MAX-PLANCK-INSTITUT FÜR EXTRATERRESTRISCHE PHYSIK

# Gamma-rays from halos around stars

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Inverse Compton scattering by cosmic-ray electrons produces a major component of the diffuse gamma-ray emission from the Galaxy. Calculations of the inverse Compton (IC) distribution have usually assumed a smooth interstellar radiation field, but in fact a large part of the Galactic luminosity comes from the most luminous stars, which are rare. Therefore we expect the ISRF, and hence inverse Compton, to be clumpy at some level - which could be detectable by instruments such as GLAST. Even individual nearby stars could be detectable assuming just the NORMAL cosmic-ray electron spectrum.

## SIMPLE ESTIMATE OF THE IMPORTANCE OF IC EMISSION FROM LUMINOUS STARS

The optical luminosity of the Galaxy is about $3\times10^{10} L_\odot$, and a typical O star has $10^5 L_\odot$ i.e. about $10^{-5} L_{GALAXY}$. Consider such a star at 100 pc distance: compared to the entire Galaxy (distance to center = 8.5 kpc) this IC source is about a factor 100 closer and hence the inverse Compton flux is $10^{-5}\times100^2$ of the Galactic IC, suggesting it could be significant. Therefore we have pursued this subject in more detail.

## SINGLE STAR THEORY

The inverse-Compton luminosity $L_{IC}$ within a volume surrounding a star goes as the radius $r$ around the star and the optical luminosity:

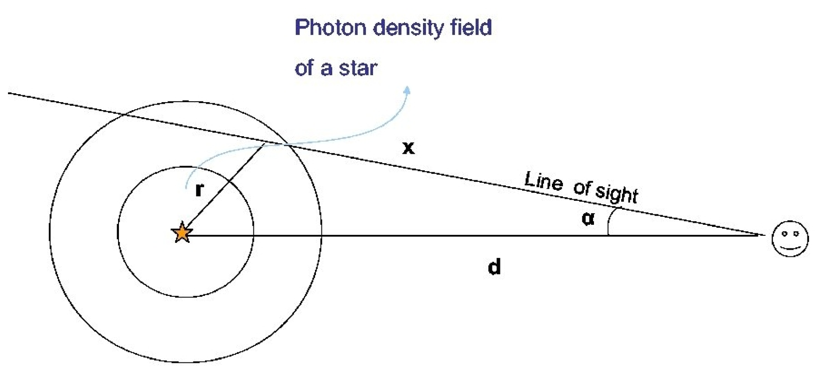
$L_{IC} \sim L_{STAR}\, r$,

but the flux depends on the star's distance d:

