GLAST detectability of gamma-ray emission from photon fields of luminous stars

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ABSTRACT

Inverse-Compton scattering by cosmic-ray electrons on the CMB and ISRF produce a major component of the diffuse gamma-ray emission from the Galaxy. The stellar ISRF is not smooth but clumpy due to the large contribution from the most luminous stars. We have shown (Orlando, E. & Strong, A.W. (2006) http://arxiv.org/abs/astro-ph/0607563) that the gamma-ray emission from the radiation field of some individual supergiant stars could be marginally detectable by GLAST. We present the basic formalism required and give possible candidate stars to be detected and make prediction for GLAST. We also apply the theory to OB associations, showing that inverse-Compton emission produced is not negligible compared to the sensitivity of GLAST. More detailed studies and an updated list of possible candidate stars for detection, will be given in Orlando et al. 2007. Recently the extended emission from the Sun has been detected using EGRET data (see our poster P17-16).

SINGLE STAR THEORY OF IC EMISSION

The inverse-Compton luminosity \( L_{\text{IC}} \) integrated over a volume surrounding a star goes as the radius \( r \) around the star and the optical luminosity:

\[ L_{\text{IC}} \propto L_{\text{opt}} \int u_{\gamma}(r,d) \frac{dV}{d^3} \]

but the flux depends on the star's distance:

\[ \text{Flux}_{\text{IC}} \propto \frac{L_{\text{IC}}}{d} \]

For angle \( \alpha \):

\[ \alpha \sim \frac{r}{d} \rightarrow \text{flux}_{\text{IC}} \sim L_{\text{IC}} \alpha / d \]

The plots below show the IC spectrum of main sequence stars (left) and giant stars (right) of different spectral type at 100 pc distance. Flux is integrated over 5° radius.

FLUX ESTIMATE FOR OB ASSOCIATIONS: CYGNUS OB2

Conervative assumptions:
- 120 O6V stars (T = 33000 K, L = 9x10^6L_☉)
- 249 B9V stars (T = 15000 K, L = 9.5x10^4 L_☉)

Flux \( 4.8x10^{-2} \times 10^{-2} \text{cm}^{-2} \text{s}^{-1} \) (100 MeV-100 GeV)

Realistic assumptions:
- 120 O6V stars (T = 42x10^4 K, L = 4.2x10^4L_☉)
- 249 B9V stars (T = 15400 K, L = 830 L_☉)

Flux \( 1.8x10^{-2} \times 10^{-2} \text{cm}^{-2} \text{s}^{-1} \) (100 MeV-100 GeV)

ESTIMATION OF POSSIBLE STELLAR CANDIDATES FOR GLAST

\( \eta \) Carinae
- T = 30000 K, L = 7x10^6L_☉; distance = 3.3 kpc
- Flux(5°) = 2.2x10^{-3} cm^{-2} s^{-1} (100 MeV-100 GeV)
- Flux(<5°) = 1x10^{-3} cm^{-2} s^{-1} (10 GeV-100 GeV)

\( \zeta \) Puppis
- T = 42400 K, L = 10^7L_☉; distance = 429 pc
- Flux(5°) = 1.1x10^{-3} cm^{-2} s^{-1} (100 MeV-100 GeV)
- Flux(<5°) = 5.8x10^{-4} cm^{-2} s^{-1} (10 GeV-100 GeV)
- Flux(<5°) = 2.5x10^{-4} cm^{-2} s^{-1} (10 GeV-100 GeV)

PREDICTED FLUXES FROM BRIGHT STARS

(70 most luminous within 600 pc from Hipparcos catalogue)

Some could possibly be detected by GLAST

GLAST sensitivity (Morselli)

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