



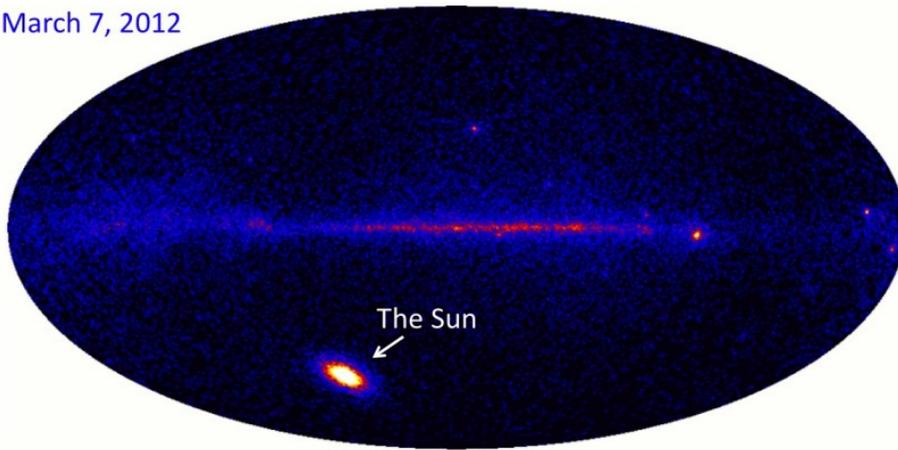
The quiet Sun in gamma rays:

Elena Orlando
(University of Trieste & INFN)

RICAP2022, Rome

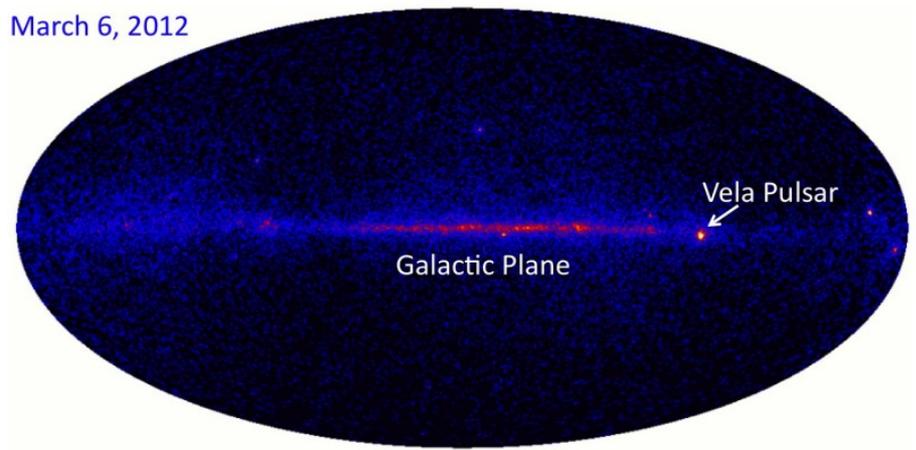
The Flaring Sun & The Non-Flaring Sun

March 7, 2012



< a few GeV

March 6, 2012

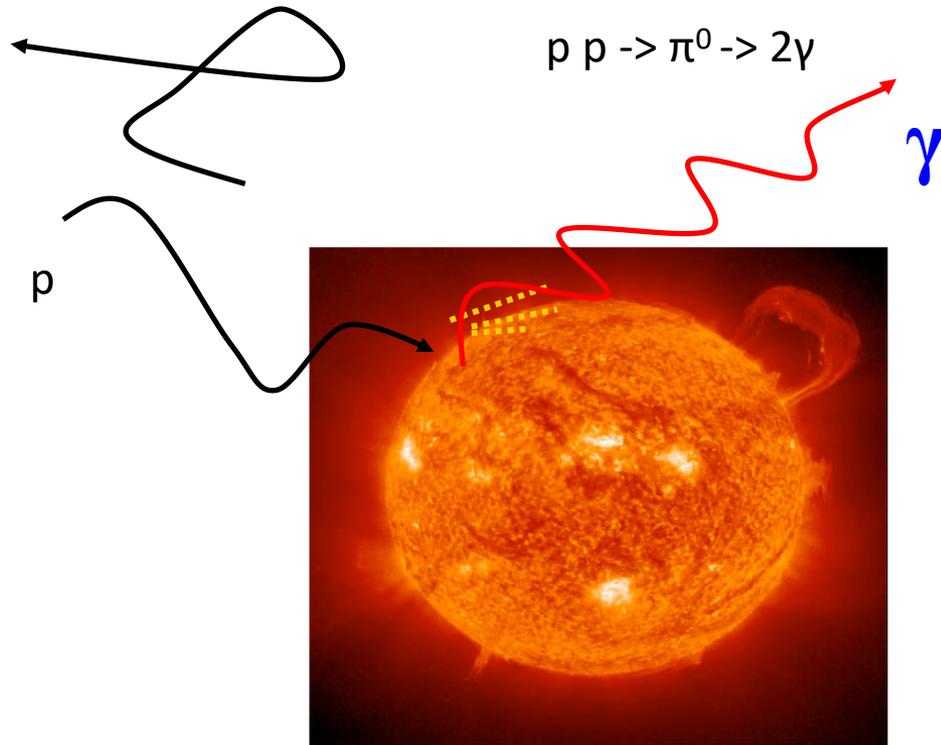


> tens of GeV

The Non-Flaring Sun (or Quiet Sun)