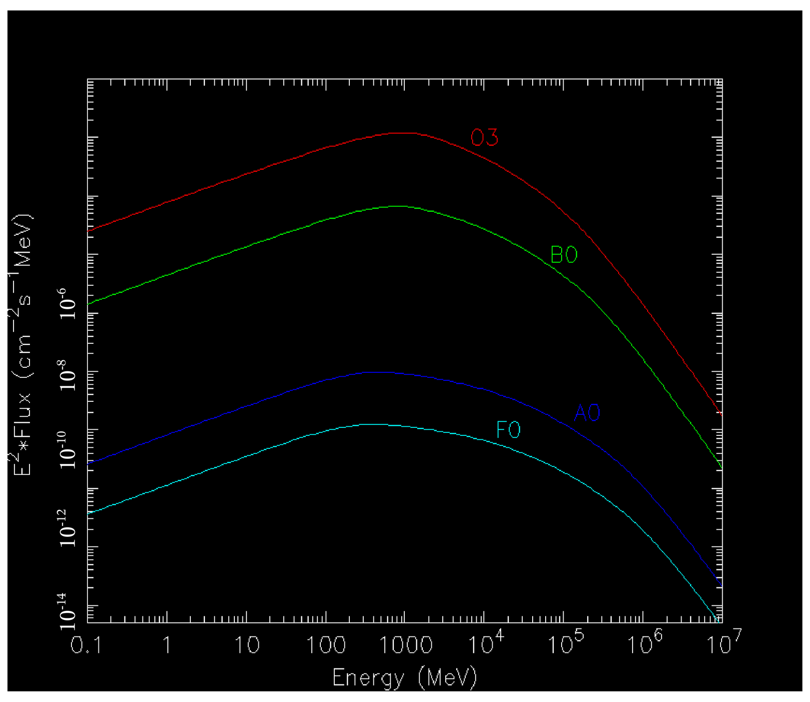
$flux_{IC} \sim L_{IC} / d^2$

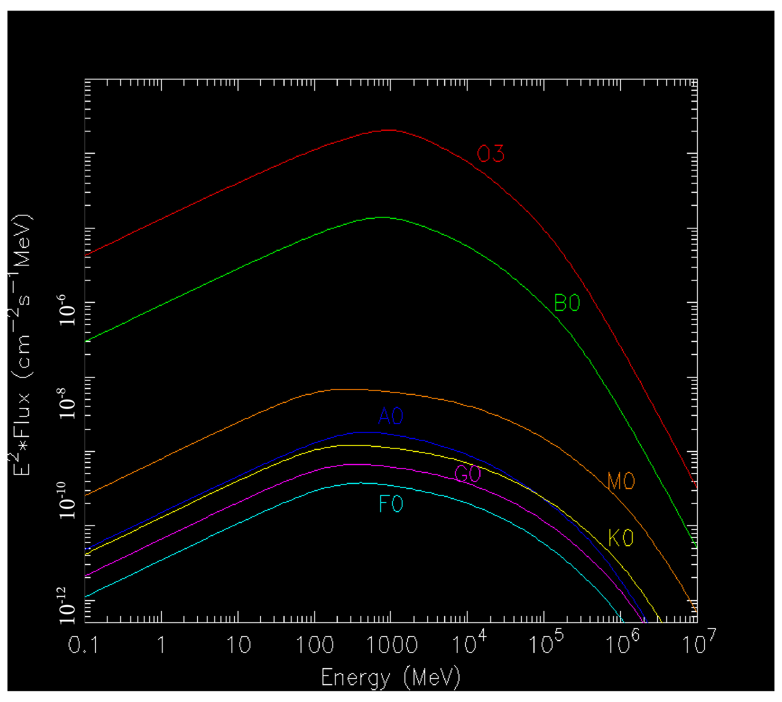
For angle α

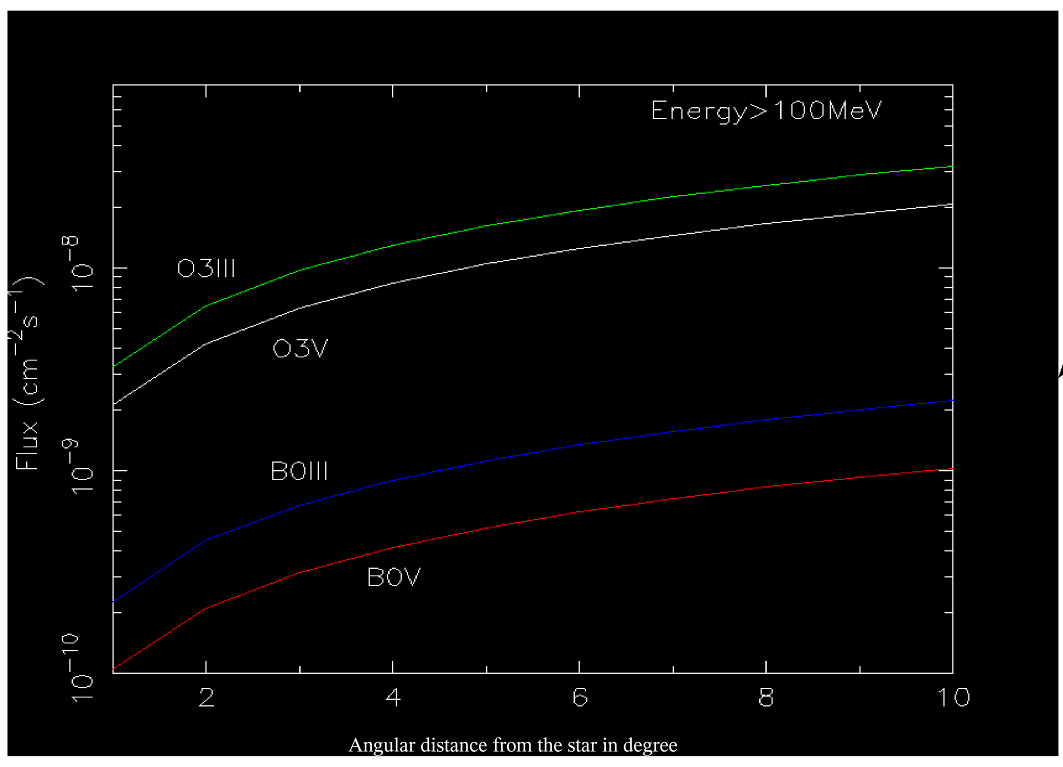
$\alpha \sim r/d \rightarrow$ $flux_{IC} \sim L_{STAR}\, \alpha / d$




