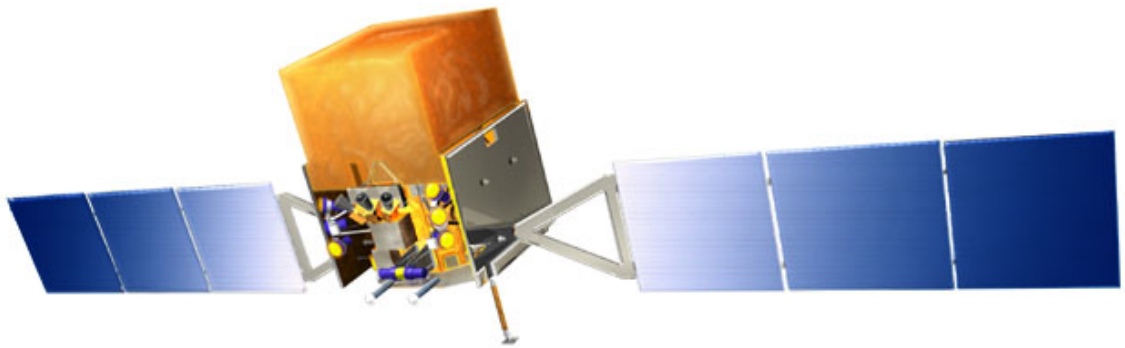
Deciphering the gamma-ray background: star-forming galaxies, AGN, and the search for Dark Matter in the GeV Band.

