フェルミ・ガンマ線宇宙望遠鏡による銀河面ガンマ線放射(The 3rd galactic quadrant)の解析
(Re-analysis of the Diffuse Gamma-ray Emission from the 3rg Galactic Quadrant)

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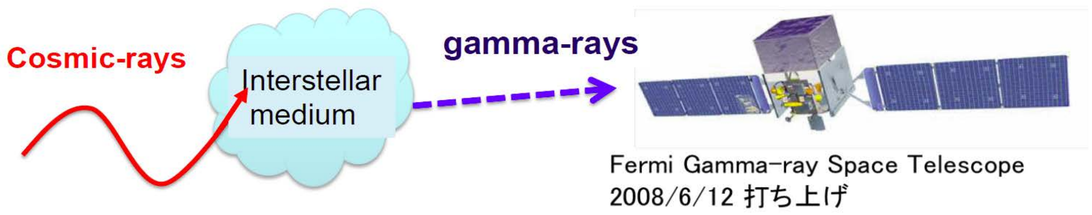
1. Introduction

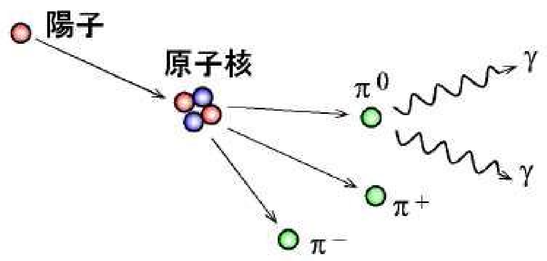
The energy and spatial distribution of cosmic-rays (CRs) in our Galaxy is a crucial input to understand their origin and propagation. However, since CRs are deflected by interstellar magnetic field, their distribution is poorly known



High energy CRs interact with the interstellar medium or radiation field and produce diffuse gamma-rays via pion production. This fact enables us to study the Galactic CRs in distant locations using high energy gamma-ray observations.

2. Processes to produce diffuse γ-rays

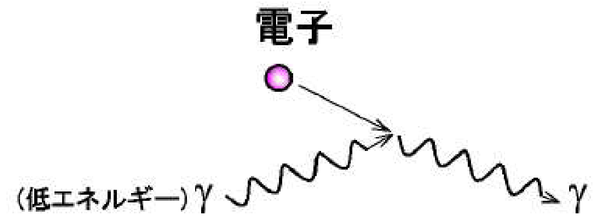
CR-p x interstellar gas (via π^0-decay)



$M_{\pi 0}$~140 MeV
In CMS, Eγ~70 MeV
In Lab frame,

$$N(E_{\mathrm{proton}})dE_{\mathrm{proton}} \propto {E_{\mathrm{proton}}}^{-p} dE_{\mathrm{proton}} \rightarrow {E_\gamma}^{-p} dE_\gamma$$

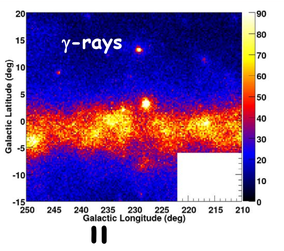
CR-e × interstellar light (via Inverse Compton)



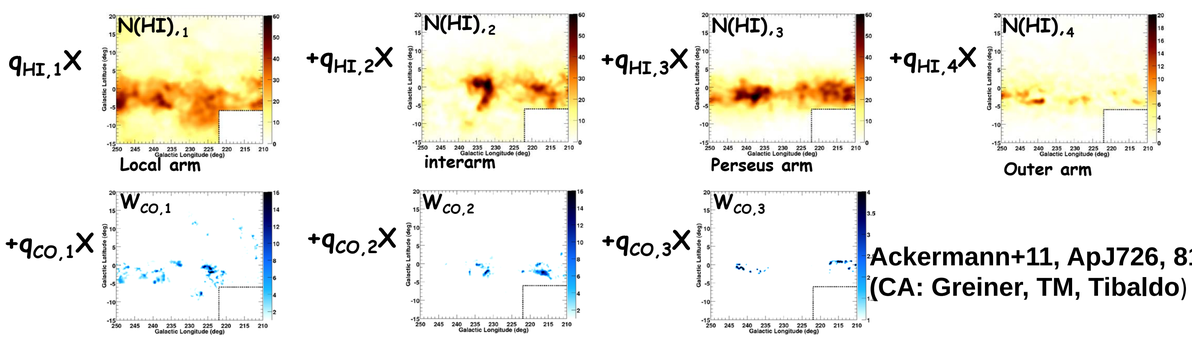
$$N(E_e)dE_e \propto {E_e}^{-p} dE_e \rightarrow {E_\gamma}^{-(p+1)/2} dE_\gamma$$

Spectrum of CRs can be reconstructed from γ-ray spectrum

3.Analysis Method



- **Prepare template maps (HI, H_2, Inverse Compton, etc.)**
- **Fit gamma-ray count map with a linear combination of them in narrow energy bins -> obtain gamma-ray spectrum of each component**

