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Constraining the cosmic star formation history with diffuse gamma-ray observations

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What I won't be talking about:

- Ultra-high--energy cosmic rays and the Pierre Auger Observatory
- Multiwavelength / multimessenger studies of high-energy systems
- Acceleration and high-energy emission properties of AGN
- Analytic models of cosmic structure formation and environmental effects

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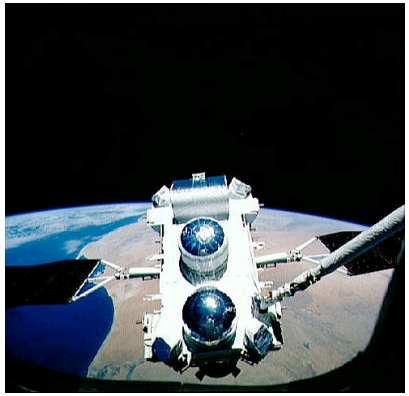
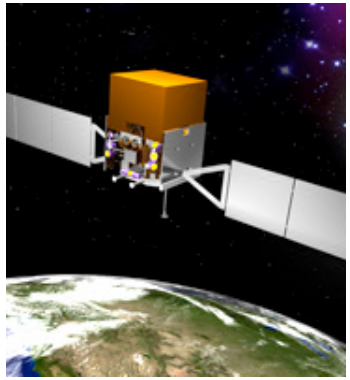
GeV gamma-ray astronomy

- Energies: 100 MeV - 100 GeV

- Measured by space-born gamma-ray telescopes:
  - EGRET aboard CGRO (1990's)
  - LAT aboard GLAST (expected launch April 2008)



- The EGRET all-sky map contains:
  - Diffuse emission from the Milky Way
  - Point sources: pulsars, AGN, normal galaxies, unidentified
  - Extragalactic diffuse emission (extragalactic gamma-ray backgroud, EGRB)



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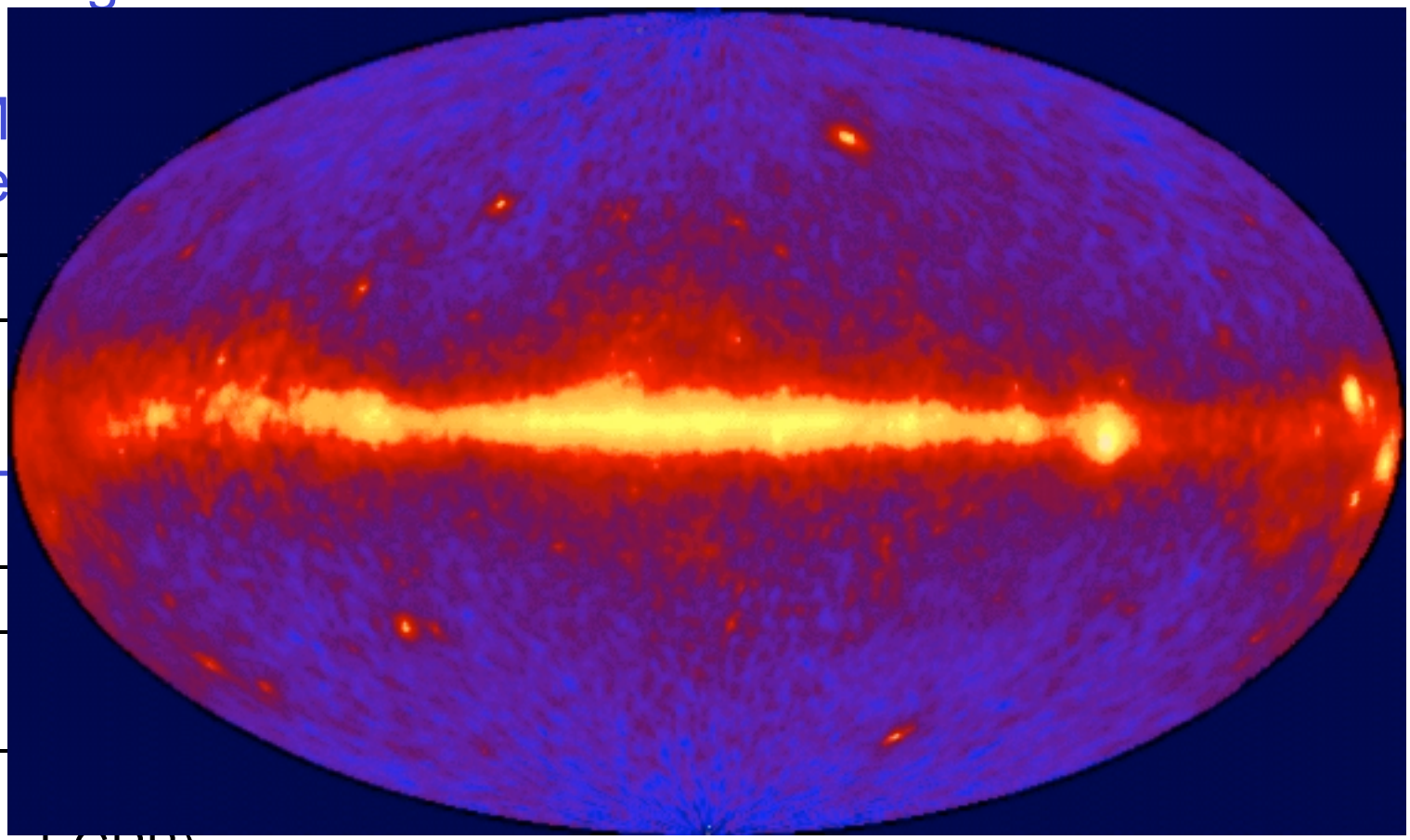