1) Disk Component

Hadronic interactions of Galactic CRs with solar atmosphere



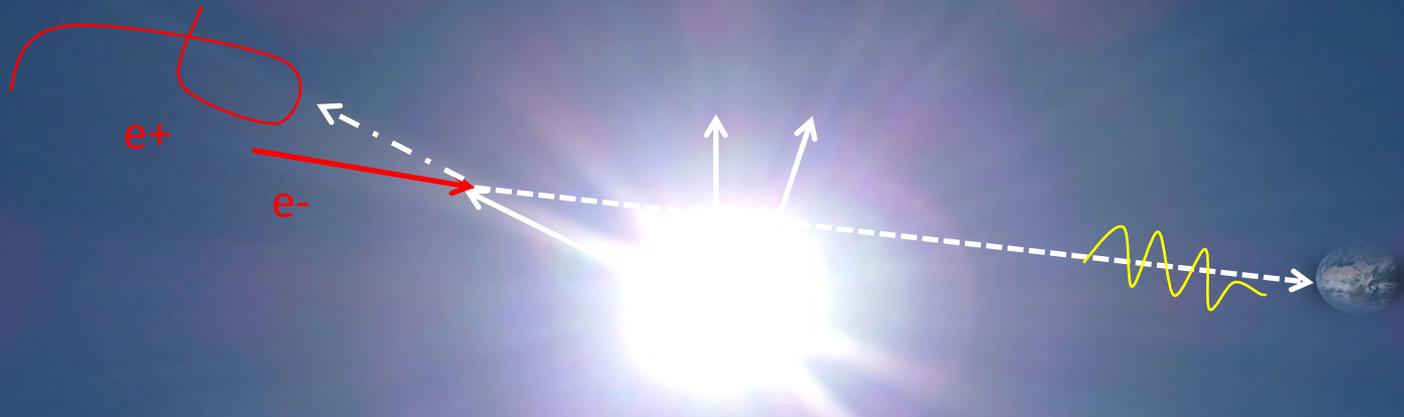
*Seckel, Stanev and Gaisser (1991)
ApJ 382, 652*

2) Inverse Compton (IC) Spatially Extended Component

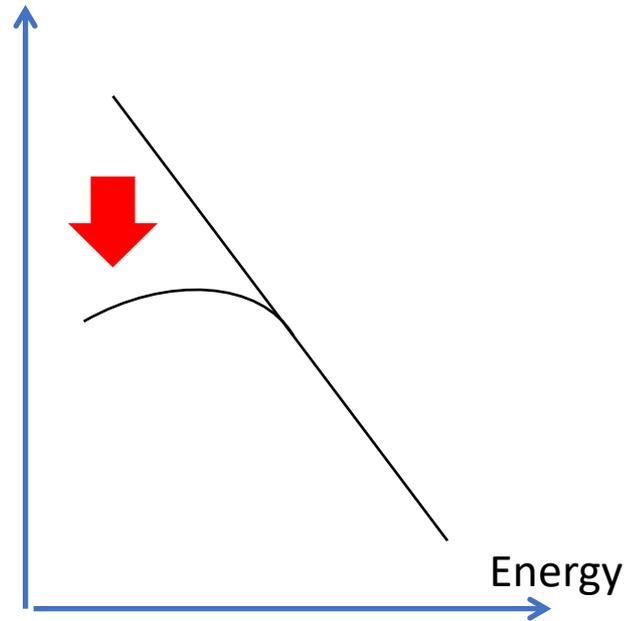
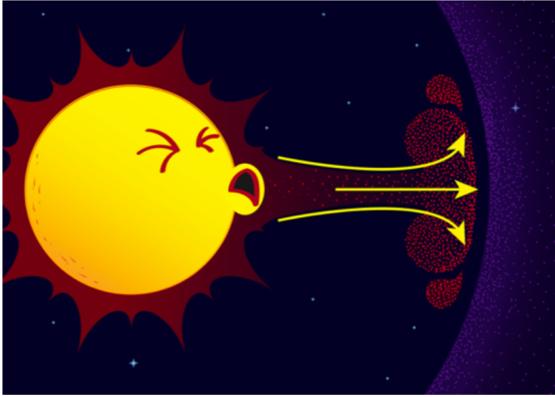
First theory:

