Diffuse Hard X-Ray/Gamma-Ray Emission from Galaxy and local group of galaxies

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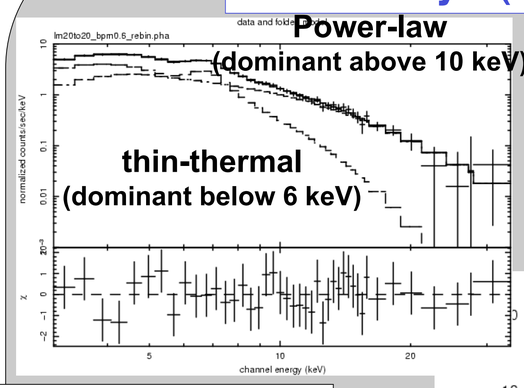
Abstract:

Diffuse gamma-ray emission in galaxies in energy of about 100 MeV or more is produced by cosmic-ray interactions with the interstellar medium and photons. Diffuse hard X-rays above 10 keV may also originate from non-thermal cosmic-ray electrons and reflect the distribution of electron component of cosmic-rays. Therefore a study of spectrum and spatial distribution of diffuse emission in hard X-rays and gamma-rays is a key to understand cosmic-ray and matter distributions in each galaxy.
The Gamma-ray Large Area Space Telescope (GLAST) has an unprecedented sensitivity and will enable us to study the diffuse gamma-ray emission from Galaxy in detail and investigate a couple of local group galaxies in addition to the Large Magellanic Could (LMC) which has already been detected by EGRET. Here we show performance estimates of GLAST on local group galaxies based on the latest simulation. We also present an RXTE view of galactic diffuse hard X-rays and compare with gamma-ray data by EGRET.

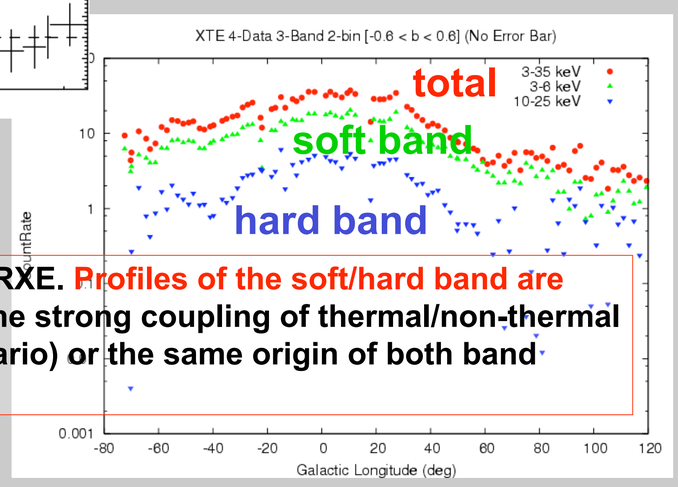
Galactic Diffuse Emission:

Hard X-rays (3-35 keV)



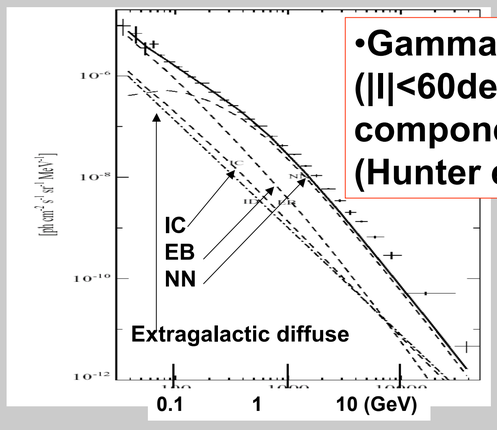
•RXTE spectrum of inner region of Galaxy (|l|<20deg) fitted by thin-thermal+PL. Spectrum in outer region is similar.

