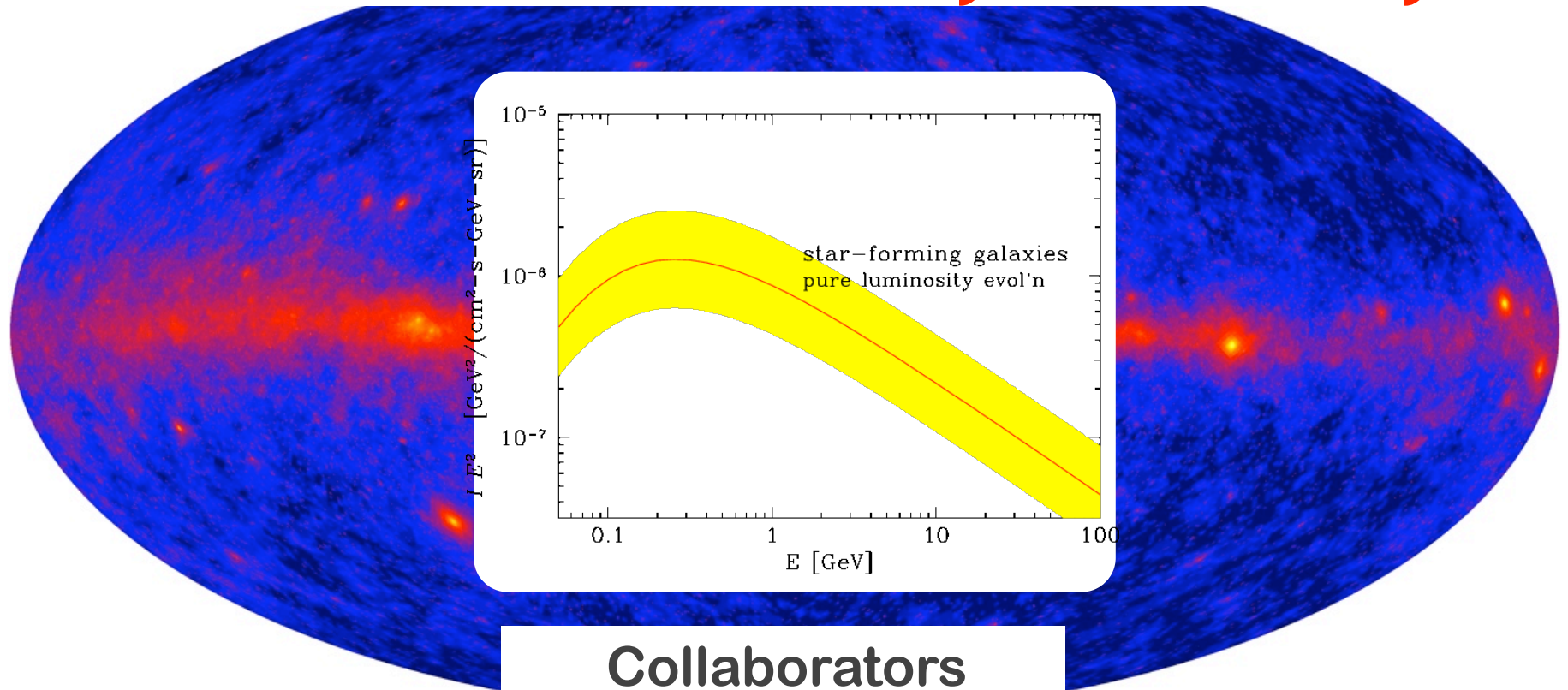
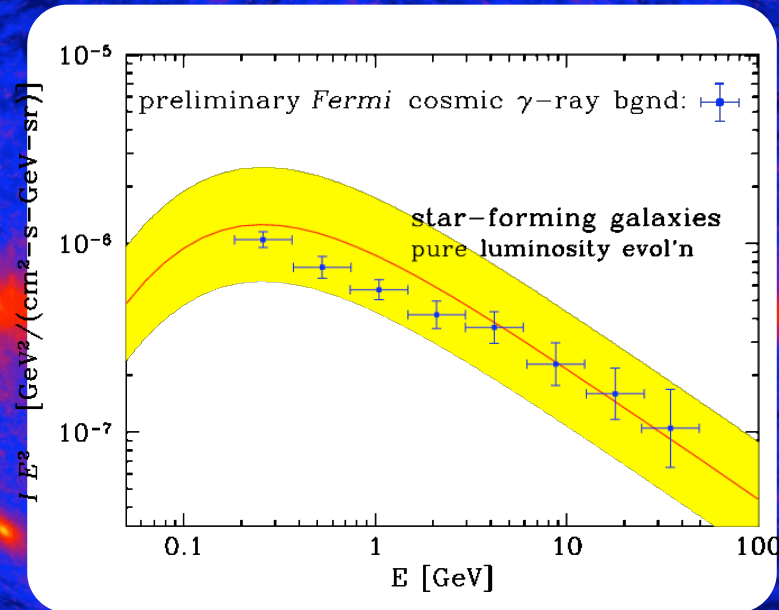


# Gamma-Ray Probes of the Star-Forming Universe and Cosmic-Ray History



**Collaborators**  
**Vasiliki Pavlidou**  
**Tijana Prodanovic**  
**Amy Lien 連雅琳**

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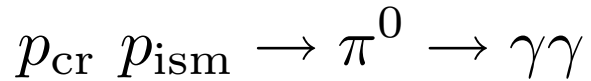
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# Cosmic Rays and the Guaranteed Gamma-Ray Background