Orlando & Strong (2006) arXiv:0607563; (2007) Ap&SS, 309, 59

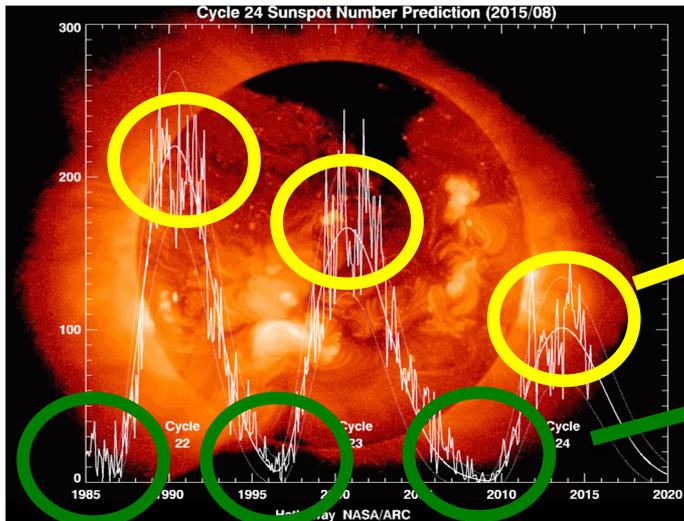
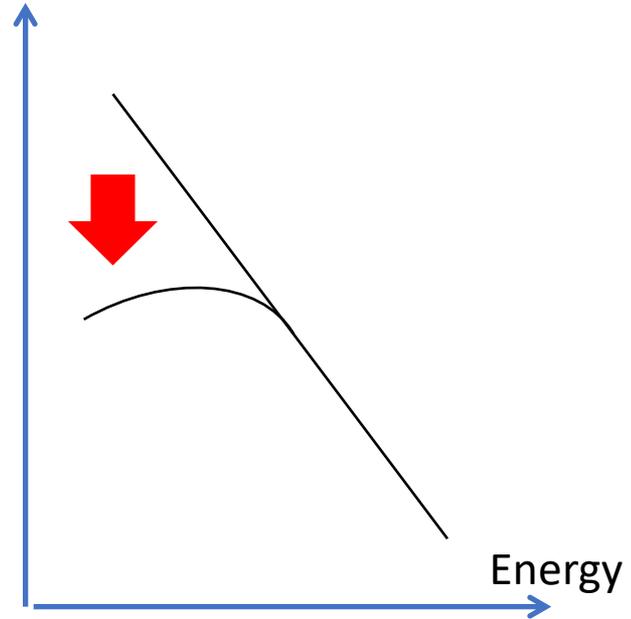
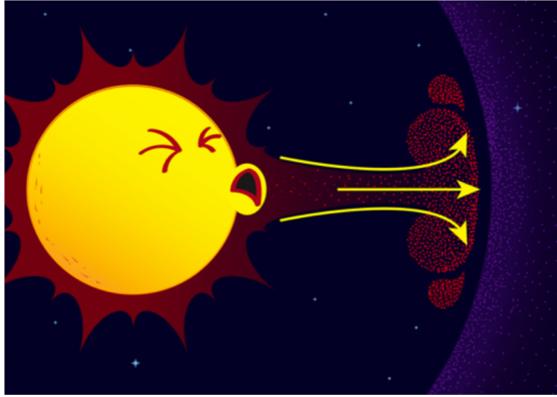
CR e^\pm + eV photon $\rightarrow \gamma$



