Unidentified EGRET Sources and the Extragalactic Gamma-Ray Background

Vasiliki Pavlidou
University of Chicago

Brian Fields   University of Illinois

Jennifer Siegal-Gaskins   University of Chicago

Angela Olinto   University of Chicago

Carolyn Brown   University of Chicago
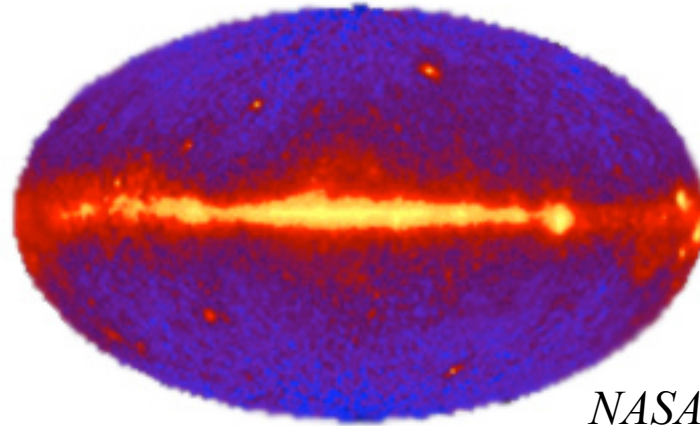
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GeV Diffuse Emission

- Origin:
  - Galactic
  - Extragalactic

- Nature:
  - Truly Diffuse Emission
  - Collective emission from unresolved sources

- Guaranteed sources of diffuse emission:
  - Faint, unresolved objects of known gamma-ray emitting classes (e.g.: blazars, normal galaxies, pulsars)

NASA - EGRET team

UnID Sources & Diffuse Emission

- Some contribution from unIDs guaranteed:

  – Most numerous sources

  – If most unIDs are extragalactic: (see Siegal-Gaskins talk on Friday)

    • Similar unresolved extragalactic objects contribute to EGRB

  – If most unIDs are Galactic:

    • similar objects in other galaxies enhance unresolved normal galaxy contribution to EGRB

    • Similar unresolved objects in MW contribute to diffuse Galactic emission

- However: uncertainties!

Our approach: I know one thing, that I know nothing

- An empirical model for collective emission from unresolved unIDs

- Seek to answer 2 questions:

  1. **Numbers/Fluxes:**
     How plausible is that unresolved unIDs, if extragalactic, have significant contribution to gamma-ray background?

  2. **Spectral indices:**
     Would collective unresolved emission from unIDs be spectrally consistent with the gamma-ray background?

Which resolved sources?

Only use sources which to this date remain without suggested candidate for a low-energy counterpart

– Many potential identifications suggested since 3rd EGRET catalog

– List of still-unidentified sources maintained by Carolyn Brown: URL:

http://home.uchicago.edu/~carolynb/unidentified_sources
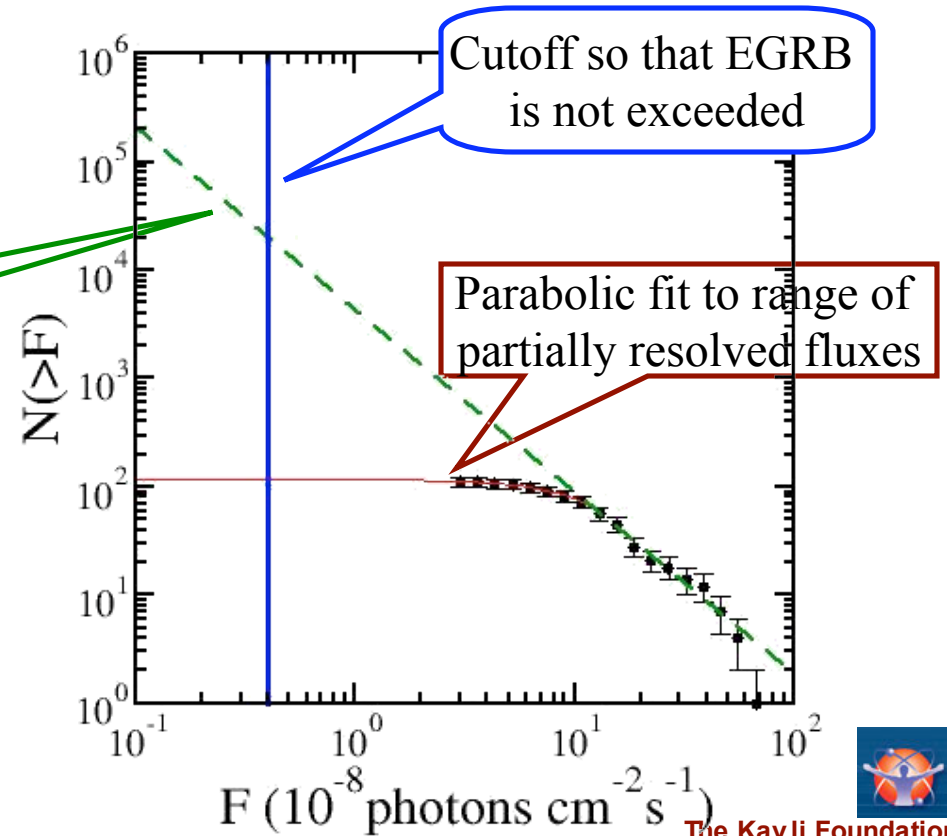
Are there enough?