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




The gamma flux integrated over solid angle from stars at 100 pc distance as a function of angle for energy >100MeV

## FLUX ESTIMATION FROM OB ASSOCIATIONS : CYGNUS OB2

distance=1.7 kpc

"Conservative" assumptions:
120 O9V stars ($T_e$=33000 K , L= $9\times10^4 L_\odot$)
2489 B9V stars ($T_e$=10500 K , L= 95 $L_\odot$)

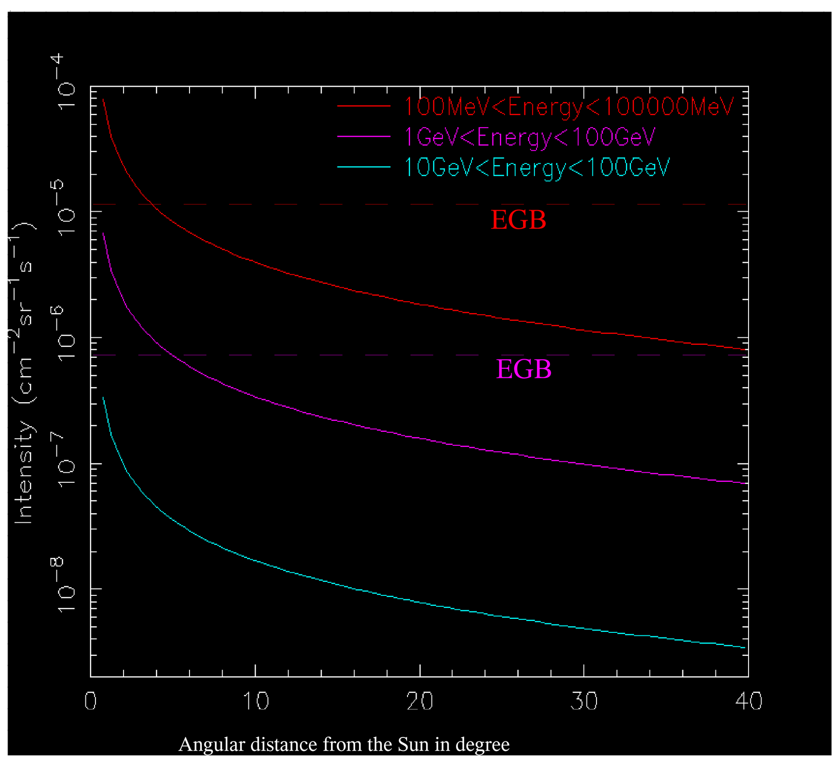
Flux~$6.5\times10^{-9}$ cm$^{-2}$s$^{-1}$ (100 MeV-100 GeV)
Flux~$6.8\times10^{-10}$ cm$^{-2}$s$^{-1}$ (1 GeV-100 GeV)
Flux~$2.4\times10^{-11}$ cm$^{-2}$s$^{-1}$ (10 GeV-100 GeV)