Solar activity & Gamma-Ray Flux



Solar activity & Gamma-Ray Flux



Lower CR flux

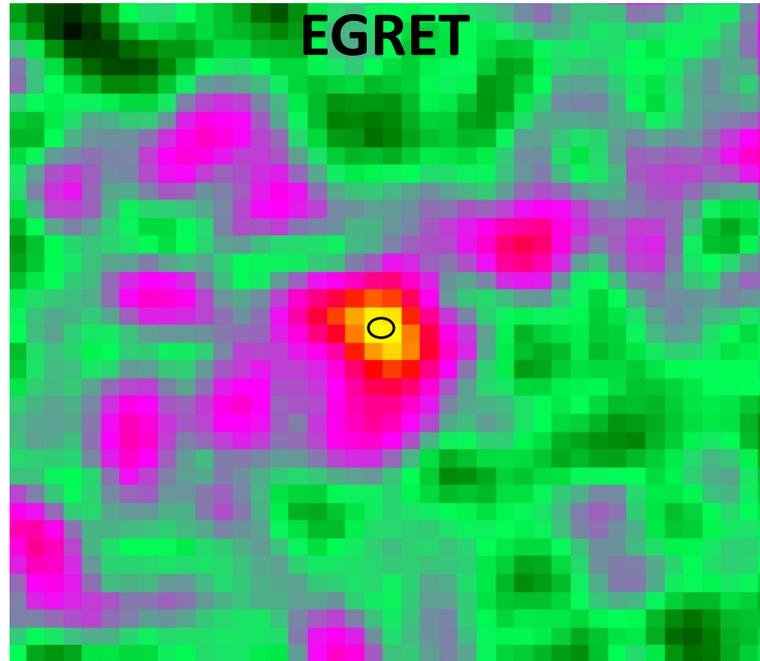
Higher CR flux



Lower gamma-ray flux

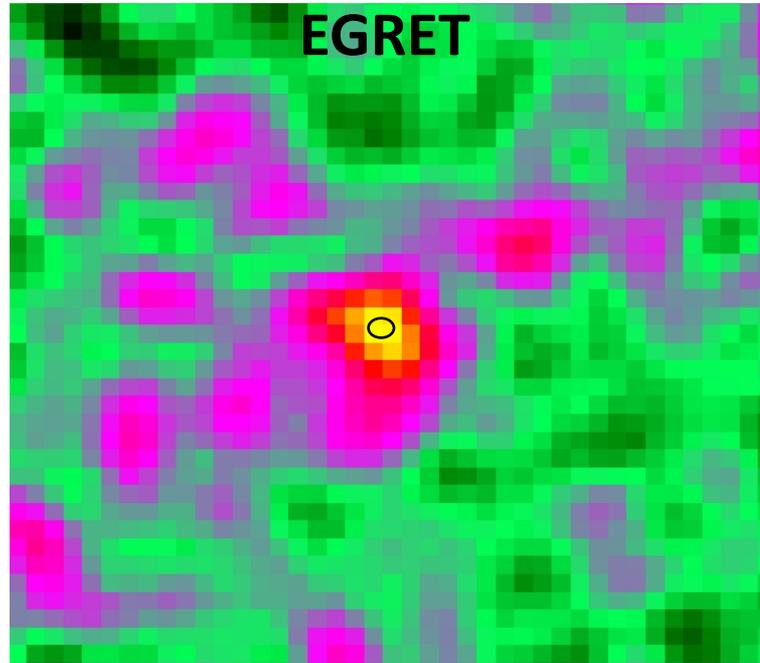
Higher gamma-ray flux

First Detection of the Quiet Sun in Gamma Rays

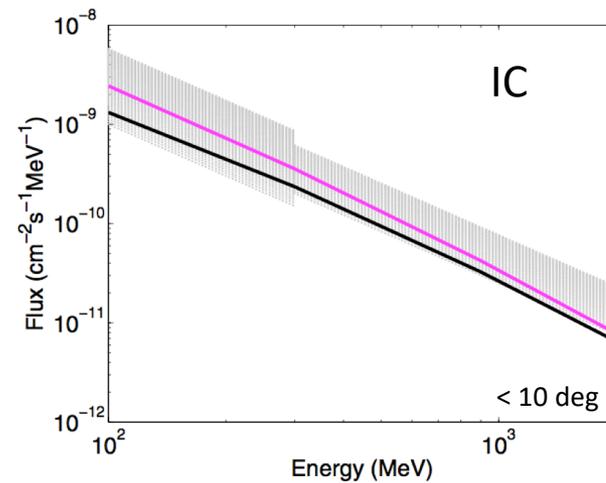
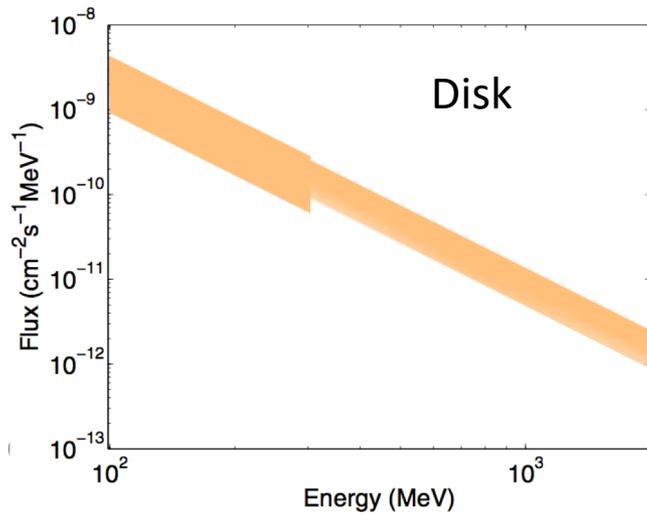