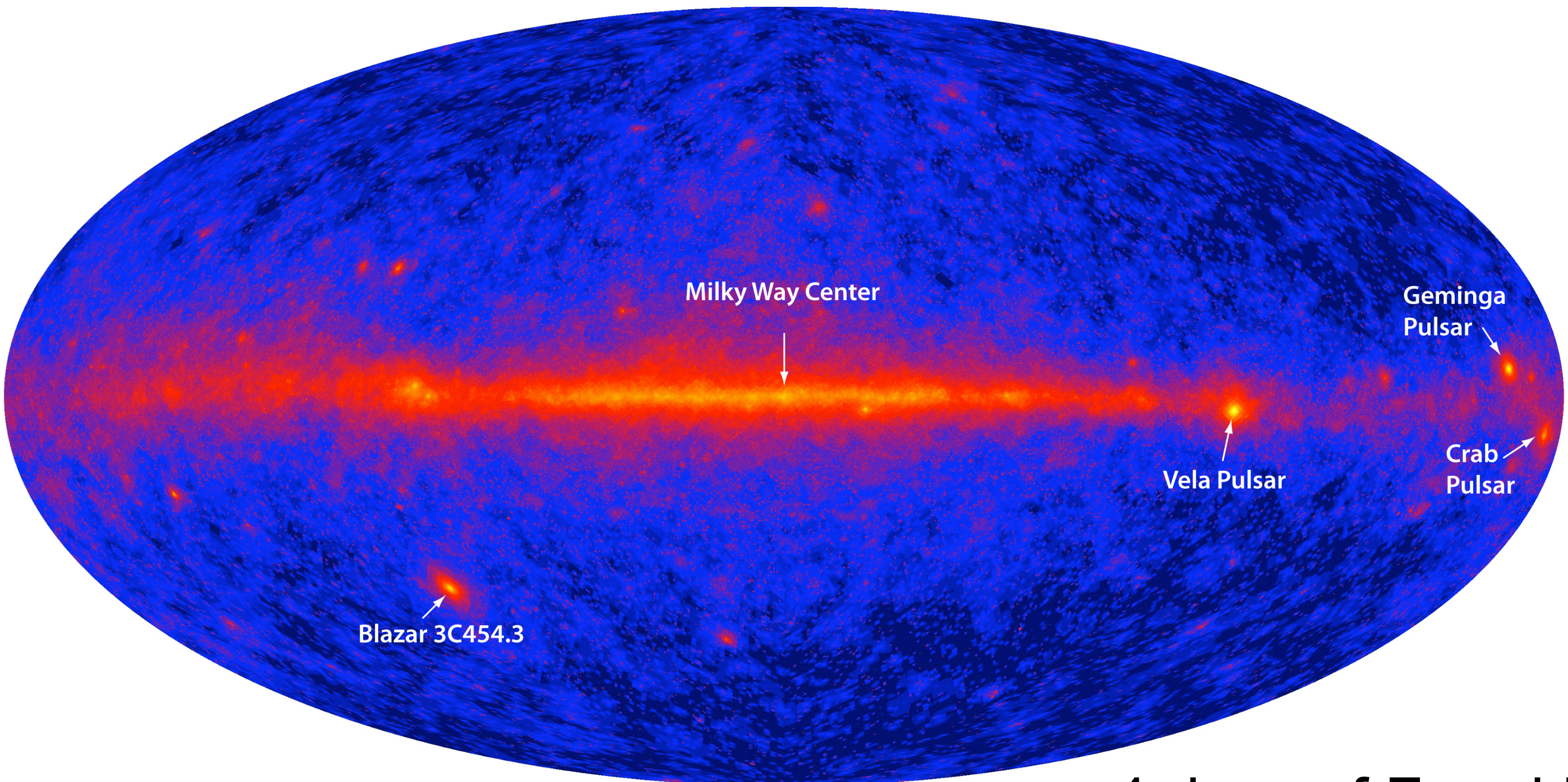


Brandon Hensley (Caltech)
Jennifer Siegal-Gaskins (Ohio State)

Shin'ichiro Ando (Caltech)
Brian Fields (U. Illinois)
T. Prodanovic (U. Novi Sad)
Luis Reyes (U. Chicago)
Tonia Venters (Goddard)

Vasiliki Pavlidou
Einstein (Fermi) Fellow

The gamma-ray sky



4 days of Fermi LAT

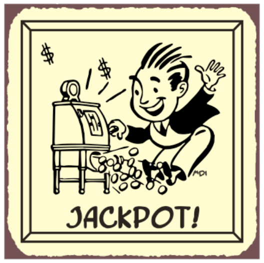
Credit: LAT collaboration

What is making the GeV isotropic diffuse background?

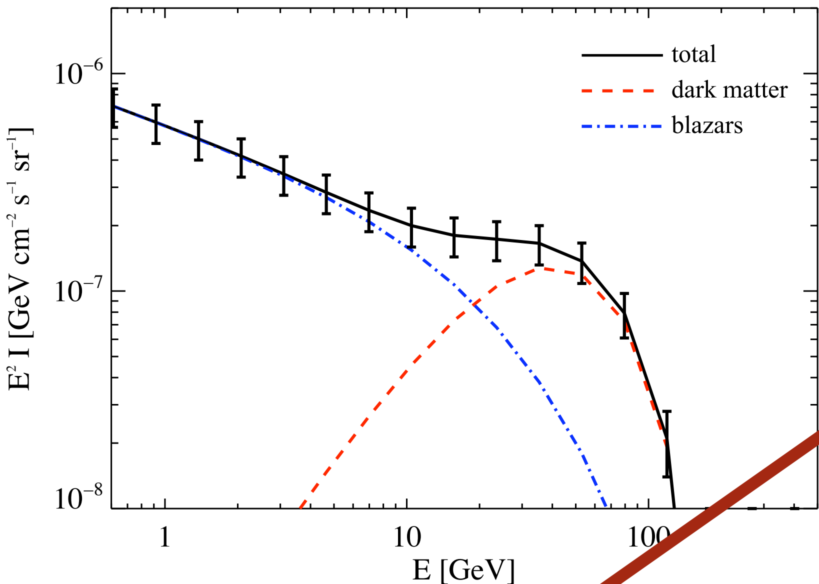
- Guaranteed sources:
  active galaxies, star-forming galaxies