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What makes up the EGRB?

- Guaranteed contributions: established classes of gamma-ray emitters
  - Normal galaxies
  - Active galaxies
  - Extragalactic unidentified sources
- Truly diffuse emission?
- Exotic physics?

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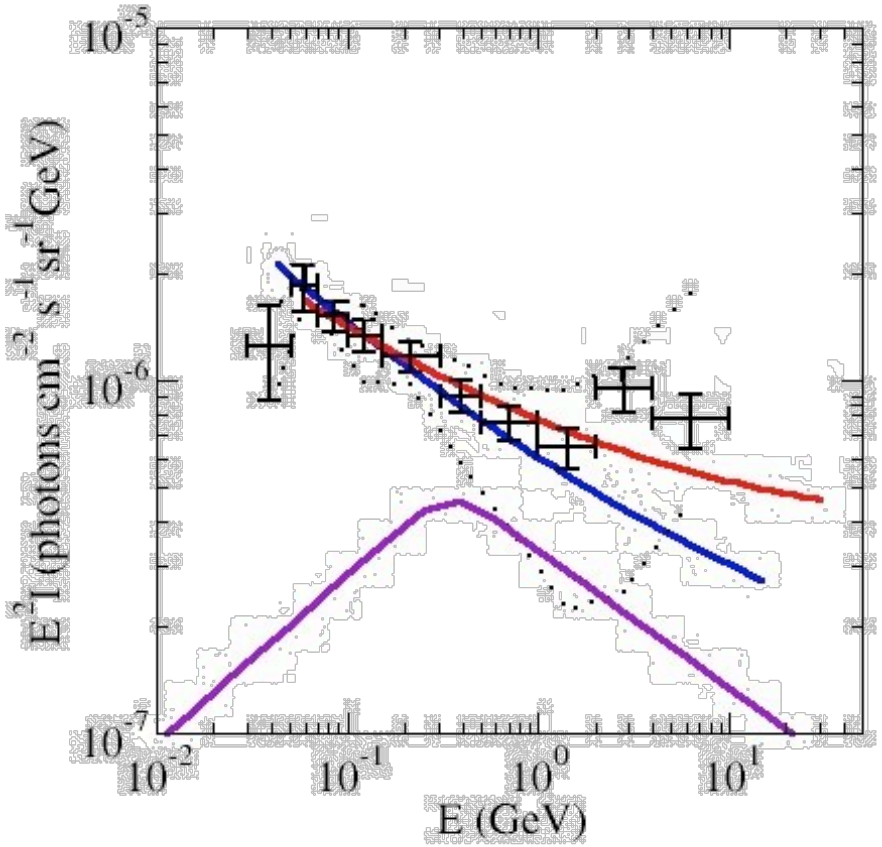

Starforming galaxies (VP & Fields 2002)
Unidentified sources (VP, Siegal-Gaskins, Fields, Olinto & Brown 2007)
Blazars (VP & Venters 2007)
EGRET gamma-ray background (Strong et al 2004)

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The normal galaxy EGRB contribution

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The normal galaxy EGRB contribution

- What determines the gamma-ray emission from a single galaxy?

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The normal galaxy EGRB contribution

- What determines the gamma-ray emission from a single galaxy?

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

  - cosmic ray flux (supernova rate)
  - gas content

- For the population of unresolved galaxies?
  - How many galaxies per unit cosmic volume
  - How much CR acceleration (SNe) as a function of z
  - Gas fraction as a function of z