Orlando & Strong (2008)
A&A, 480, 847

First Detection of the Quiet Sun in Gamma Rays

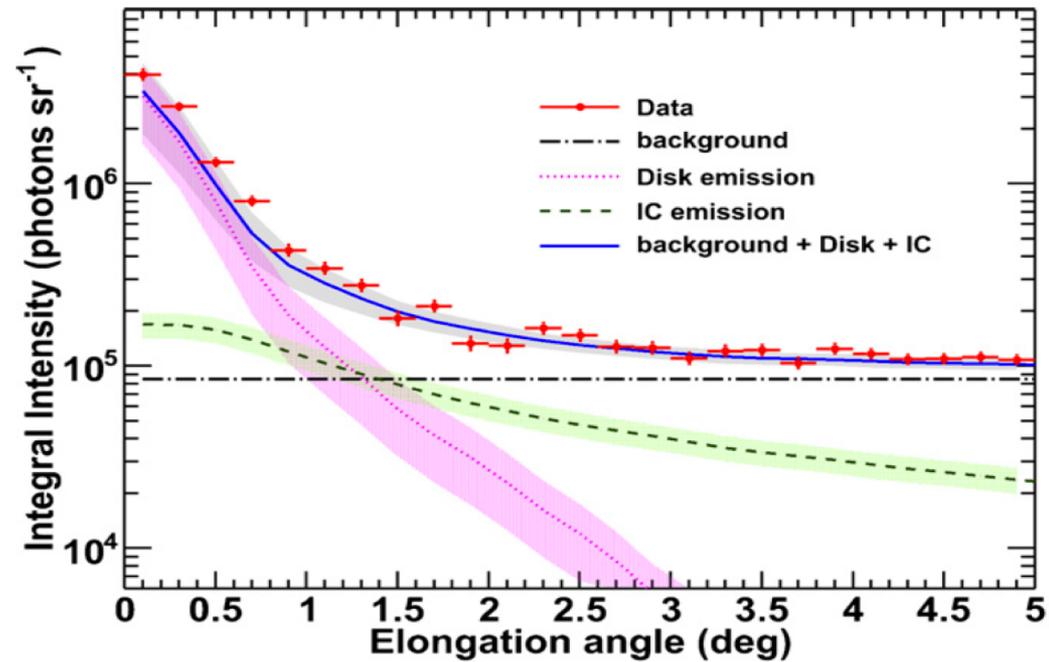
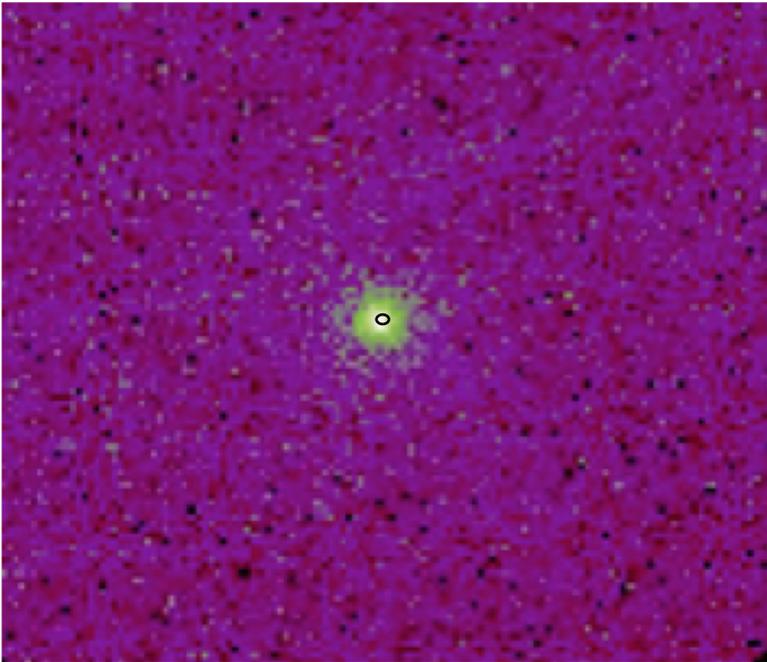