c.f.
Valinia et al. 1998
Revnivtsev et al. 2006

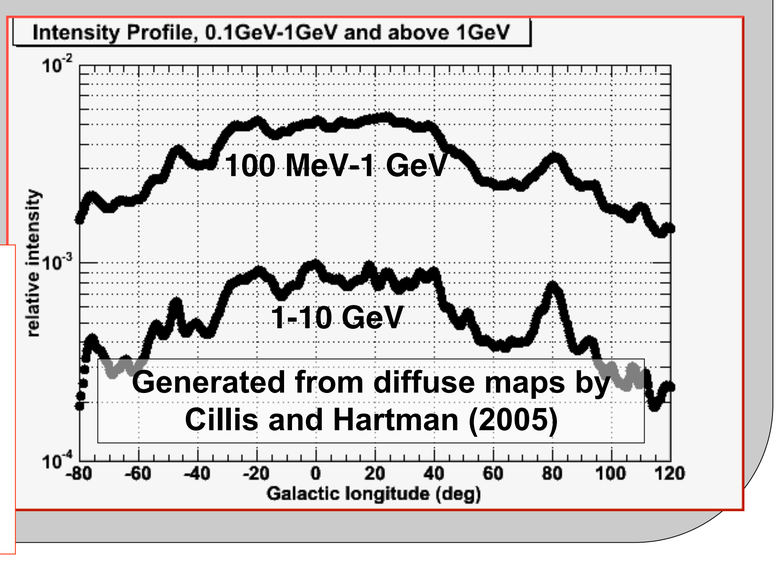


•Intensity profile of the GRXE. Profiles of the soft/hard band are quite similar, indicating the strong coupling of thermal/non-thermal component (diffuse scenario) or the same origin of both band (point-source scenario).

Gamma-rays (>100MeV)