Use cumulative flux distribution of resolved objects and extrapolate to lower fluxes

(cutoff so that EGRET EGRB is not exceeded)

Cutoff so that EGRB is not exceeded

Parabolic fit to range of partially resolved fluxes

Power-law fit to range of fully resolved fluxes
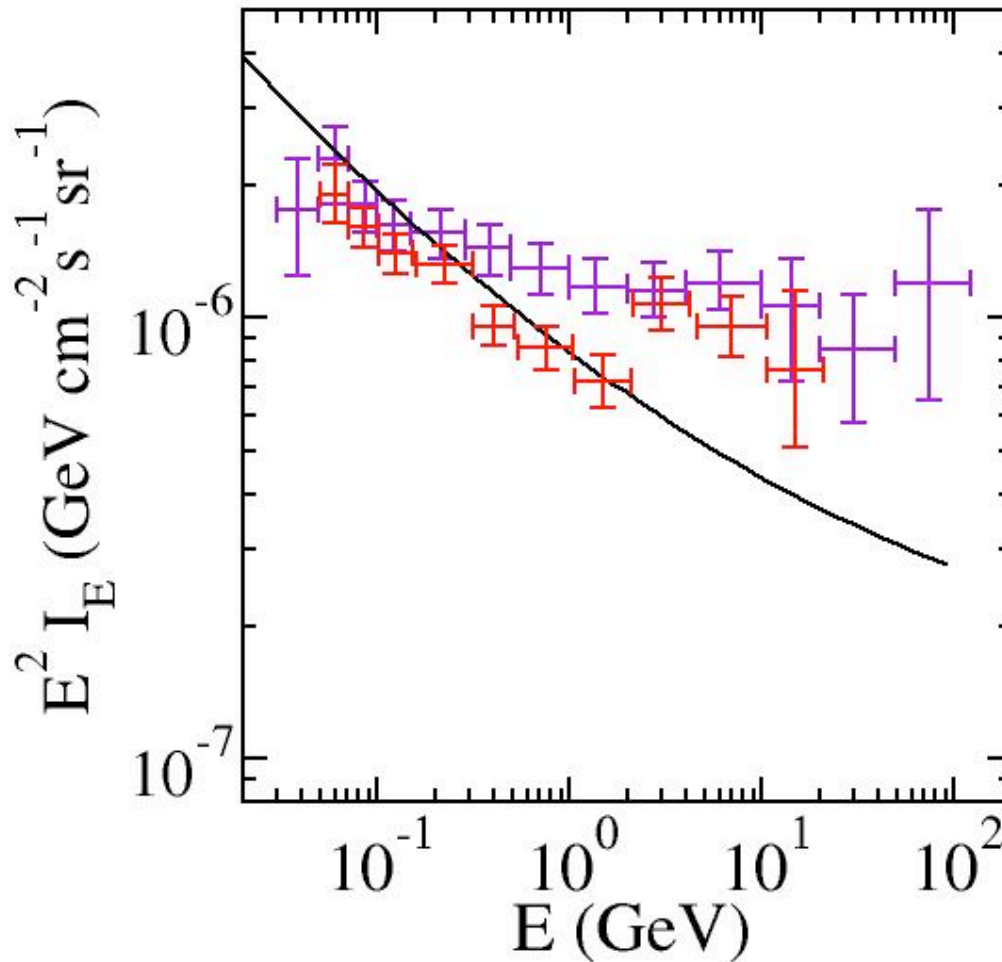
Does the spectrum work?