Orlando & Strong (2008)
A&A, 480, 847



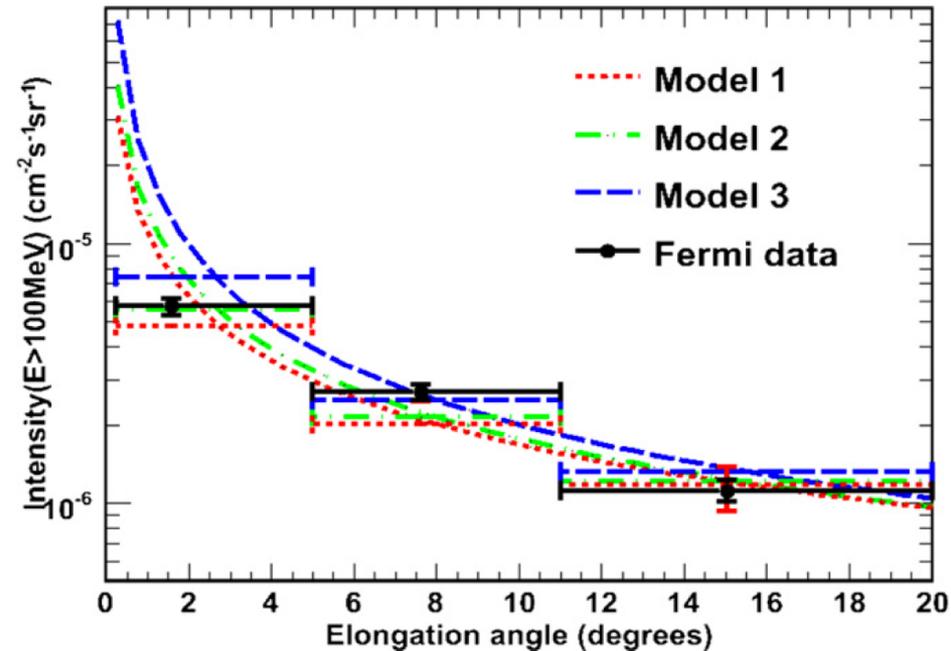
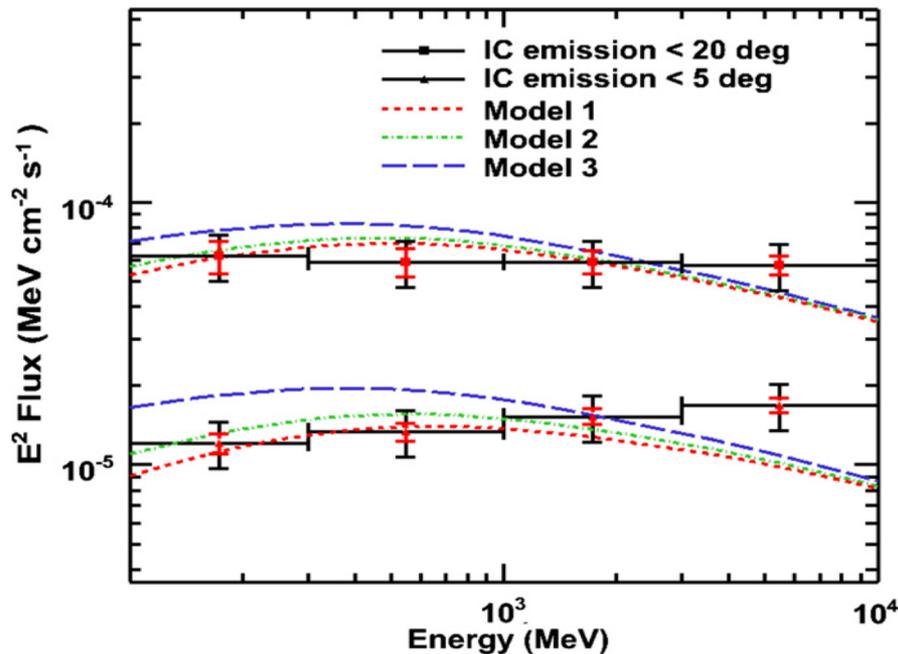
Following studies with Fermi LAT data