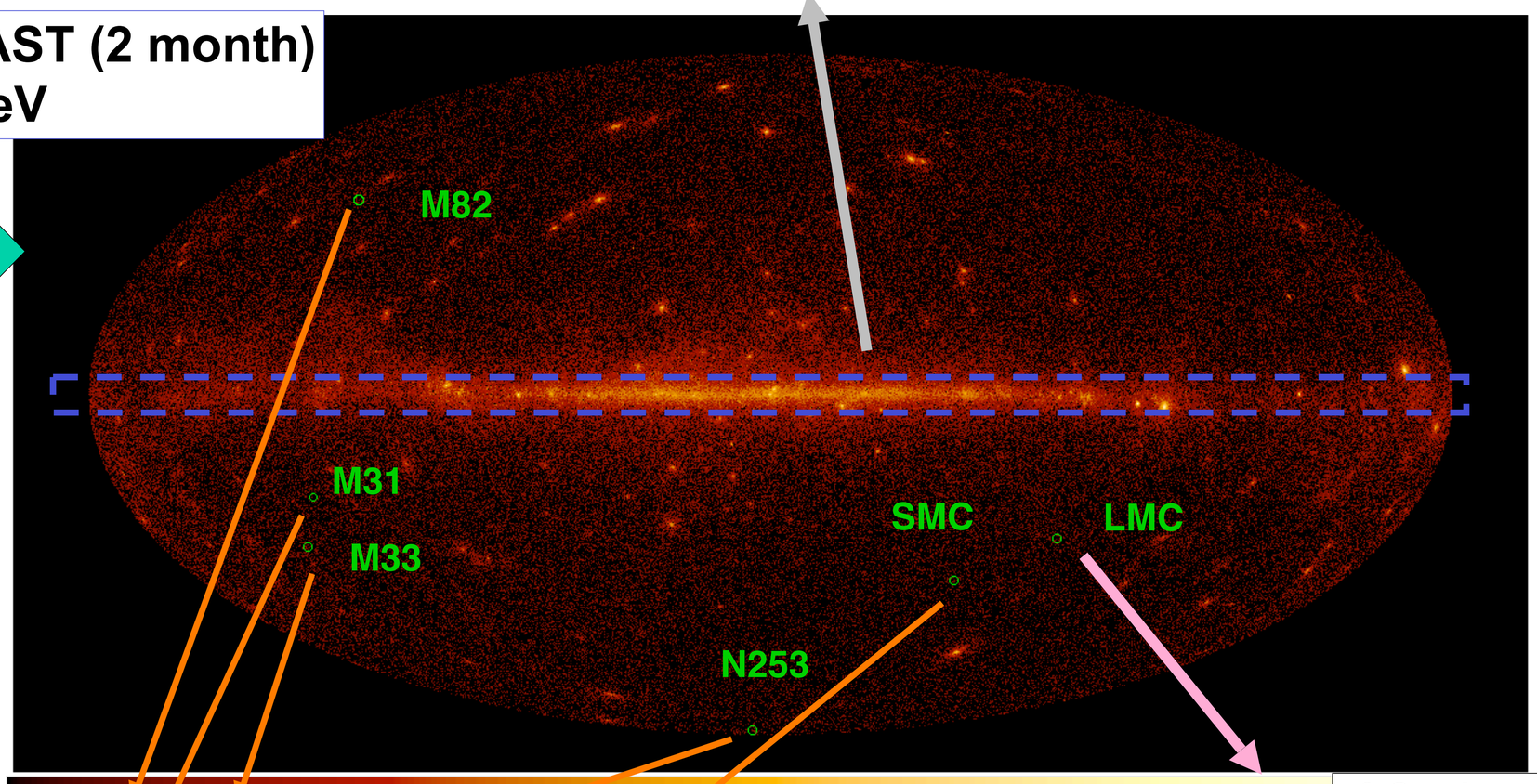


•Gamma-ray spectrum of inner region of Galaxy (|l|<60deg and |b|<10deg). Cosmic-ray proton component dominates above a few hundreds MeV. (Hunter et al. 1997)

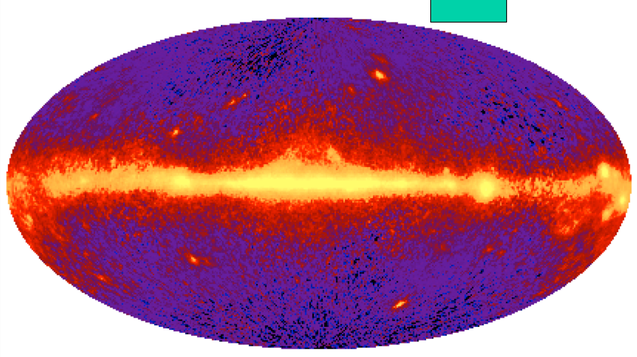


•Intensity profile of galactic diffuse gamma-rays above 100 MeV. Similar to GRXE but the X/γ ratio is not constant along the plane. GLAST will allow us to perform a more detailed comparison.

DC2 All-Sky map by GLAST (2 month) above 100 MeV



EGRET all-sky map above 100 MeV



cf. Sreekumar et al. 1992

Local Group Galaxies:

•GLAST detection feasibility of nearby galaxies by 1 year observation. Point source with photon index=2.1 is assumed.
•GLAST will detect a couple of galaxies and allow us to study cosmic-ray fluxes of them.
High latitude objects such as NGC 253 have higher possibility to be detected.

Detection Feasibility

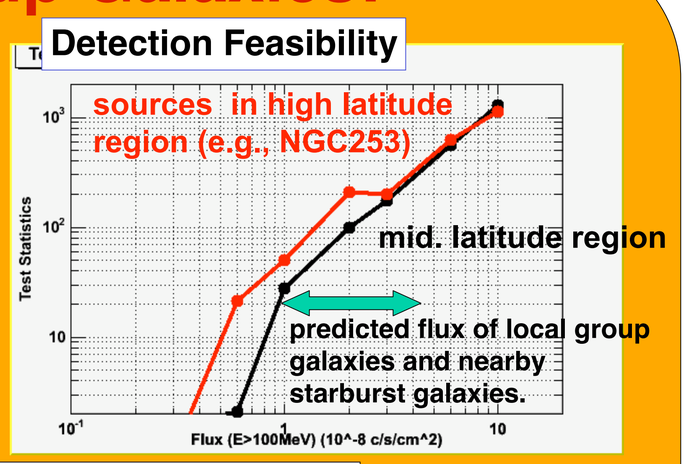
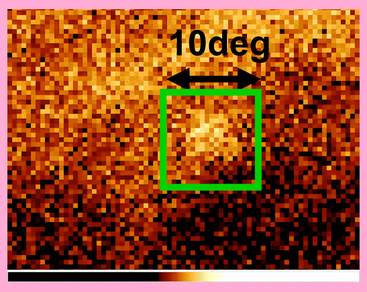


