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

Collaborators
Vasiliki Pavlidou
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Amy Lien

Brian Fields  Fermi Symposium  Nov 4, 2009
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Cosmic Rays
and the
Gauranteed Gamma-Ray Background

diffuse Fermi sky: Porter, Digel, Ackermann talks
Galactic plane dominates
due to cosmic-ray propagation

\[ p_{cr} \rightarrow p_{ism} \rightarrow \pi^0 \rightarrow \gamma\gamma \]

working hypothesis: supernovae are engines of cosmic-ray acceleration

star formation $\rightarrow$ supernovae $\rightarrow$ cosmic rays
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resolved star-forming galaxies: new cosmic-ray laboratory Pavlidou & BDF 01;
Knodlseder, Bechtol, Karlsson talks
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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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- each galaxy:
  - gamma spectrum: pionic (Galactic)

Abdo et al 2009
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  - today: from cosmic star-formation rate
  - future: directly count SNe to \( z \sim 1 \)

Lien & BDF 09

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Hopkins & Beacom 2006

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    - Lien & BDF 09
- total diffuse intensity
  - \( I_\gamma \sim \frac{c}{4\pi} \int dt \ L_\gamma \)
    - Hopkins & Beacom 2006
Theory vs Observation

Preliminary Status

[Graph showing the relationship between $I E^2$ and $E$ (GeV), with the x-axis ranging from 0.1 to 10 GeV and the y-axis ranging from $10^{-7}$ to $10^{-5}$. The graph includes two curves labeled "star-forming galaxies" and "pure luminosity evol'n".]
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Curves: Pavlidou & BDF 02; Pavlidou, Prodanovic, & BDF in prep
✓ shape: Galactic/pionic feature redshifted

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Points: Ackerman talk,
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✓ angular dist: ~isotropic, but should cluster like galaxies

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Ando & Pavlidou 09
Gamma Probes of Cosmic Star-Formation & Cosmic-Ray History

star-forming galaxies ➔ SN ➔ cosmic rays ➔ gamma rays
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  **spectral feature:** redshifted Galactic (pionic) peak

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Fermi resolved star-forming galaxies will calibrate

Milky Way diffuse, LMC, starbursts, M31?
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- stay tuned!