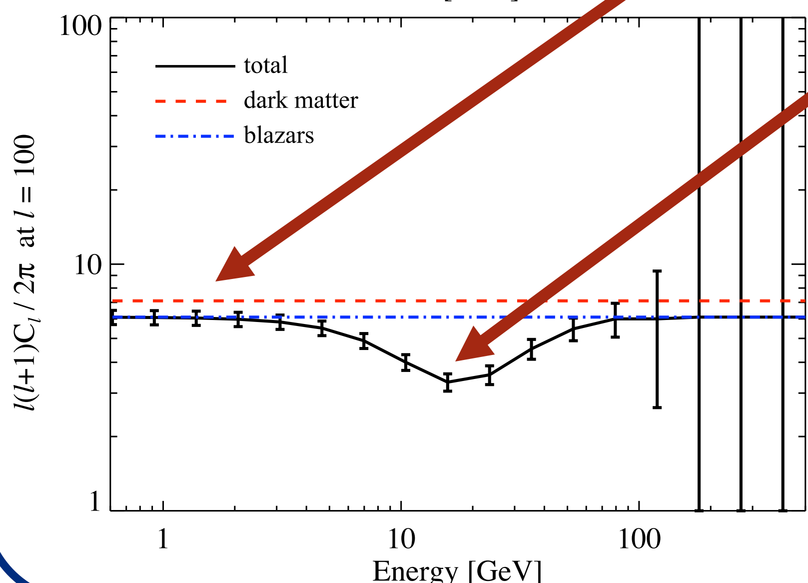
- Hypothesized source classes:
  galaxy clusters, dark matter cusps

+



How to break the degeneracies?





$$C_\ell^{\rm tot} = f_{\rm EG}^2 C_\ell^{\rm EG} + f_{\rm DM}^2 C_\ell^{\rm DM}$$

$$f_{EG} + f_{DM} = 1$$

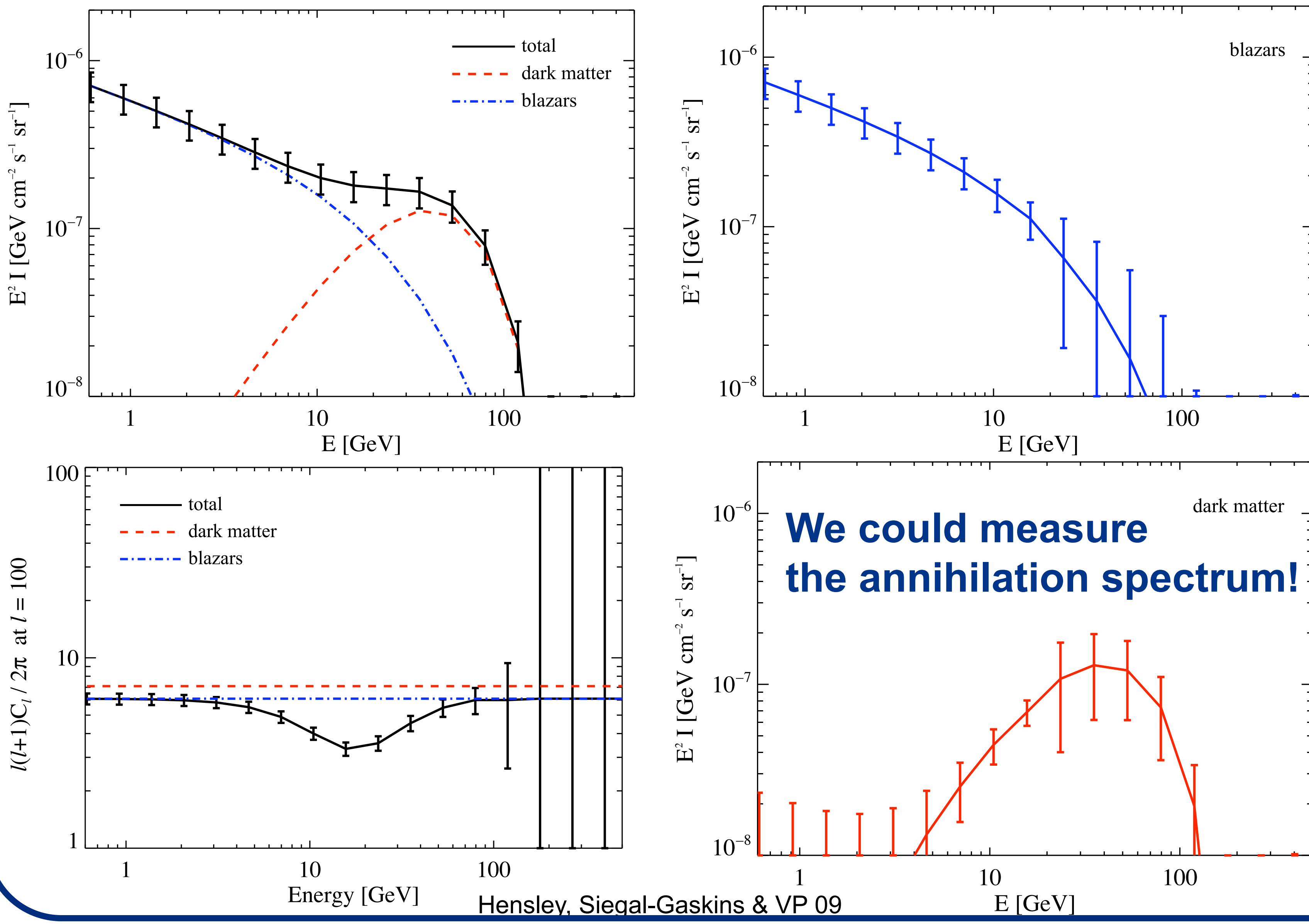
$$\mathrm{I}_{\rm DM} = \mathrm{I}_{\rm tot}\left(\frac{C_\ell^{\rm EG} \mp \sqrt{C_\ell^{\rm EG}C_\ell^{\rm tot} + C_\ell^{\rm DM}C_\ell^{\rm tot} - C_\ell^{\rm EG}C_\ell^{\rm DM}}}{C_\ell^{\rm EG} + C_\ell^{\rm DM}}\right)$$