TABLE 2
PREDICTED GAMMA-RAY FLUX AND *GLAST* REQUIREMEN

GALAXY	FLUX > 100 MeV: Prediction (photons cm^{-2} s^{-1})	FLUX > 100 MeV: EGRET Value/Limit (photons cm^{-2} s^{-1})
LMC	11×10^{-8}	$(14.4 \pm 4.7) \times 10^{-8}$
SMC	1.7×10^{-8}	$< 4 \times 10^{-8}$
M31	1.0×10^{-8}	$< 1.6 \times 10^{-8}$
M33	0.11×10^{-8}	...
NGC 6822	2.6×10^{-11}	...
IC 10	2.1×10^{-11}	...

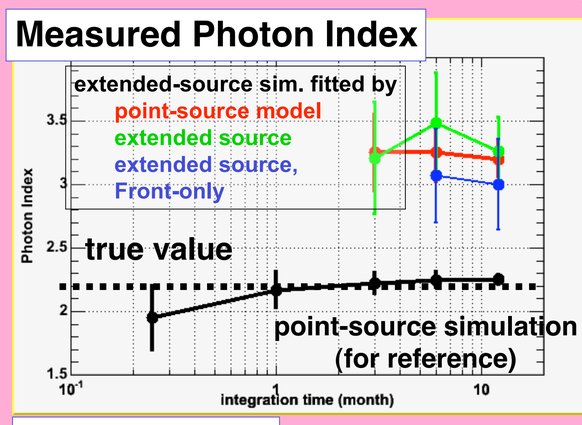
Gamma-ray flux prediction by Pavlidou and Fields (2001). See also Blom et al. (1999) for prediction of M82 and NGC253.

The Large Magellanic Cloud:

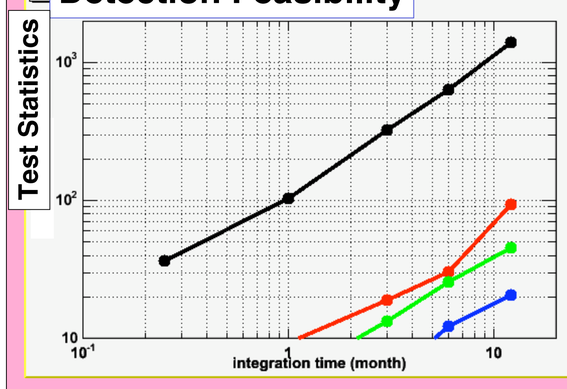


1 year obs. simulation of LMC region. (galactid diffuse+extragalactic diffuse+LMC model of DC2)

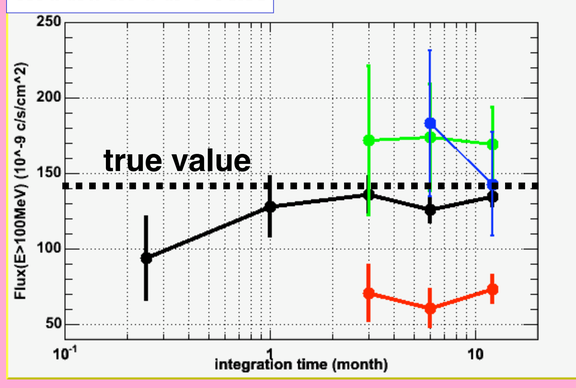
Measured Photon Index



Detection Feasibility



Measured Flux



A few months obs. by GLAST (scan mode) will detect the LMC with high significance. Expected source extent will result in softer spectrum than the model and an analysis of only Front-events solves this partially. A more sophisticated analysis is necessary to obtain a "correct" spectral index.

Conclusions:

•Hard X-rays and gamma-rays are important tool to study cosmic-ray and matter distributions in galaxies.
- **The Galaxy.**
  - **✓Spectrum and morphology is essential to study the origin.**
  - **✓GLAST will enable us to study matter/cosmic-ray distributions in detail.**
- **Nearby galaxies:**
  - **✓GLAST will allow us to compare cosmic-ray fluxes among galaxies.**
  - **✓Careful analysis is required to study extended sources like LMC.**