diffuse Fermi sky: Porter, Digel, Ackermann talks

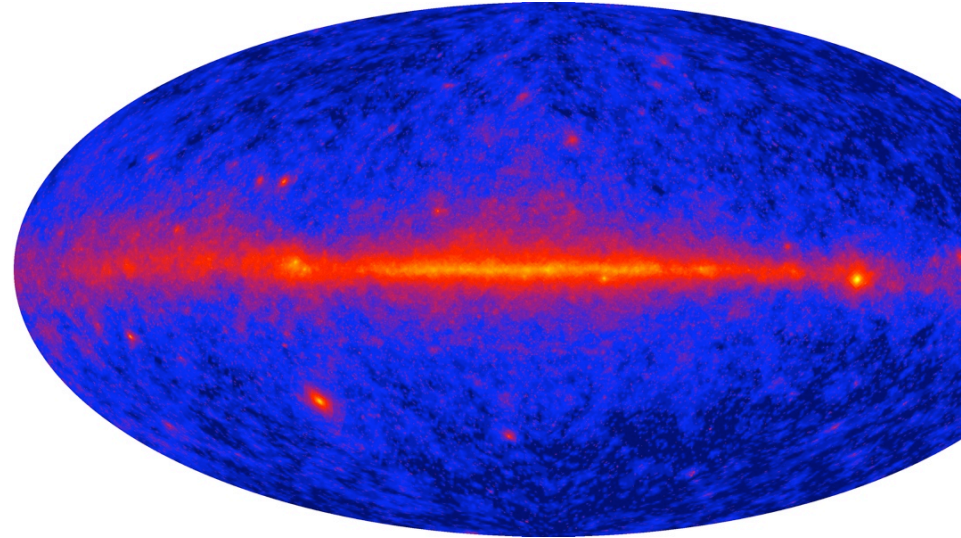
Galactic plane dominates

due to cosmic-ray propagation



working hypothesis: **supernovae are engines of cosmic-ray acceleration**

star formation  $\Rightarrow$  supernovae  $\Rightarrow$  cosmic rays

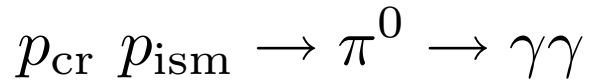


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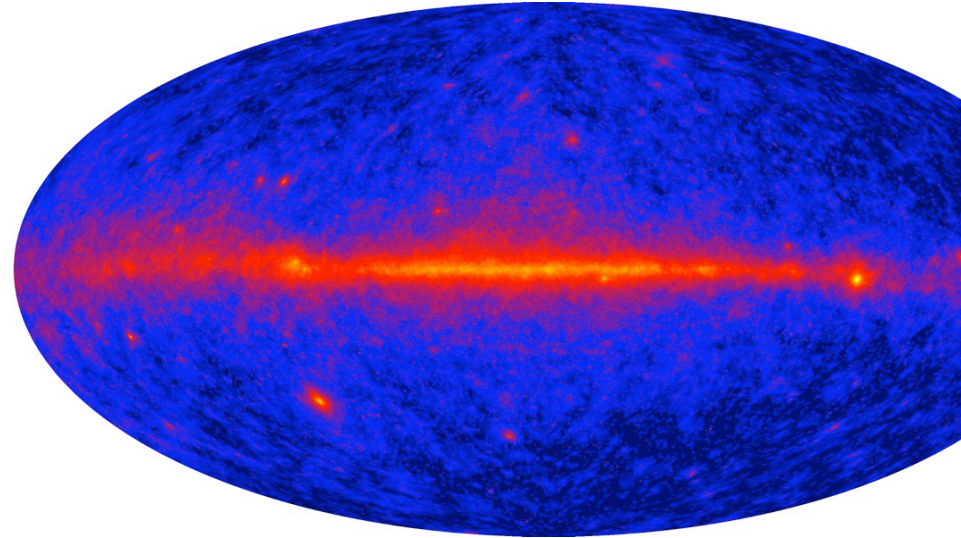
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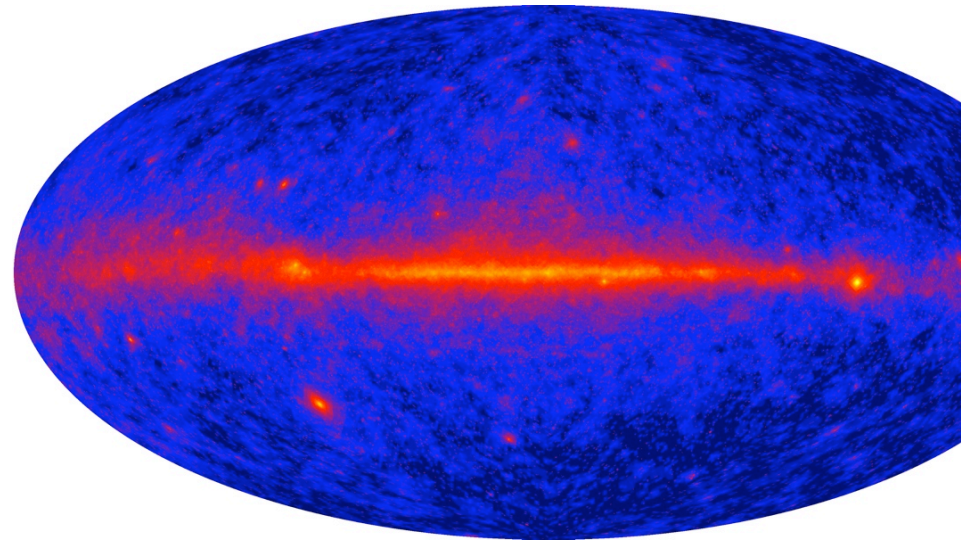
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$$p_{\text{cr}} p_{\text{ism}} \rightarrow \pi^0 \rightarrow \gamma\gamma$$

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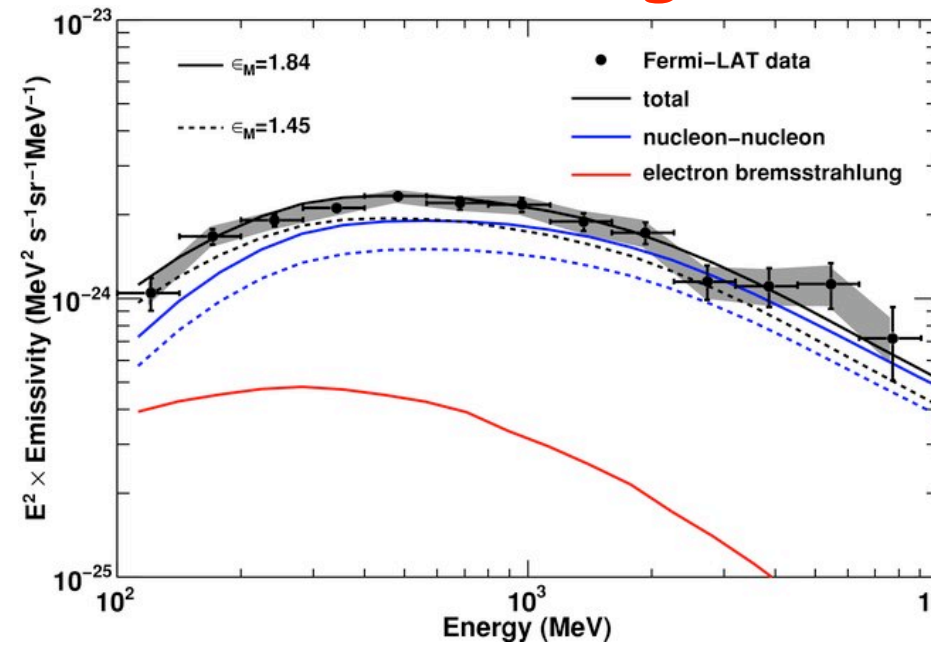
★ **but most galaxies unresolved:**

