The Guaranteed Gamma-Ray Background

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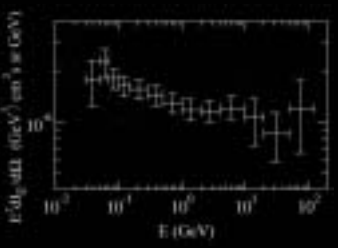
The Observed Gamma Ray Background



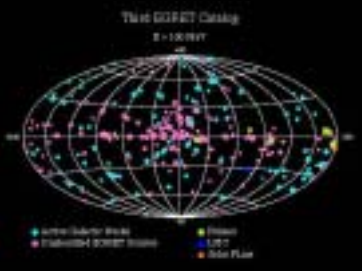
EGRET observations
of γ-ray background
(Sreekumar et al. 1998):

- *isotropic (extragalactic)*
- *single power law of index* - 2.1± 0.03
- *all-sky avg.* ~ 1.45×10^{-5} $cm^{-2}s^{-1}sr^{-1}$

EGRET observations
of extragalactic γ -ray sources
(Hartman et al. 1999):

identified
- ✓AGN (blazars)
- ✓normal galaxies

Unresolved sources of same class
contribute to diffuse background



The Guaranteed Gamma-Ray Background

guaranteed γ-ray background ≡ sum of γ -ray emission from all unresolved identified sources

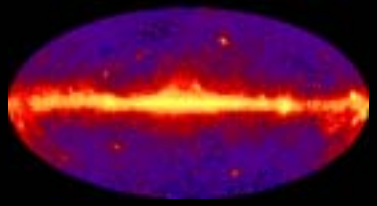
= unresolved blazars + unresolved normal galaxies

Other proposed γ -ray sources
e.g.: annihilating dark matter (Bergstroem talk)
structure formation cosmic rays (Miniati talk),
constrained by :
(observed background) – (guaranteed background)

Gamma rays from Normal Galaxies

γ - rays in normal galaxies produced through:

$$p_{CR} + p_{ISM} \rightarrow p + p + \pi^0$$
$$\hookrightarrow \gamma + \gamma$$



EGRET γ-ray sky

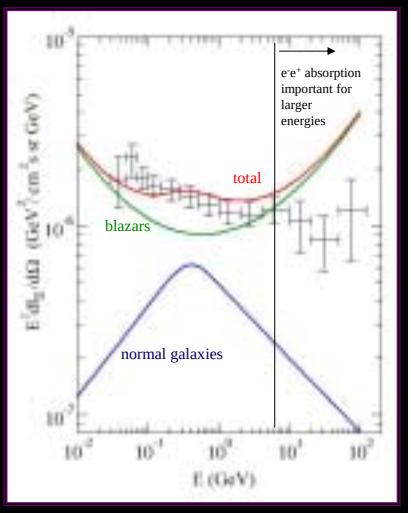
γ -ray flux of typical galaxy *higher* in the past because:

1. *Star formation rate higher*
   ⇒ more supernovae
   ⇒ larger cosmic ray flux
2. *More targets available*

- use *cosmic star formation rate* to calculate both effects.
- normalize γ -ray luminosity and spectrum produced per star formation rate unit to Milky Way

Gamma Ray Background – the Minimal Model

- ✓ Minimal 2-component model for γ-ray background : normal galaxy contribution + blazar contribution (Stecker & Salamon 1996)
- ✓ Blazar spectrum: concave
  Normal galaxy spectrum: convex
  Summed spectrum: flatter than either
  ⇒ *better fit to observations*
- ✓ Relative normal galaxy contribution: highest at ~ 1GeV
  (about 1/3 of summed spectrum)

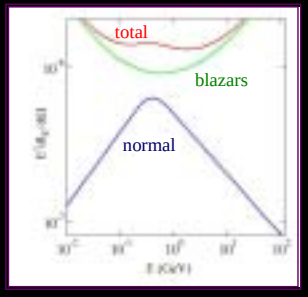


Observational Tests

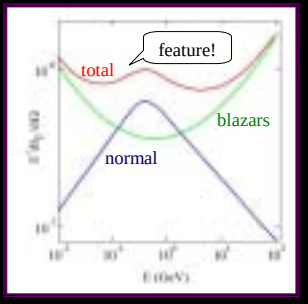
GLAST will:

1. *test the minimal model*:

   will resolve many more blazars but at most 3 new normal galaxies
   ⇒ relative blazar contribution reduced
   ⇒ will detect normal galaxy peak at ~ 1 GeV



EGRET



GLAST

2. *improve observational inputs for both models*

Conclusions

1. Unresolved normal galaxies & blazars:
   guaranteed, identified sources of diffuse γ-ray background.
   Need to understand those to constrain any other source
   and relevant physics.

2. Normal galaxy spectrum convex, blazar spectrum concave.
   Sum flatter than either.

3. GLAST observations *will test* relative contribution of two components to the gamma-ray background.