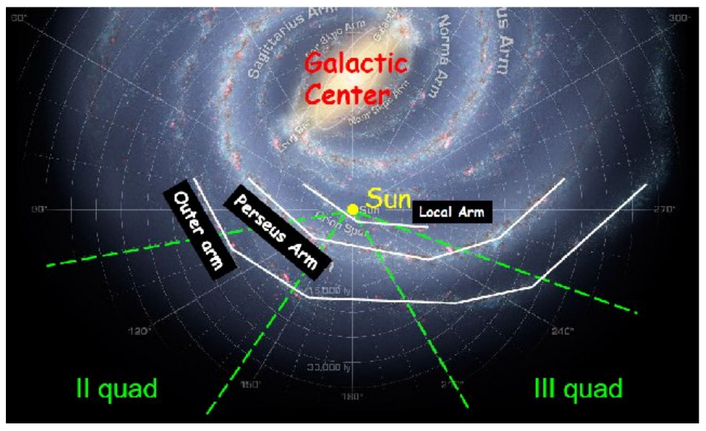


+IC+Iso+PS

IC has often been fixed to a particular model (only weakly coupled to structured gas component)

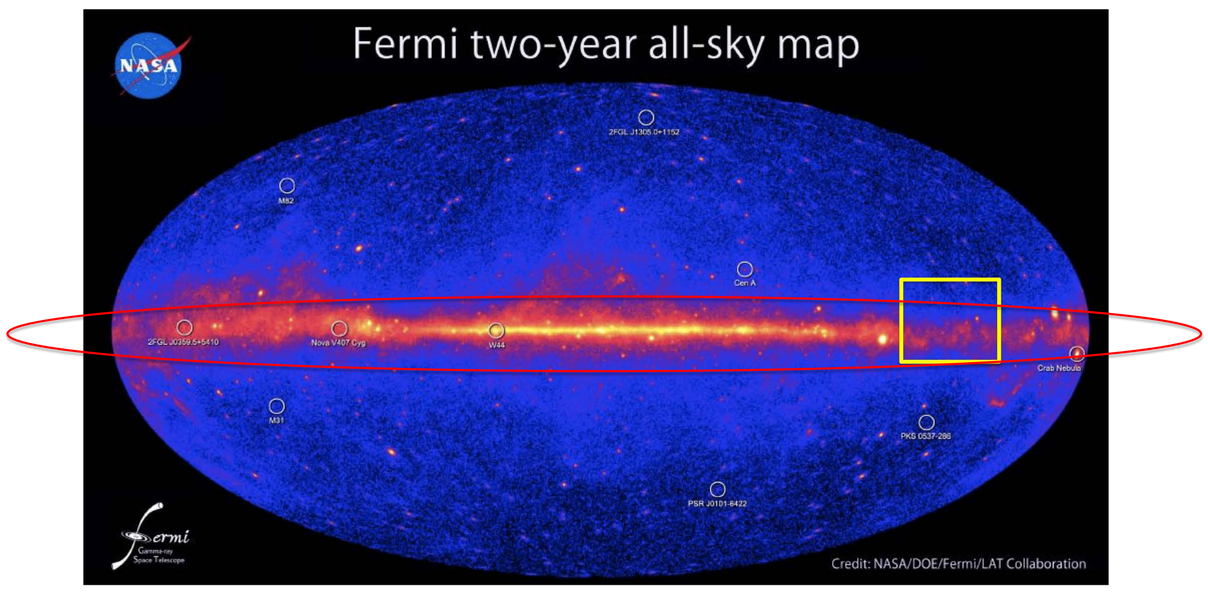
Ackermann+11, ApJ726, 81 (CA: Greiner, TM, Tibaldo)

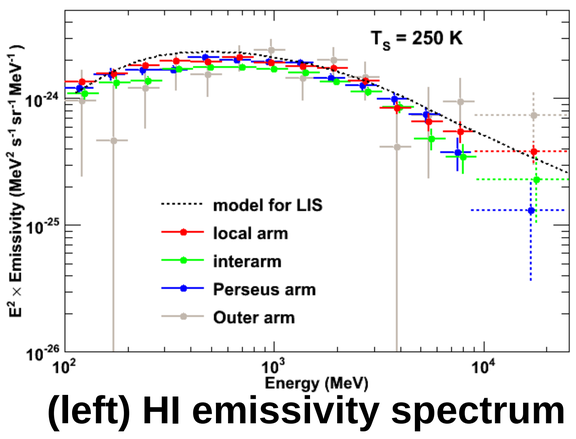
4.Result of Published Analysis



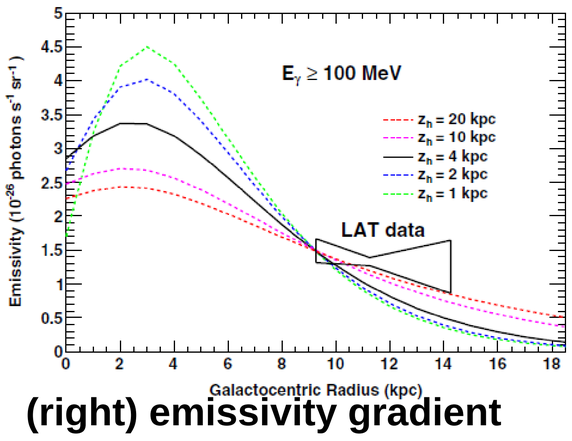
- **Outer galaxy is ideal to study CR and matter distribution from diffuse γ-rays**
- **18 months data of 3rd quadrant published as Ackerman+11 (ApJ 726, 81)**