**guaranteed contribution to diffuse background** Pavlidou & BDF 02; Prodanovic & BDF 06

# Fermi Star-Forming Signal: Cosmic-Ray Source History

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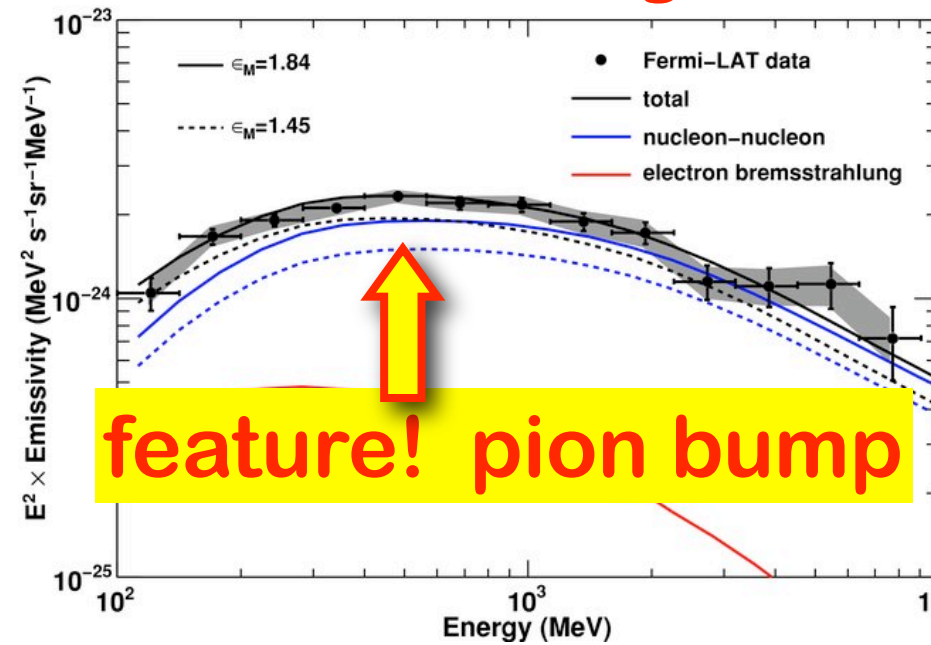
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Abdo et al 2009

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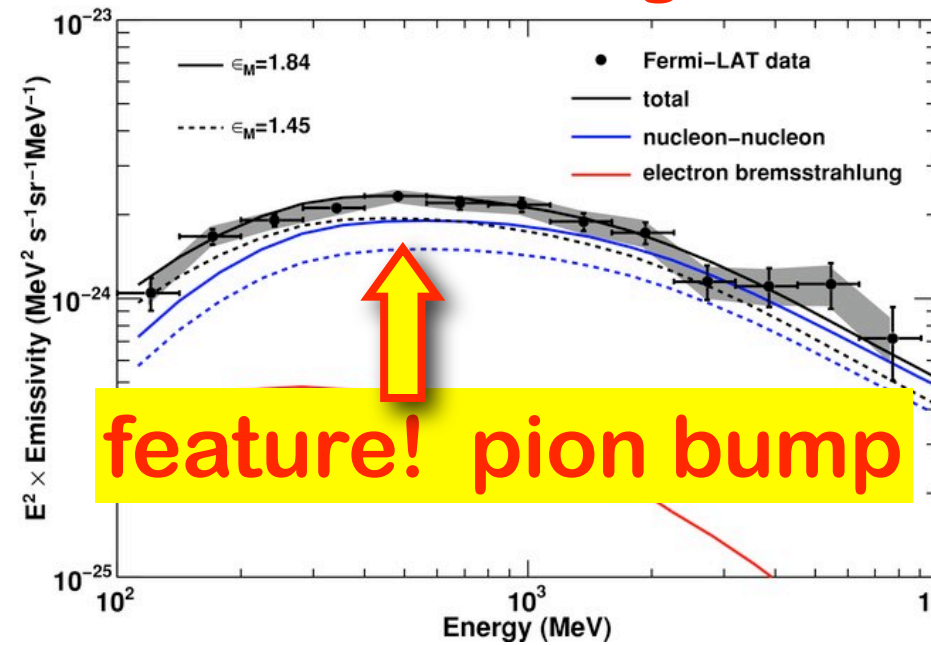


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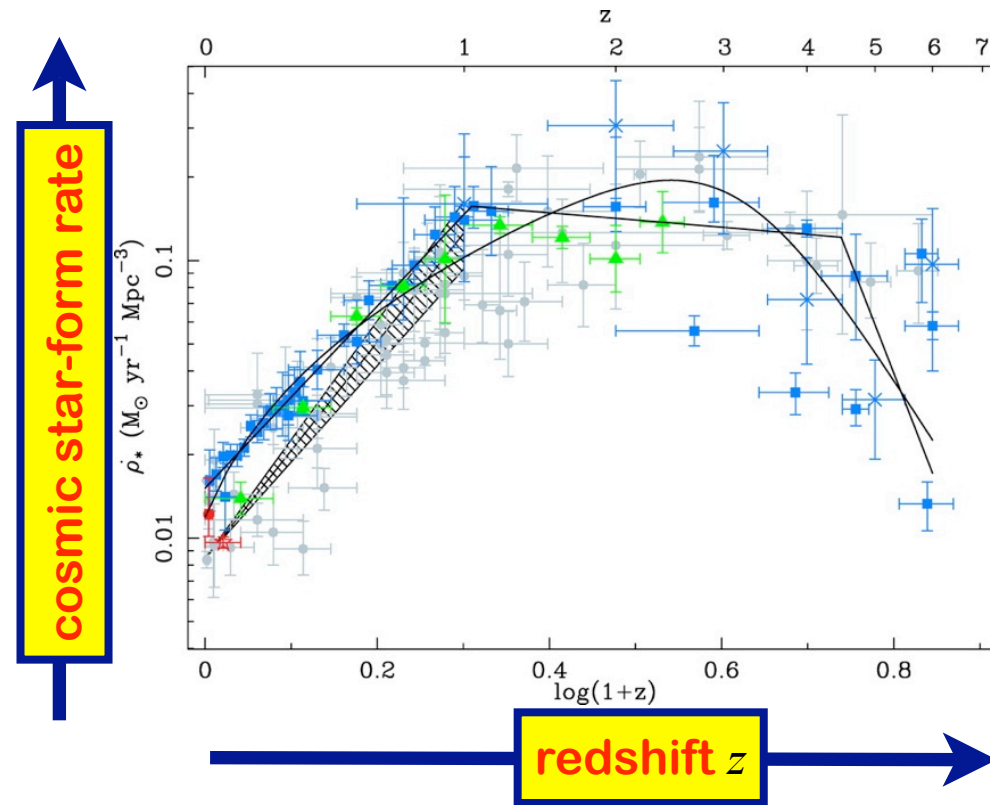
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today: from cosmic star-formation rate  
future: directly count SNe to  $z \sim 1$   
Lien & BDF 09