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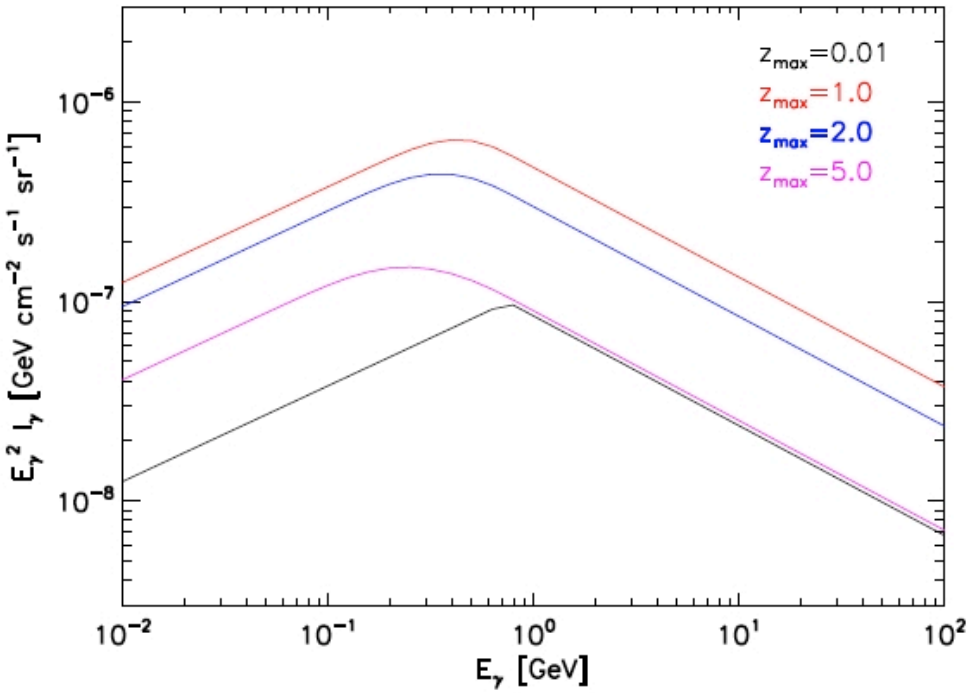

Prodanovic, VP & Fields ***preliminary***

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How do we utilize this connection?

- Until now: use knowledge of CSFR to predict normal galaxy signal for gamma-ray telescopes
- The future: GLAST observations will allow inversion of the problem: *use observations of gamma-ray normal galaxy spectral feature to constrain CSFR*
  - *Why will GLAST see the feature?*
  - *What does GLAST need to measure?*

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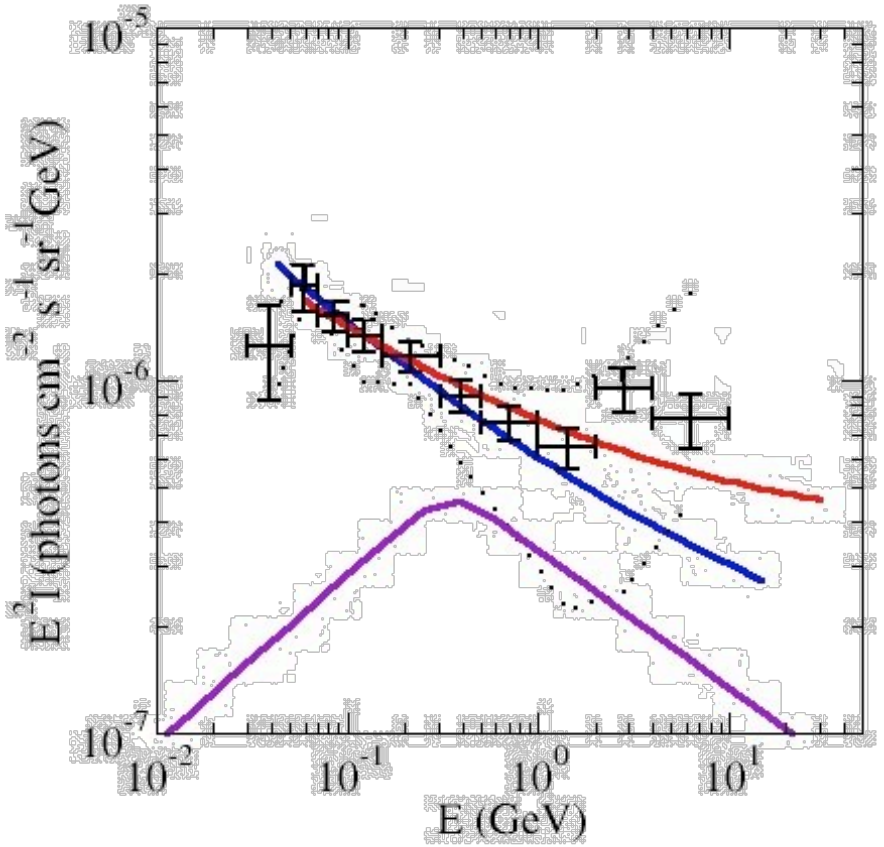

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Conclusions

- Cosmic star formation history imprinted on extragalactic gamma-ray background:
  - Normal galaxy spectral feature @ ≈ 1GeV
  - EBL absorption pileup/suppression @ ≥20GeV
- GLAST will:
  - resolve thousands of bright point sources (e.g. AGNs) but at most 3 normal galaxies -> normal galaxy feature expected to become visible
  - Probe the >20GeV regime, map the shape of high-E absorption feature
- A new era: observations of the EGRB can offer new, dust-independet constraints on the cosmic history of star formation