Fermi LAT Coll. (2011) ApJ. 734, 116



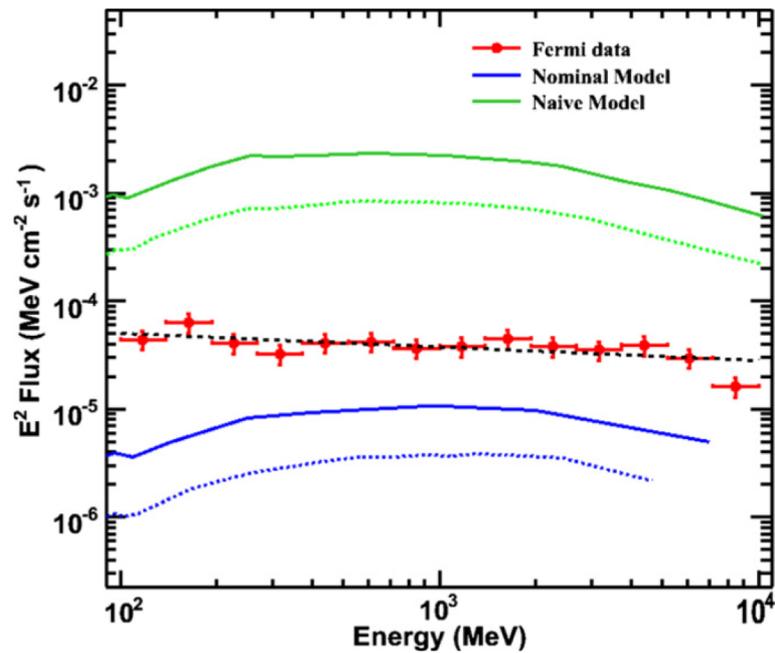
IC Spectrum and Morphology

Abdo et al. (2011) Apj 734, 116



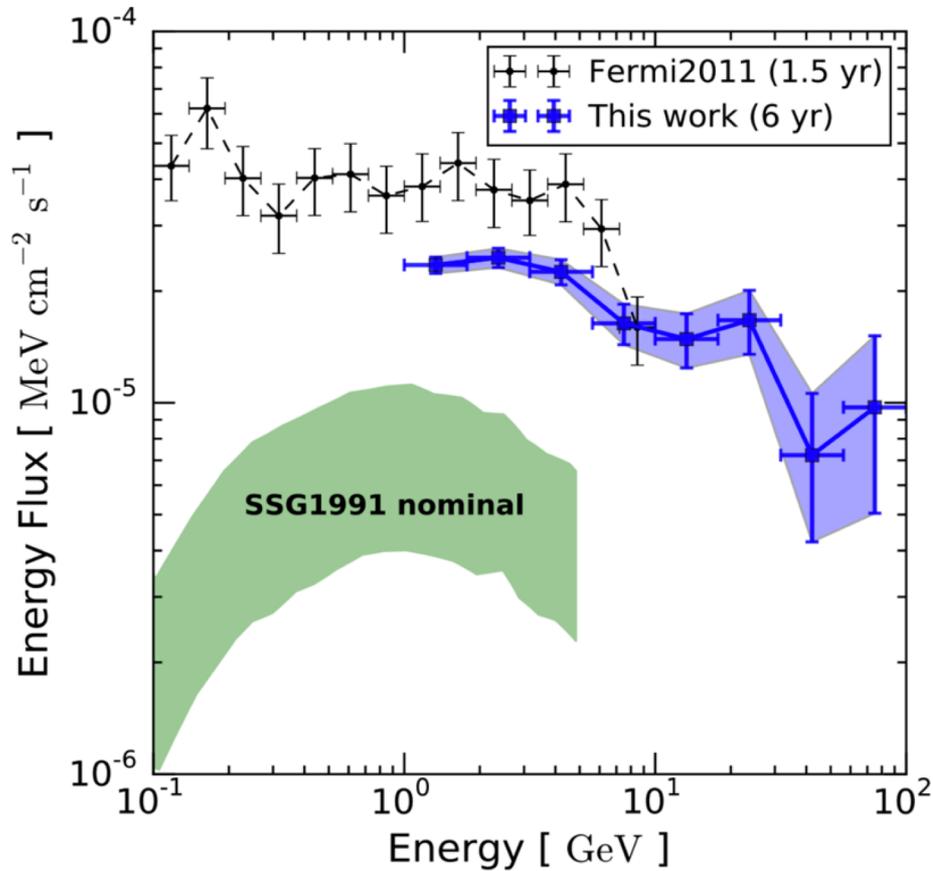
Disk Spectrum

Abdo et al. (2011) Apj 734, 116

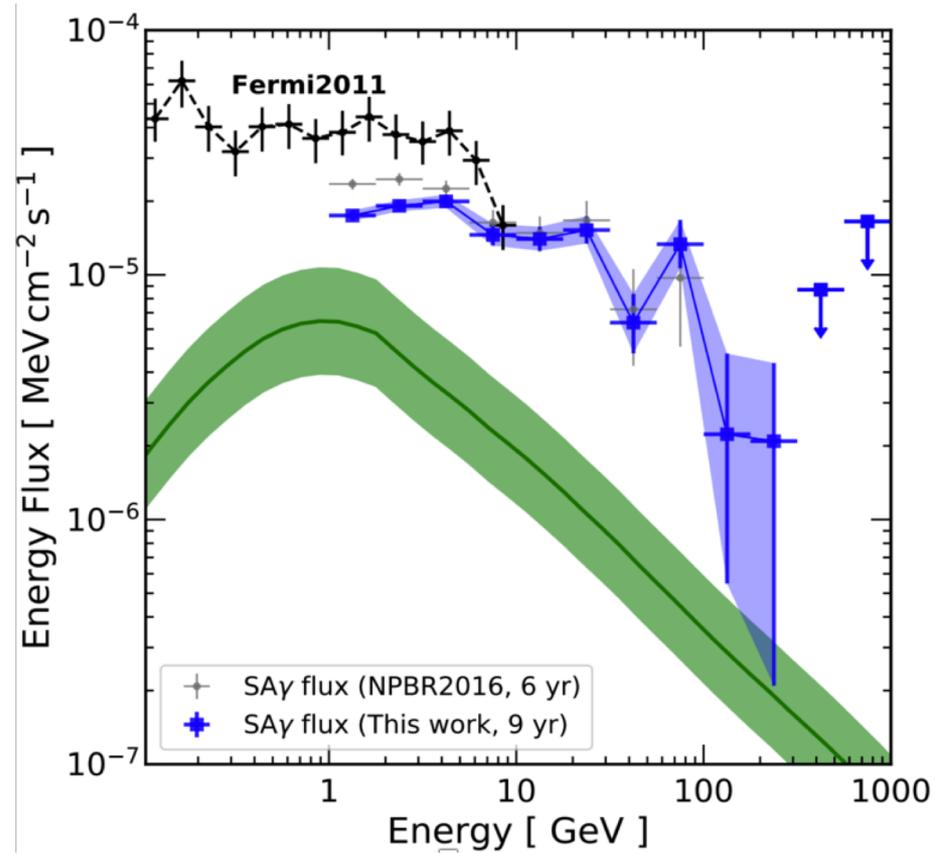