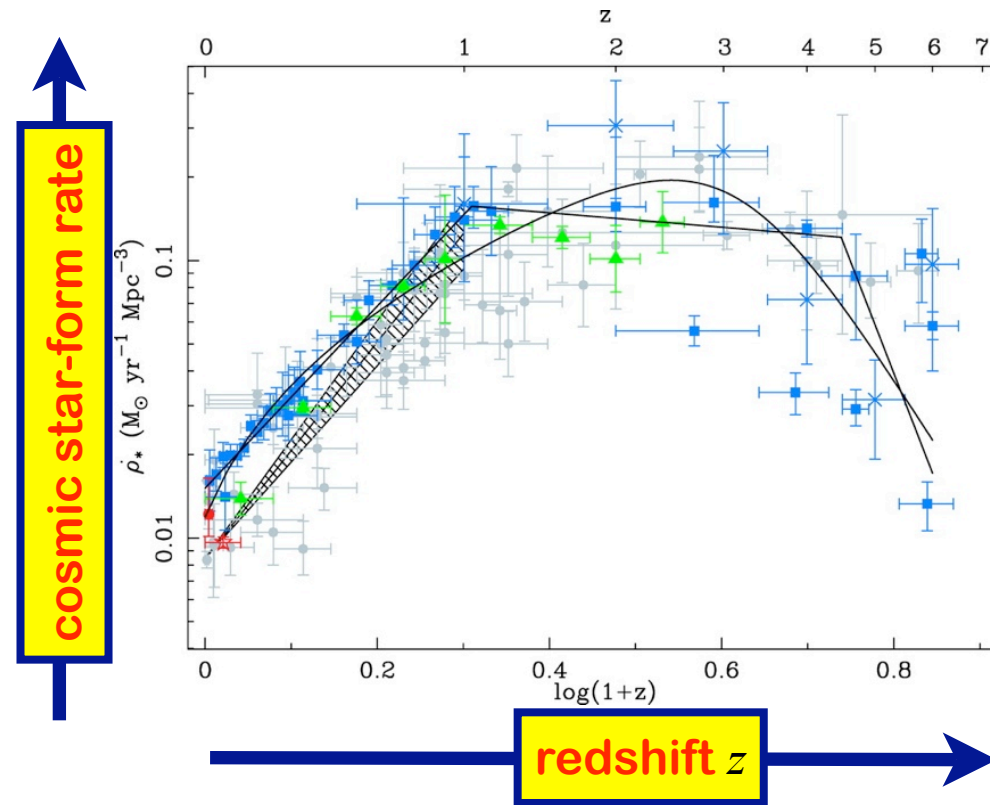


Hopkins & Beacom 2006

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- total diffuse intensity

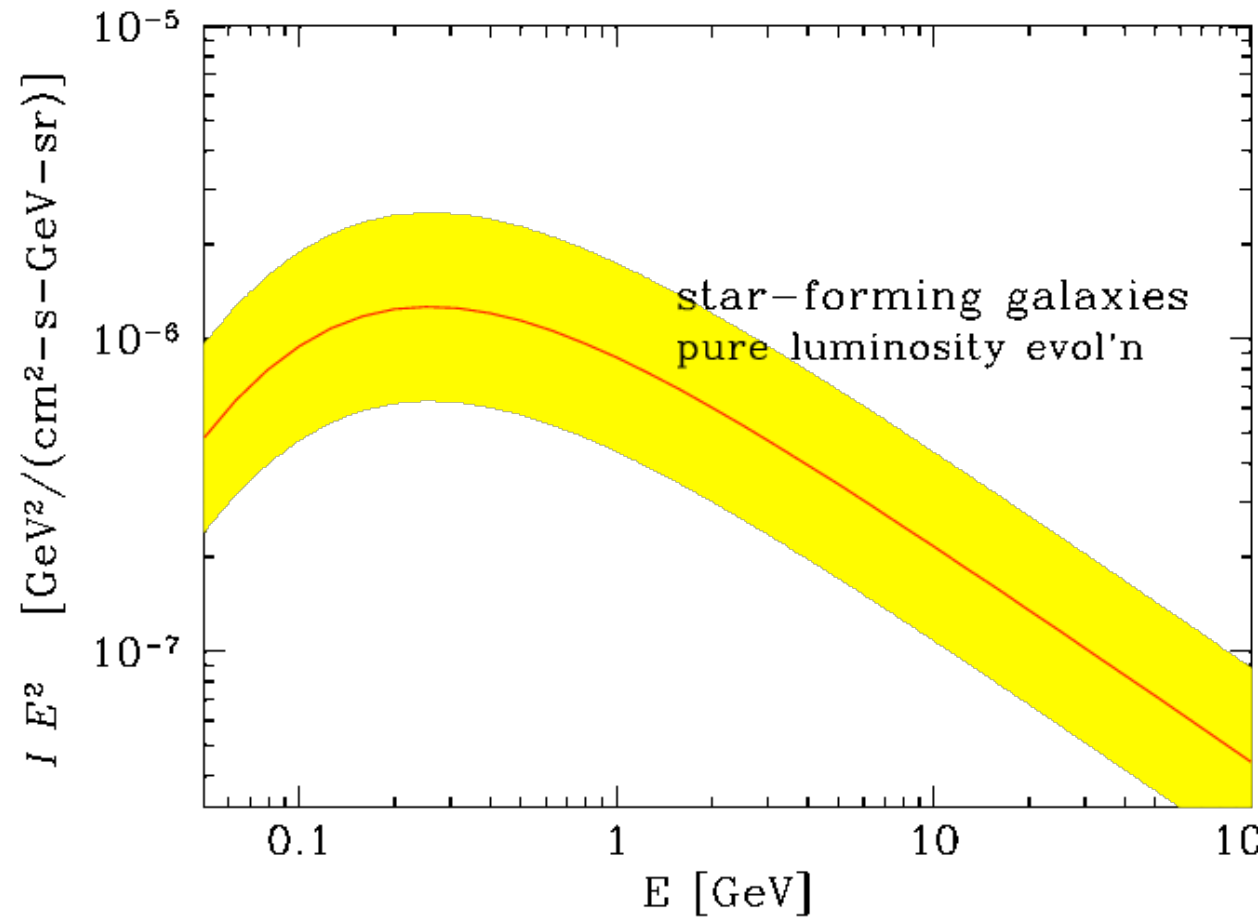
$$I_\gamma \sim \frac{c}{4\pi} \int dt \mathcal{L}_\gamma$$