$$\mathrm{I}_{\rm EG} = \mathrm{I}_{\rm tot}\left(\frac{C_\ell^{\rm DM} \pm \sqrt{C_\ell^{\rm EG}C_\ell^{\rm tot} + C_\ell^{\rm DM}C_\ell^{\rm tot} - C_\ell^{\rm EG}C_\ell^{\rm DM}}}{C_\ell^{\rm EG} + C_\ell^{\rm DM}}\right)$$

At minimum: $$C_\ell^{\rm DM} = \frac{C_\ell^{\rm EG}C_\ell^{\rm tot}}{C_\ell^{\rm EG} - C_\ell^{\rm tot}}$$

Hensley, Siegal-Gaskins & Pavlidou 2009
On arXiv soon!

Deconvolve the components!



Hensley, Siegal-Gaskins & VP 09

What about the foregrounds?

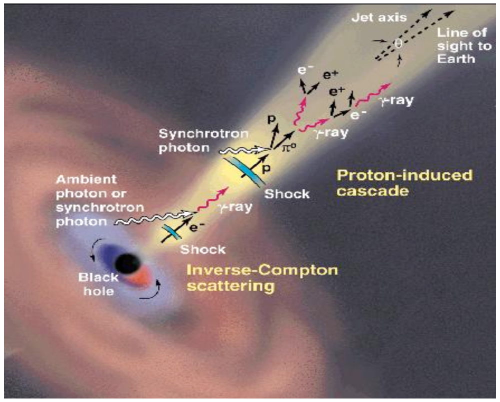
Some people's foregroun is other people's signal!

- If deconvolution can be done:
  I no longer have to carefully model foreground to obtain DM spectrum from residuals

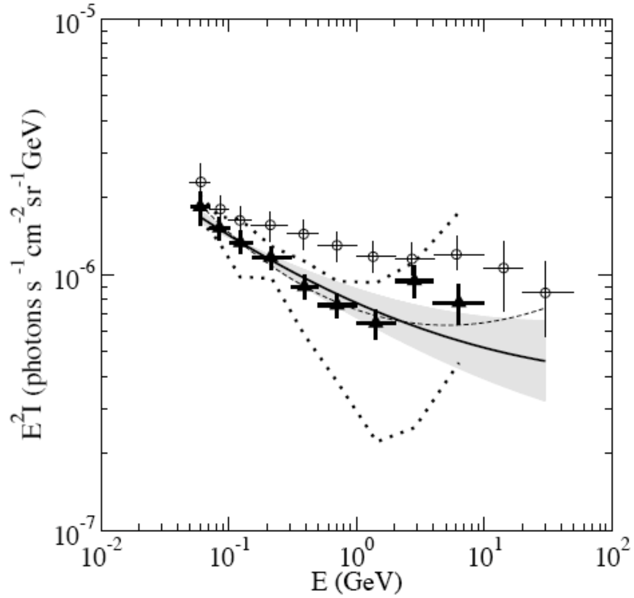
- A deconvolved extragalactic source intensity spectrum encodes physics about the parent population

What physics can we learn about AGN?