- The spectral index distribution:

  Assume spectral index distribution
  of unresolved objects
  same as that
  of resolved objects
   (BUT - accounting for individual measurement errors!
  likelihood approach,
  similar to T. Venters & VP
  treatment of blazars)
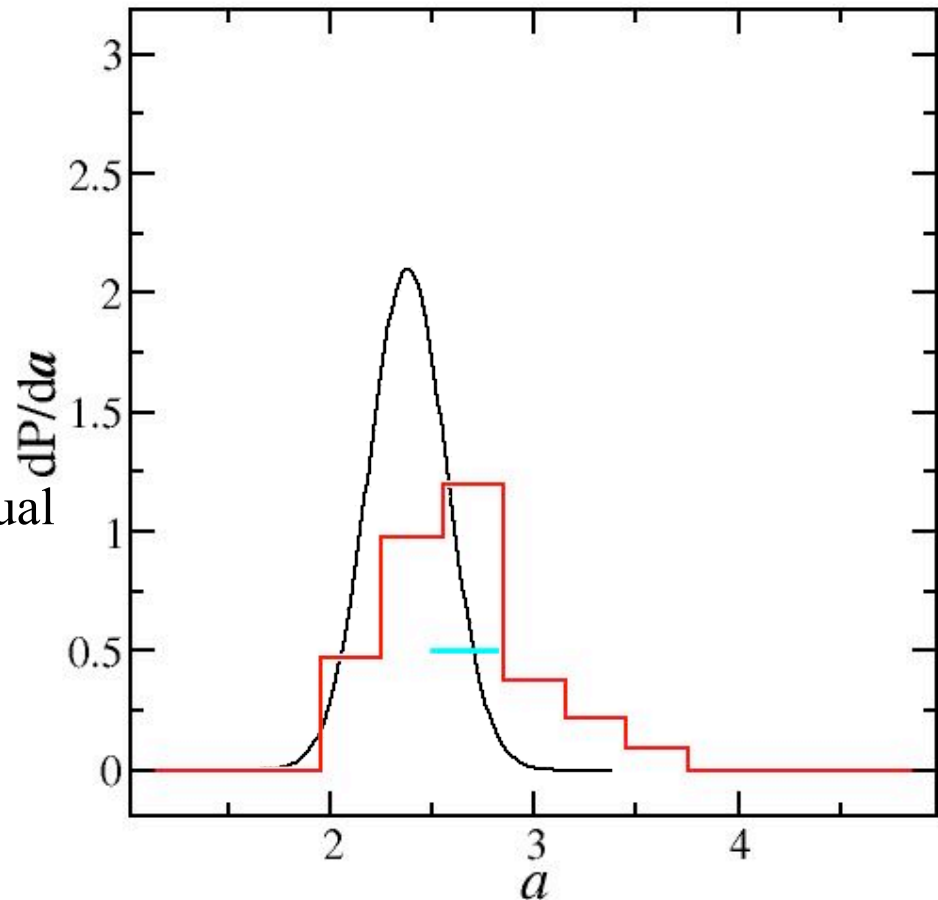
Results