Hopkins & Beacom 2006

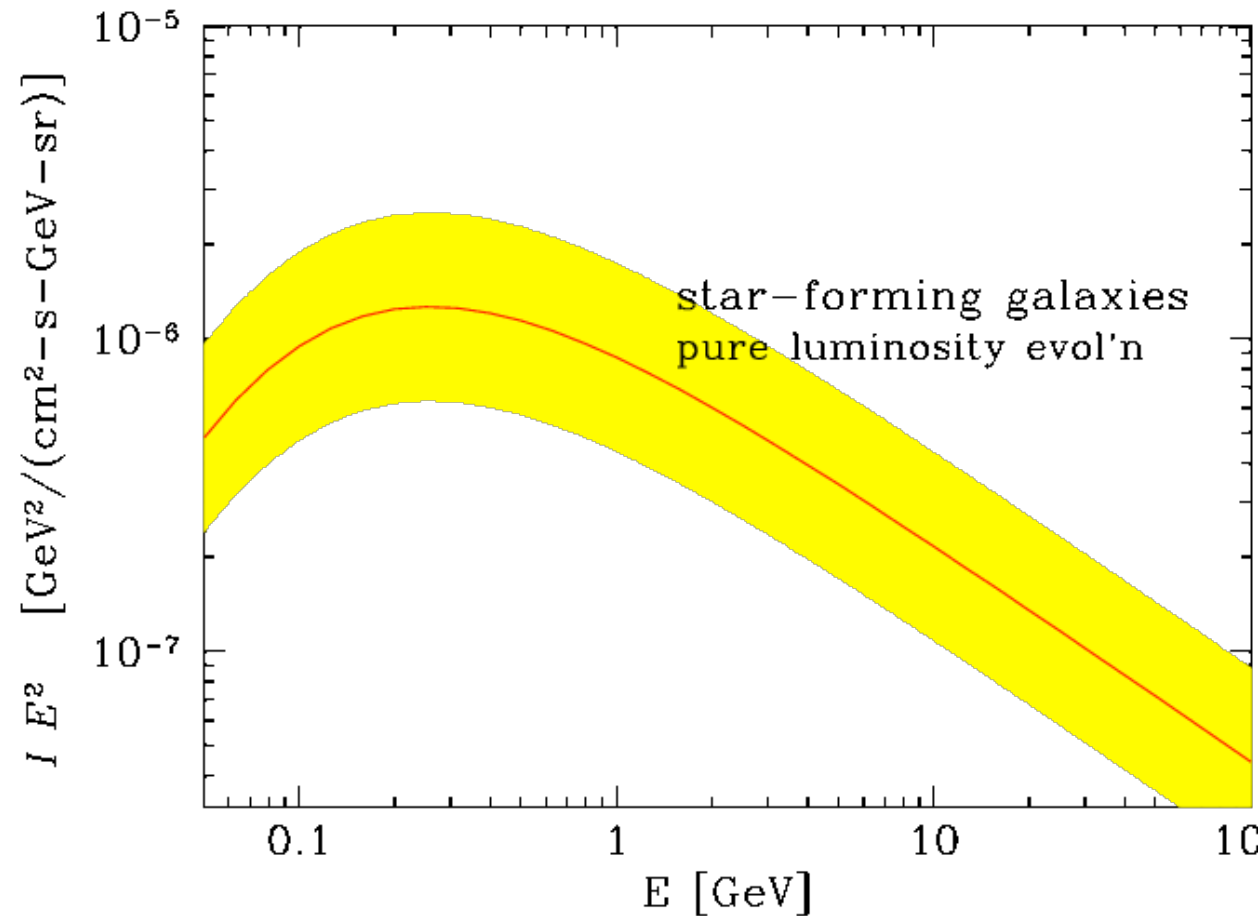
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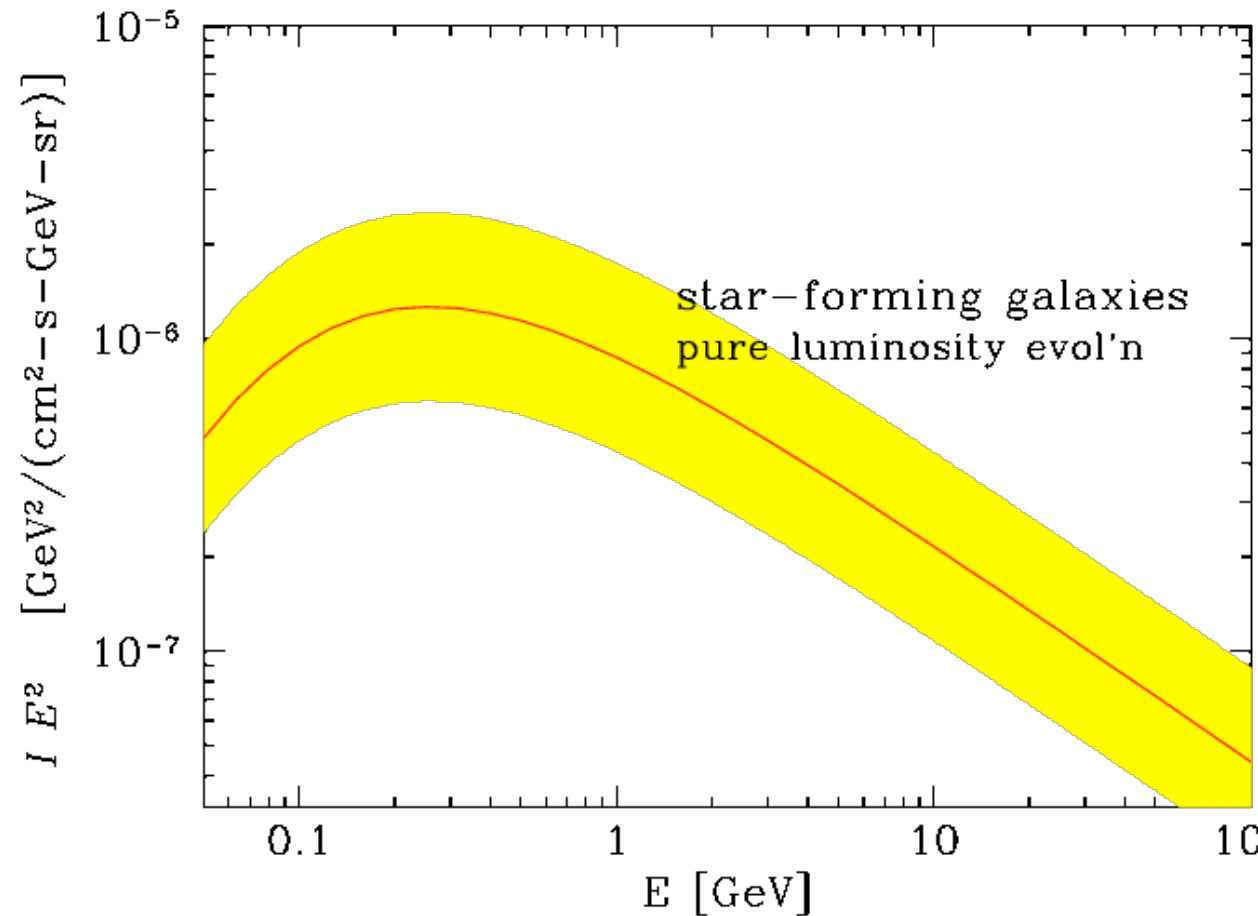