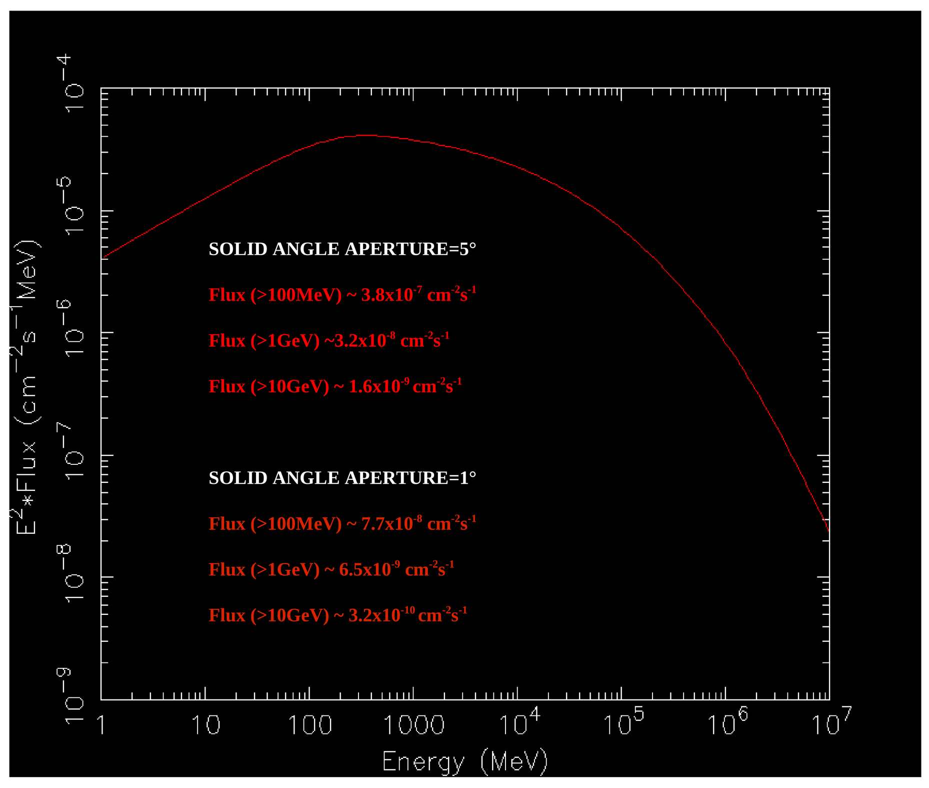
"Optimistic" assumptions:
120 O6V stars ($T_e$=41000 K , L= $4.2\times10^5 L_\odot$)
2489 B5V stars ($T_e$=15400 K , L= $830 L_\odot$)

Flux~$2.4\times10^{-8}$ cm$^{-2}$s$^{-1}$ (100 MeV-100 GeV)
Flux~$2.6\times10^{-9}$ cm$^{-2}$s$^{-1}$ (1 GeV-100 GeV)
Flux~$7.6\times10^{-11}$ cm$^{-2}$s$^{-1}$ (10 GeV-100 GeV)

## THE SUN

The IC emission from the region around the Sun is not negligible. In future a model of the gamma flux from the Sun will be implemented, in order to take it into account for diffuse background emission.




Flux ~ 0.1 Crab in 100 MeV - 10 GeV

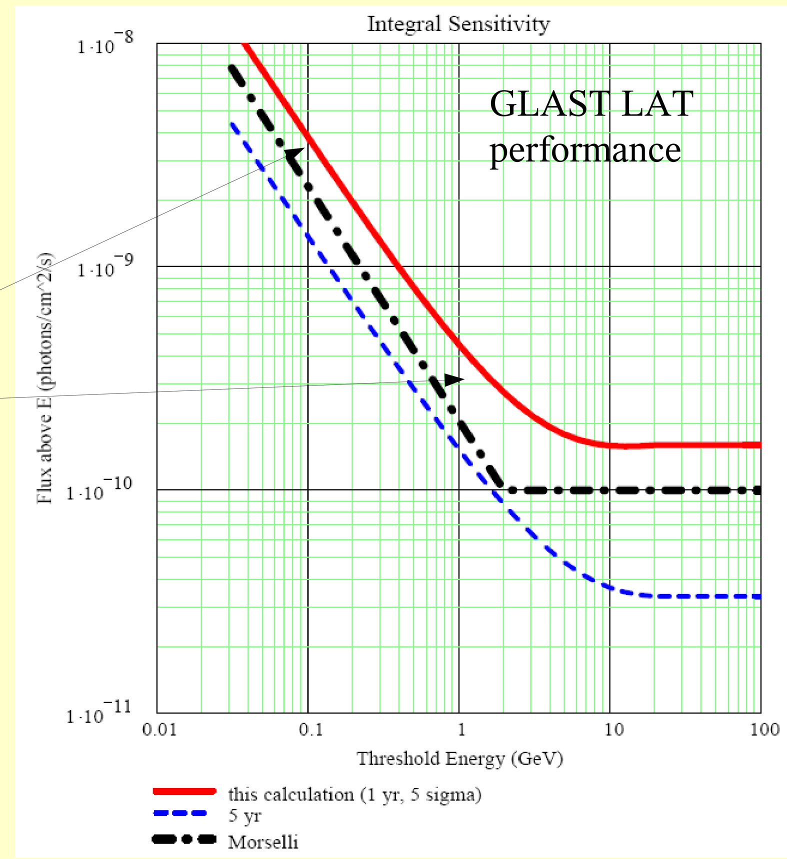
## ESTIMATION OF POSSIBLE STELLAR CANDIDATES FOR GLAST