$(210° \leq l \leq 250, -15° \leq b \leq 20°)$
$100\ \mathrm{MeV} \leq E \leq 25\ \mathrm{GeV}$





(left) HI emissivity spectrum



(right) emissivity gradient

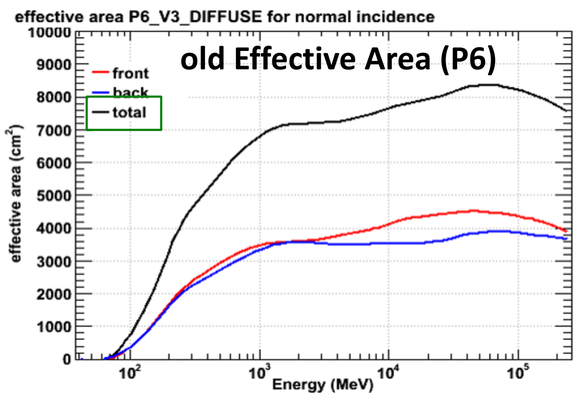
- **Spectral shapes agree with the expectation from LIS**
- **Flat emissivity gradient than usually assumed**
  - **➢Detailed discussion of the spectrum not performed**
  - **➢Cause of flat emissivity not uniquely identified (more CRs or missing gas)**

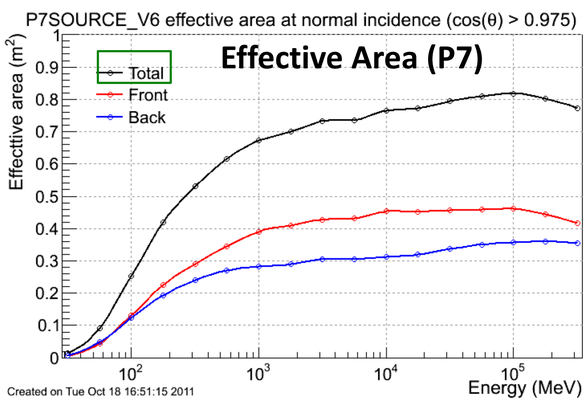
➡ Improved analysis with more data

5.Status of Re-analysis

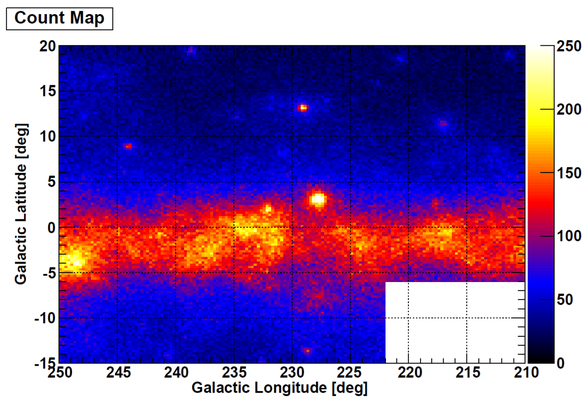
Modification/Improvement of the analysis

- **24 months source list instead of 11 months list**
- **Improved handling of dark-gas in the fitting**
- **Increase the amount of data (18 months->4 years)**
- **Update response function (P6->P7)**
  Low energy Effective area increased (E<200 MeV)
- **Fit Inverse Compton instead of fixed**
  Better constrain IC (and CR-e)

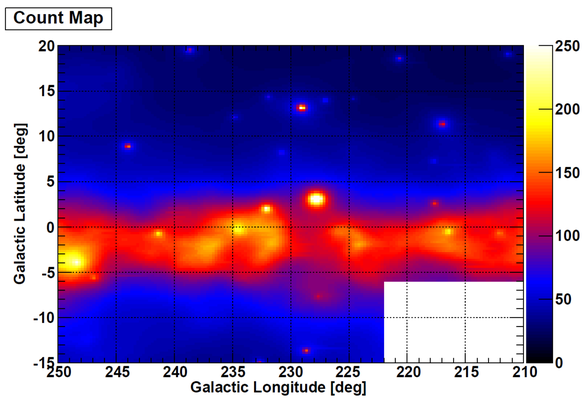




low energy effective area increased ($E \leq 200\mathrm{MeV}$)



(left)Data count map



(right)Model count map

6. Summary&Future Plan

- **Flat emissivity gradient than usually assumed**
  - **➢Cause of flat emissivity not uniquely identified (more CRs or missing gas)**
- **We are improving analysis with more data to better constrain CR-p and CR-e spectra**
- **We also plan to evaluate the effect of HII on other components**