Curves: Pavlidou & BDF 02; Pavlidou, Prodanovic, & BDF in prep

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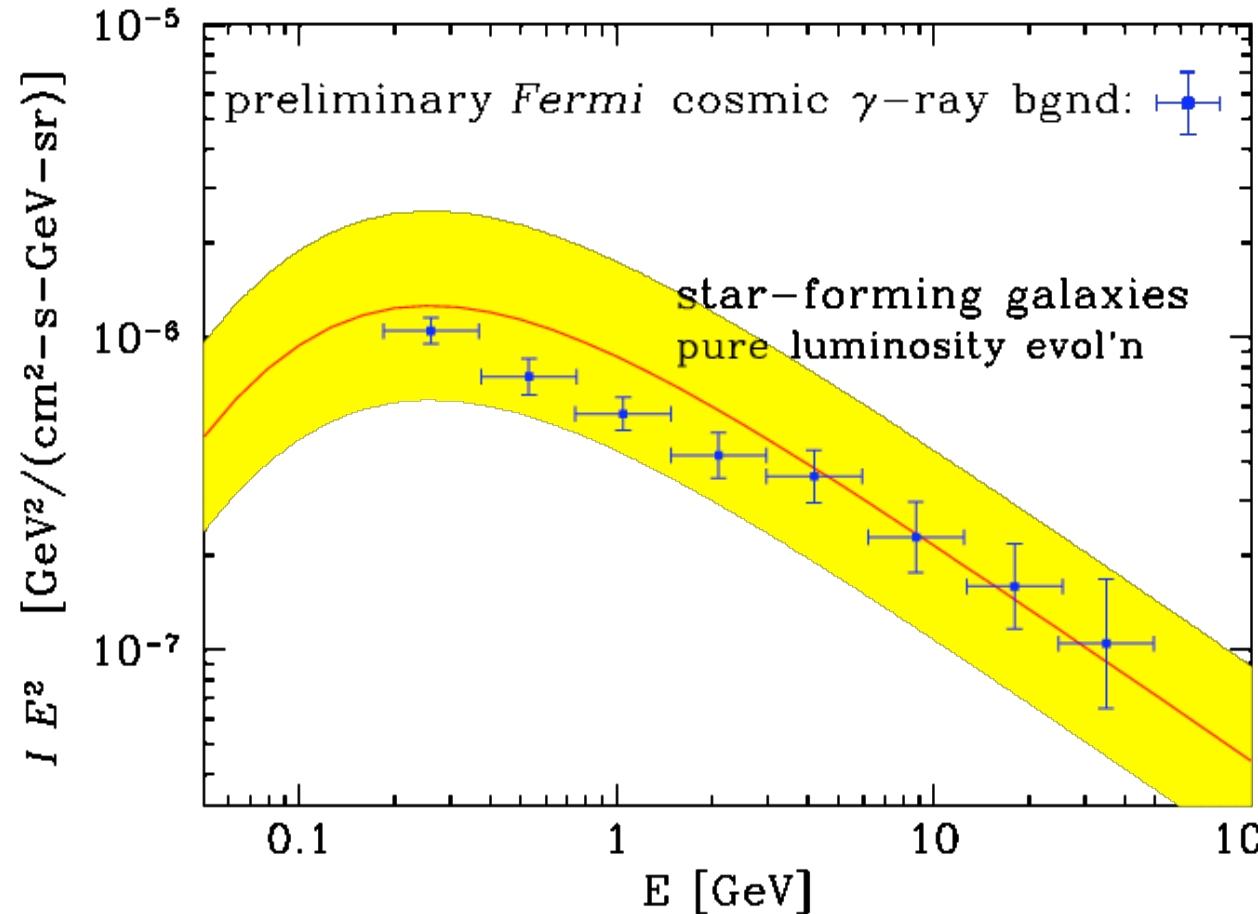