Legend:
- Sreekumar et al 1998
- Strong, Moskalenko & Reimer 2004
- Max. likelihood. Sp. Ind. Dist.
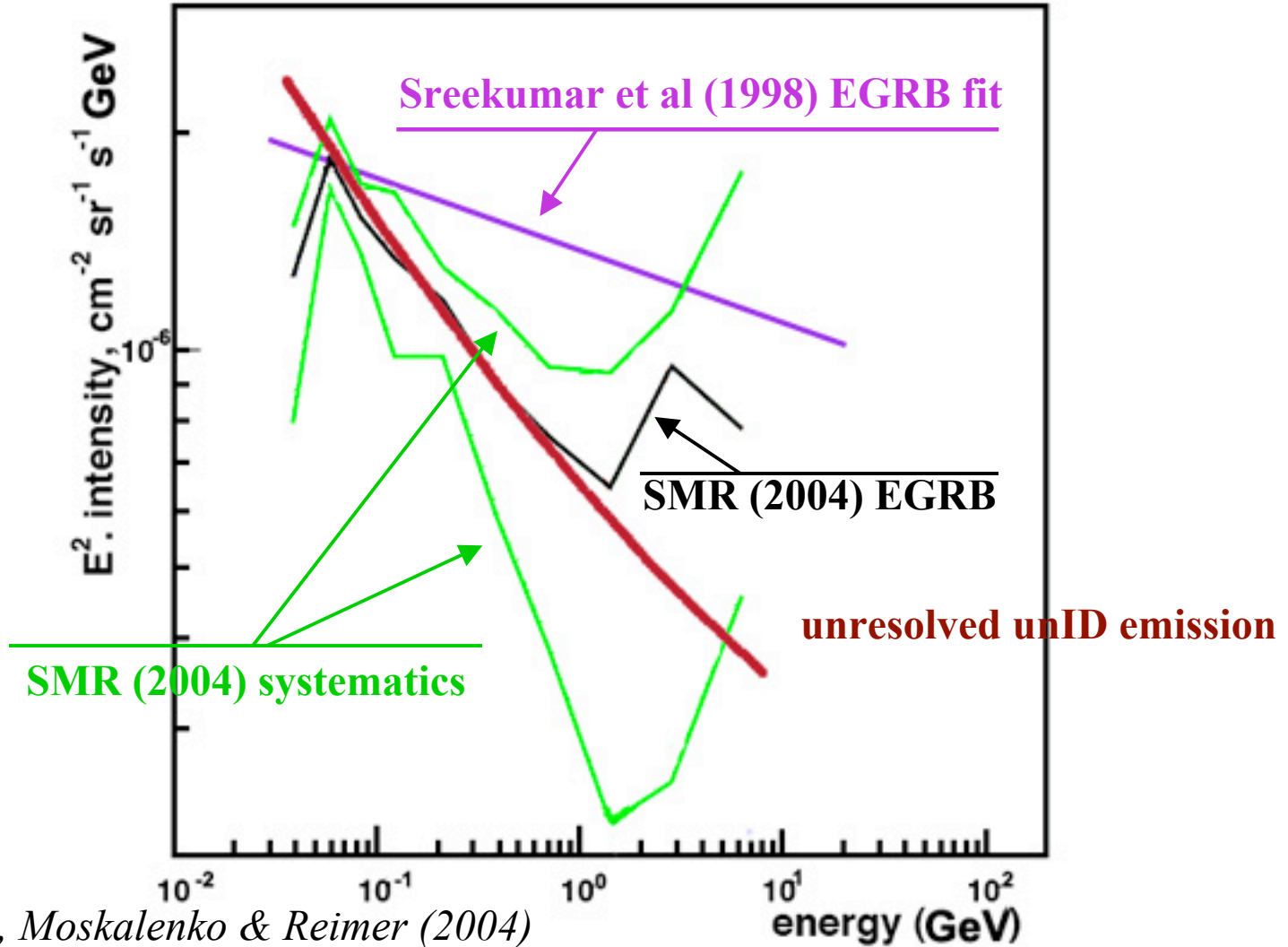- Max lik. mean, ±2σ variance
- Max. lik. variance, ±2σ mean

Axis labels: $E^2 I_E$ (GeV cm^{-2} s^{-1} sr^{-1}) vs E (GeV)

Results

Strong, Moskalenko & Reimer (2004)

GLAST!

- Whatever the nature of the EGRET unIDs, GLAST will resolve many more

  - if unresolved unIDs currently responsible for considerable fraction of EGRB:

    $\Rightarrow$ associated reduction of GLAST EGRB

  - If unresolved unIDs currently responsible for considerable fraction of Galactic diffuse emission:

    $\Rightarrow$ associated reduction of GLAST diffuse MW

    (GeV excess affected?)

Future directions

- Simple empirical model $\Rightarrow$ unresolved unIDs have potentially significant contribution to diffuse emission, with good spectra agreement.

- Worth pursuing more detailed (but also more uncertain) models:
  - What if most of them AGN?
  - What if most of them associated with cosmic structure?
  - What if most of them Galactic?

Conclusions

- Contribution of unresolved unIDs to diffuse emission guaranteed

- Empirical model:

  - If flux distribution does not break for ~ 1 order of magnitude, enough to account for all of EGRB in low energies

  - If spectral index distribution same in resolved and unresolved sources, spectrum consistent with *Strong et al* EGRB within systematic uncertainties

  - Hint for other component at high energies?

- GLAST will determine whether most EGRET unIDs Galactic or extragalactic

- Future directions: specific models of unID unresolved emission