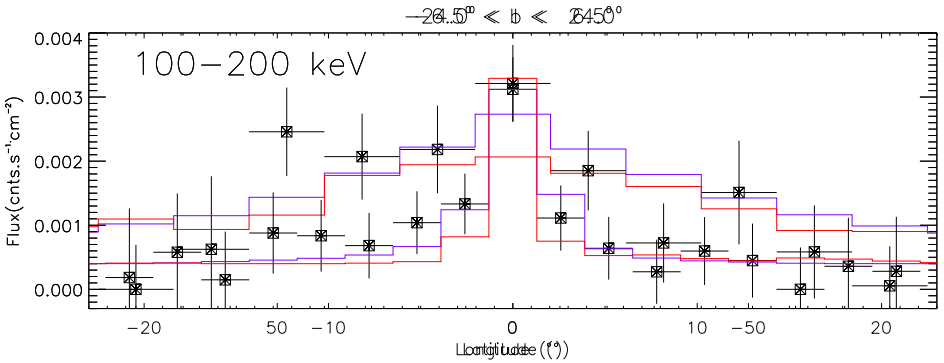
  - **e+/e- interaction**
    - **Complex geometry**
    - **Disk/halo detection**
      - » **Flux : 1.6 x 10^{-3} ph.cm^{-2}.s^{-1} (5-6 σ)**
      - » **^{26}Al decay chain = > 3-5 x 10^{-4} ph.cm^{-2}.s^{-1} (20-30 %)**
    - **~ 65% to be explained**

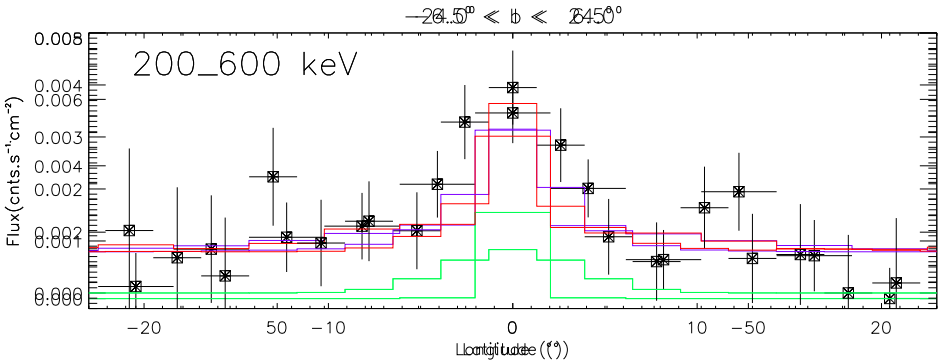
  - **Interstellar emission**
    - **Inverse-Compton : GALPROP model (Strong & Moskalenko 2004, 2007 , Moskalenko et al., in preparation)**
    - **Unresolved sources**