**η Carinae**

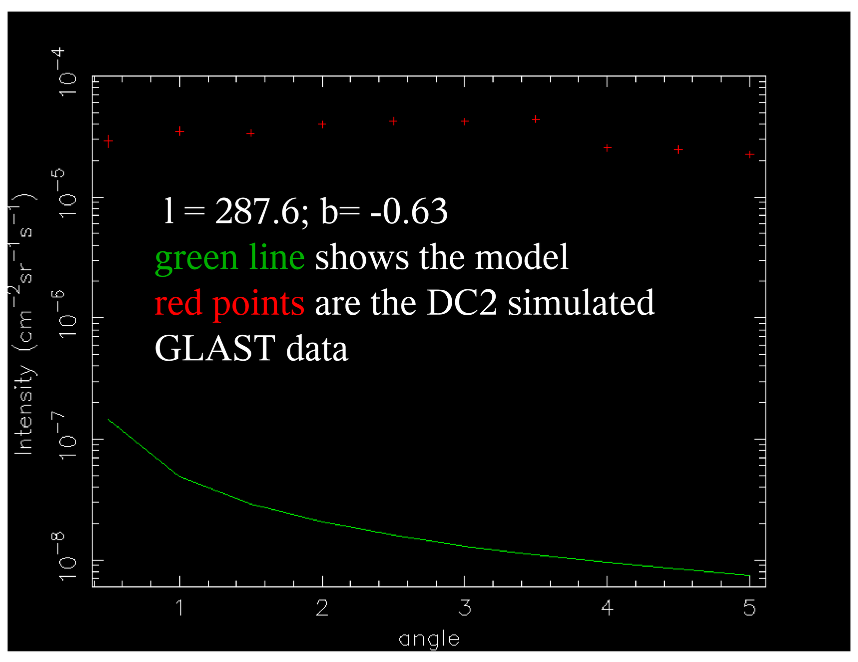
$T_e$=30000 K; L~ $7\times10^6 L_\odot$; distance = 2.3 kpc;
Flux(<5°)~ $3\times10^{-9}$ cm$^{-2}$s$^{-1}$ (100 MeV-100 GeV)
Flux(<5°)~ $3\times10^{-10}$ cm$^{-2}$s$^{-1}$ (1 GeV-100 GeV)
Flux(<5°)~ $1\times10^{-11}$cm$^{-2}$s$^{-1}$ (10 GeV-100 GeV)

**ζ Puppis**

$T_e$ = 42400 K; L~ $10^{5.9} L_\odot$; distance = 429 pc;
Flux(<5°)~ $1.4\times10^{-9}$ cm$^{-2}$s$^{-1}$ (100 MeV-100 GeV)
Flux(<5°)~ $1.5\times10^{-10}$ cm$^{-2}$s$^{-1}$ (1 GeV-100 GeV)
Flux(<5°)~ $4\times10^{-12}$ cm$^{-2}$s$^{-1}$ (10 GeV-100 GeV)




## η CARINAE AND COMPARISON WITH GLAST SIMULATION




## FURTHER CONTRIBUTION OF KNOWN STARS

(from Hipparcos catalogue)

These are mostly too weak to be detected by GLAST