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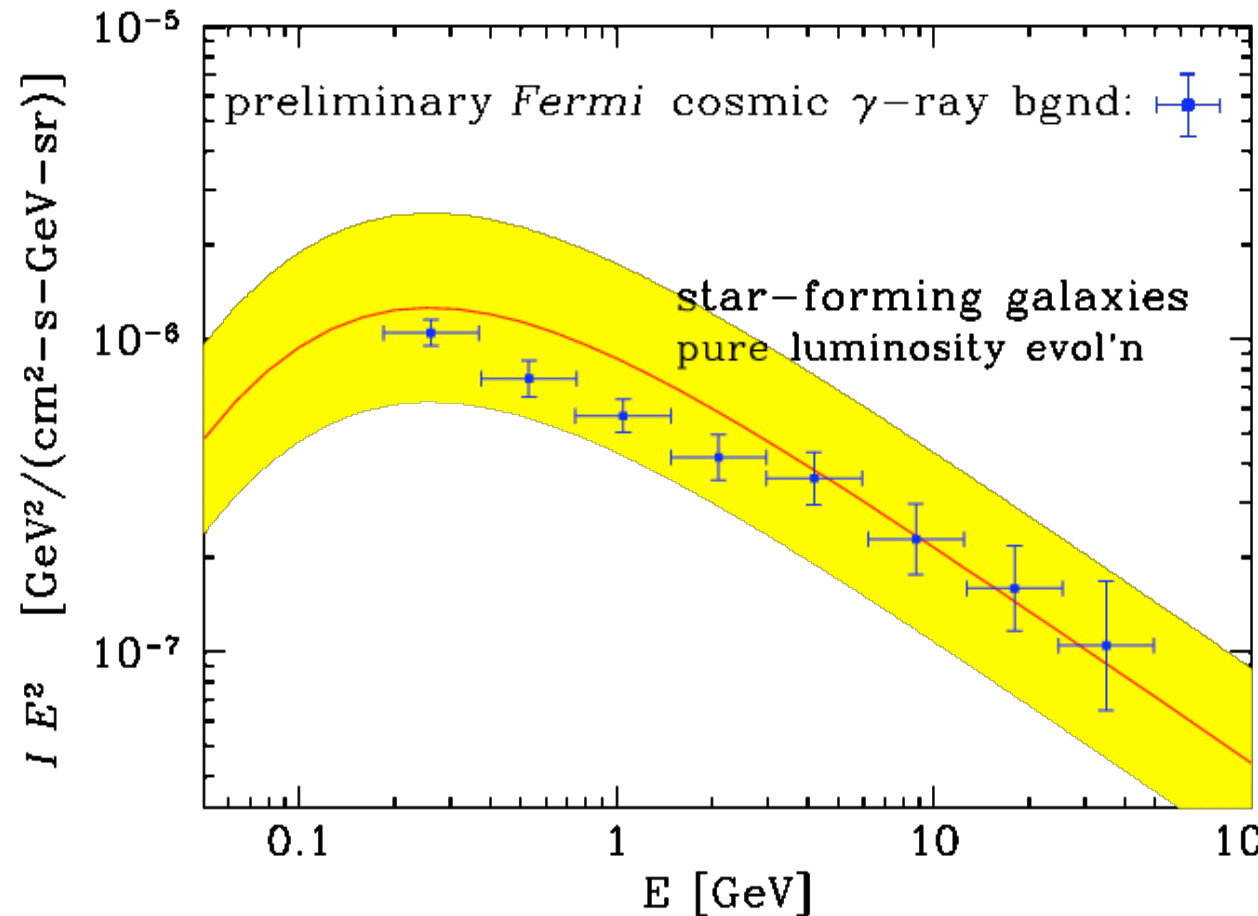
**Points:** Ackerman talk,