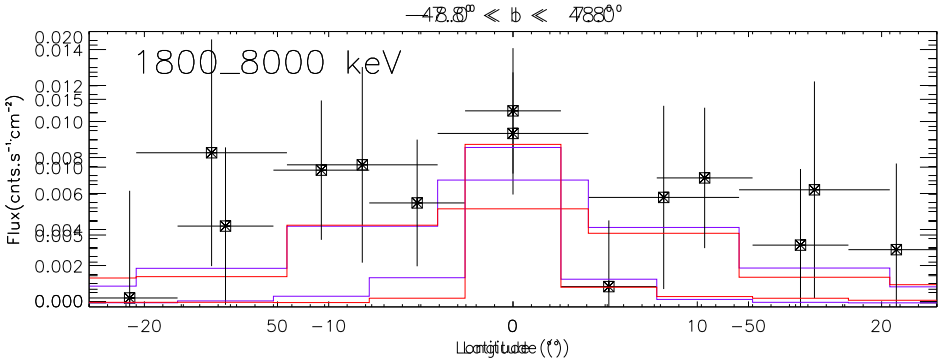
DIFFUSE PROFILES









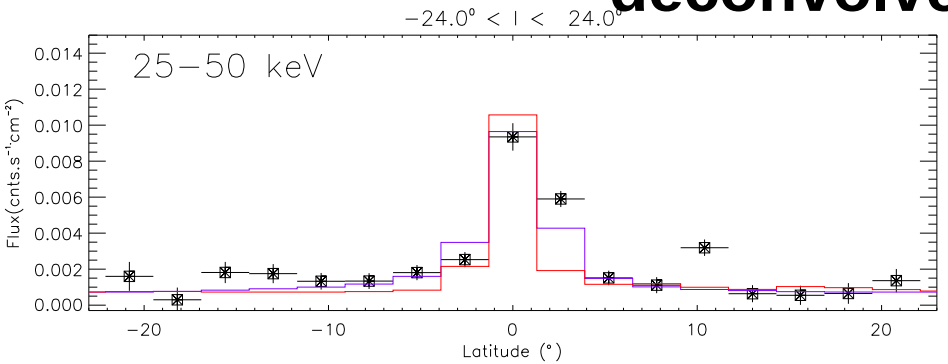


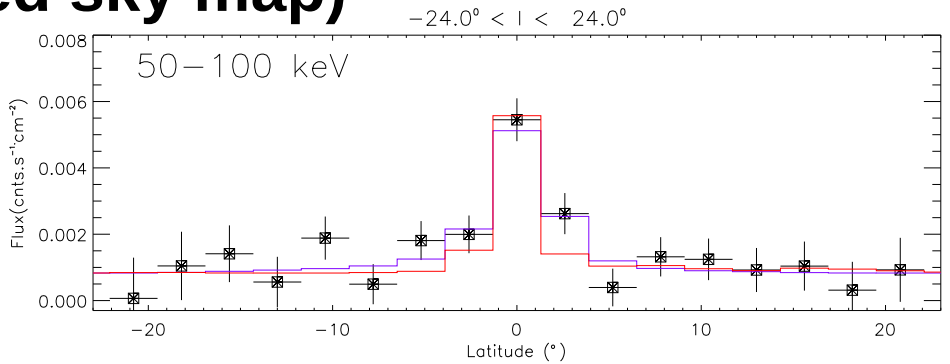
Blue : NIR 4.9 m (stellar emission)

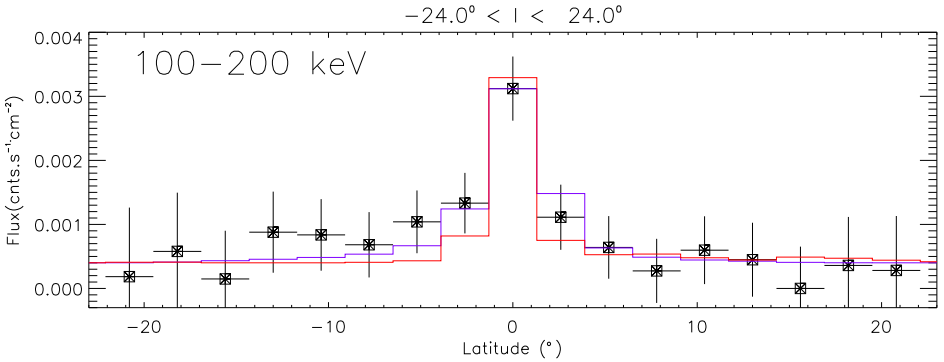
Red : CO (interstellar particle interaction)

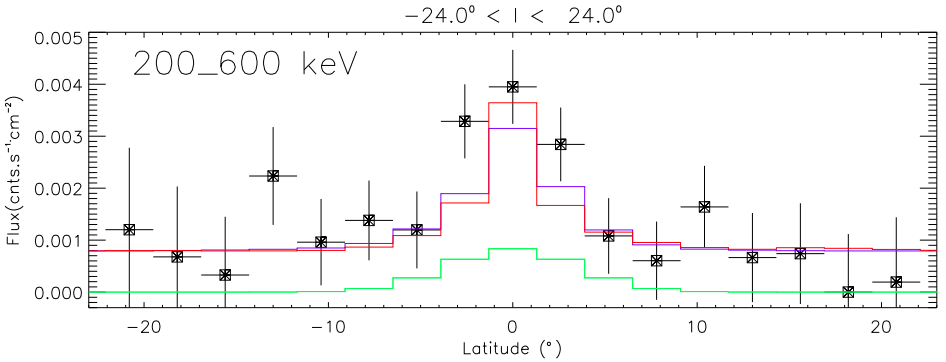
Green 8° Gaussian of annihilation spectrum

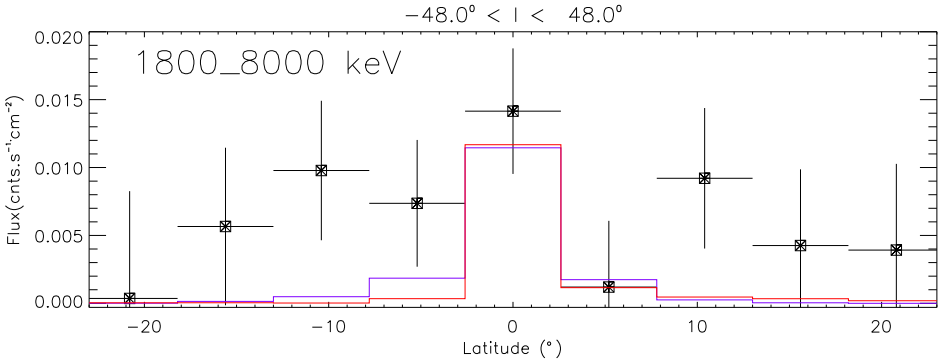
DIFFUSE LATITUDE PROFILES (2D fit of the deconvolved sky map)











Red : CO

Blue : NIR 4.9 m

Green 8° Gaussian of annihilation spectrum

Broad band diffuse spectrum