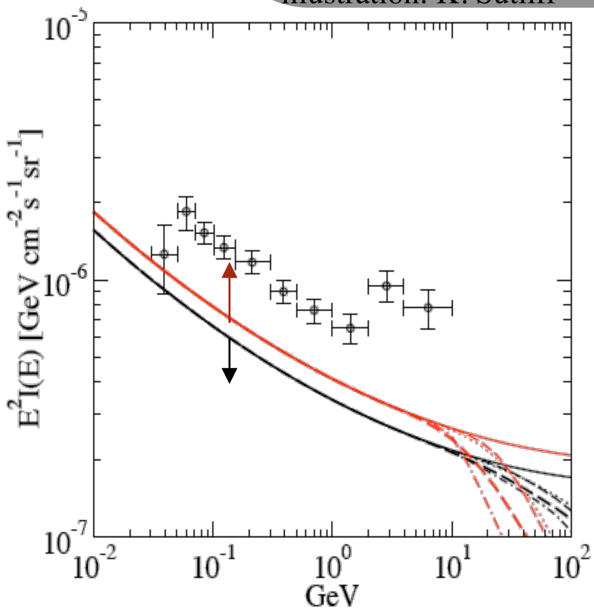
- **How much diffuse gamma-ray emission due to all AGN, everywhere, ever?**
- Physics input to this calculation:
  - Energy spectrum
  - Luminosity function
  - Duty cycle
  - Extragalactic UV, optical, IR backgrounds!



Credit: J. Buckley 1998 (Science), illustration: K. Sutliff



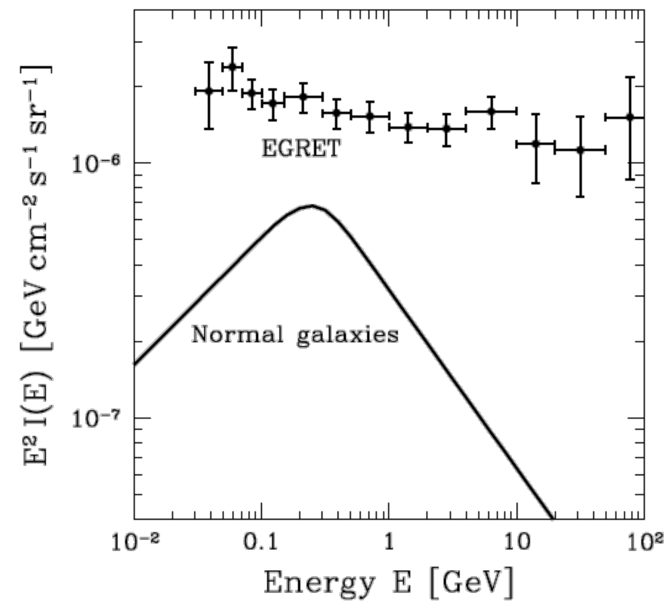
VP & Venters 08



Venters, Reyes & VP 09

What physics can we learn about galaxies?

- **How galaxies make gamma rays**:
  - Gas makes stars
  - Stars blow up and make supernova remnants
  - Supernova remnants accelerate cosmic rays
  - Cosmic rays collide with gas, make pions,
  - Pions decay into gamma rays



VP & Fields 02,
Ando & VP 09

- **How much diffuse gamma-ray emission due to all galaxies, everywhere, ever?**
  Physics input to this calculation:
  - Cosmic star formation history (how much star formation, gas)
  - Cosmic-ray -- gas interactions
  - Cosmic-ray acceleration, confinement, escape

Learn about B-field at high-z!

Conclusions

1. Gamma-ray background is a multi-component emission.
   starforming galaxies, blazars, galaxy clusters, dark matter …

2. Combining intensity energy spectrum + anisotropy energy spectrum may allow us to DECONVOLVE the components

3. For DM: can measure annihilation spectrum *independently of any model for the foreground components*! Measure mass, annihilation channel

4. Deconvolution can turn foregrounds into signal: extract physics of e.g. blazar or star-forming galaxy population

5. Deconvolution not feasible in all cases BUT: if feasible…