url <http://www-conf.slac.stanford.edu/tevpa09Ackermann090714v2.ppt>

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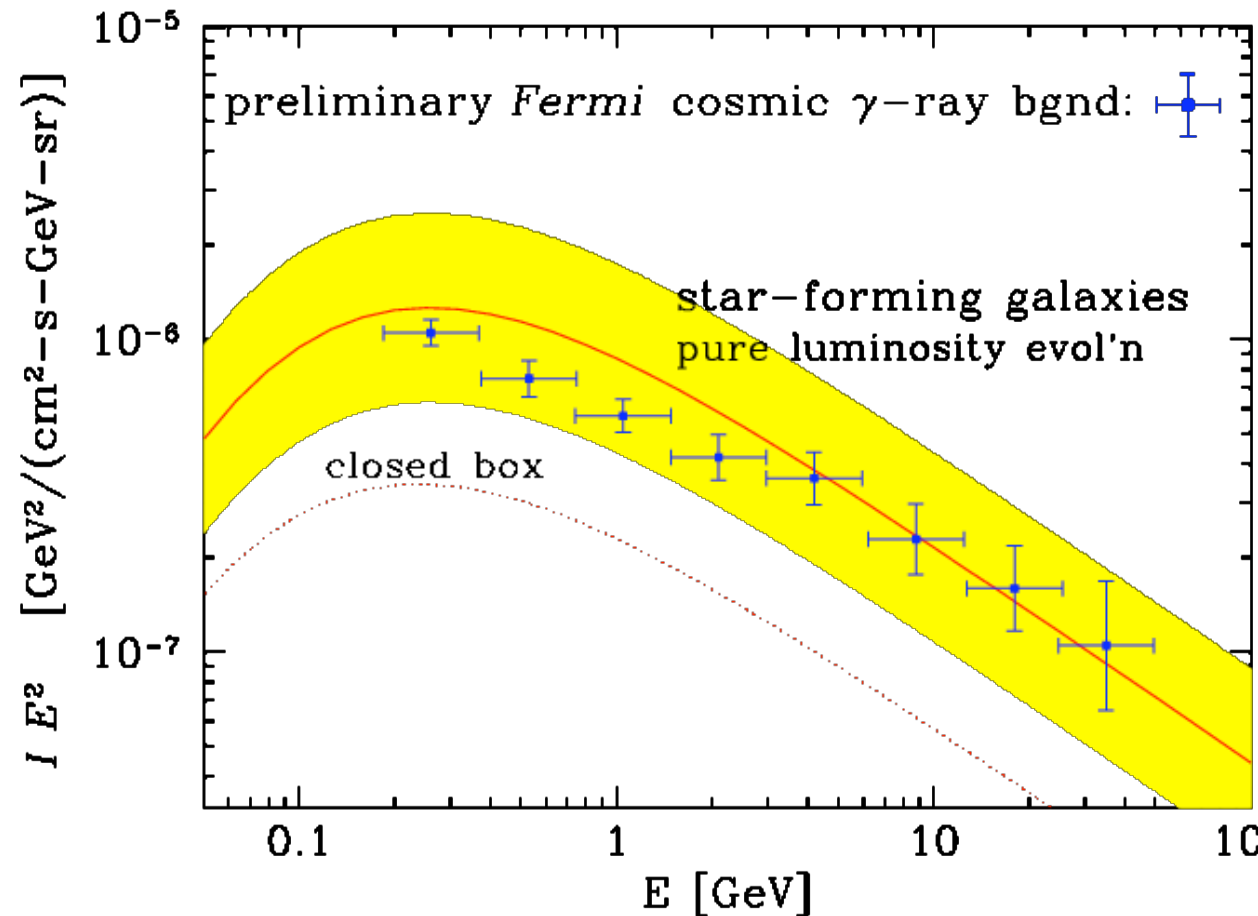
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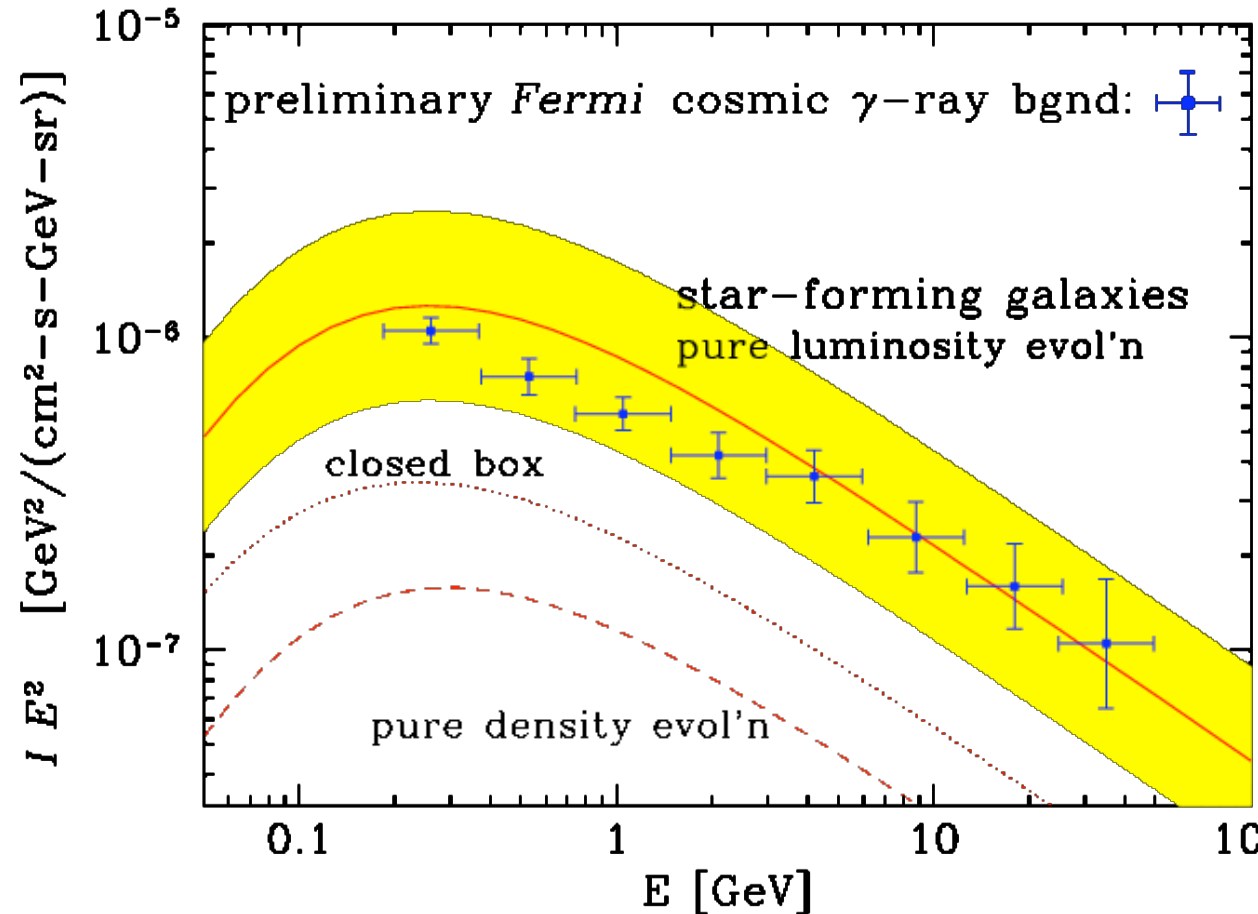
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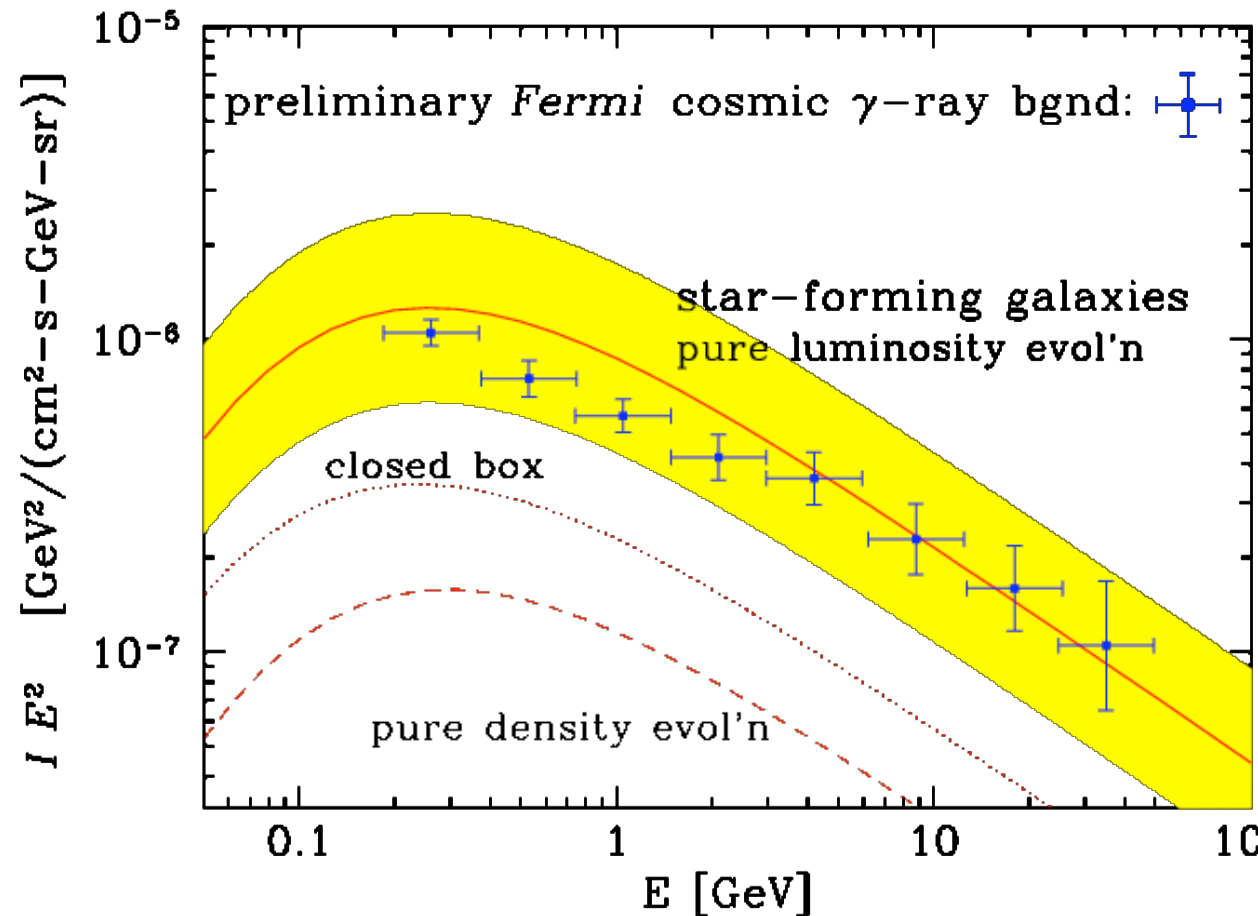
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- ✓ **angular dist:** ~isotropic, but should cluster like galaxies

Ando & Pavlidou 09



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