Disk Spectrum

Ng et al. (2017) Phys.Rev.D 96, 103006

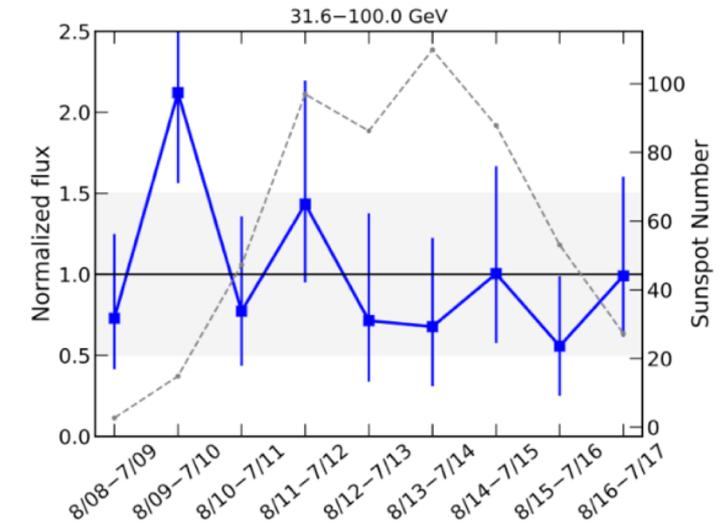
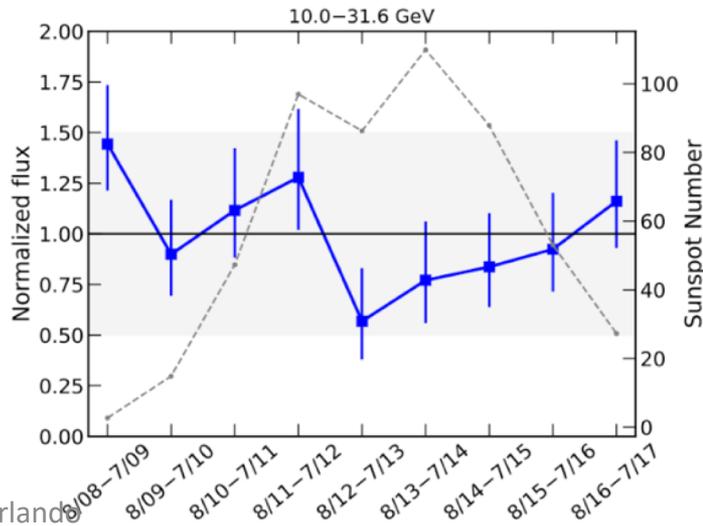
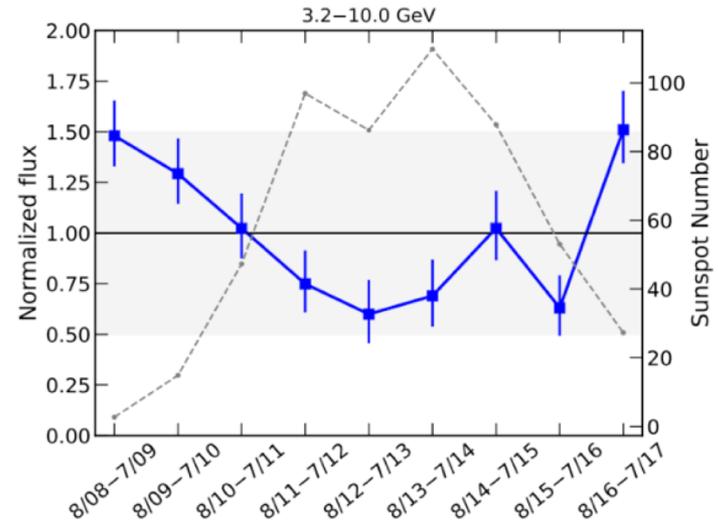
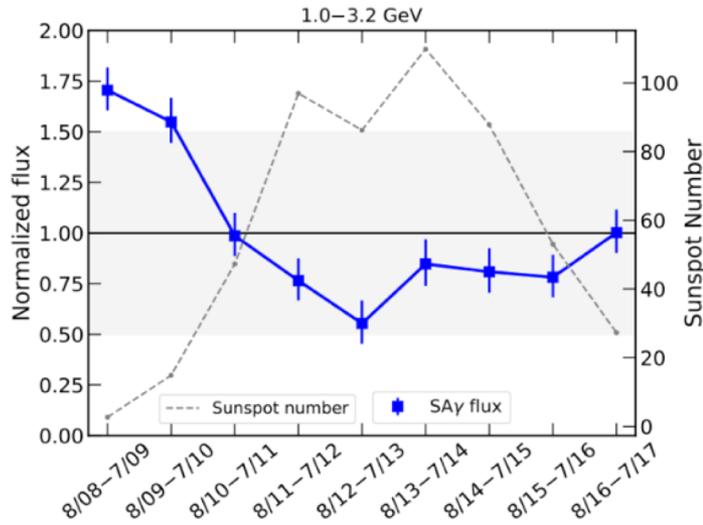


Tang et al. (2018) Phys. Rev. D98, 063019



Disk Time Variability

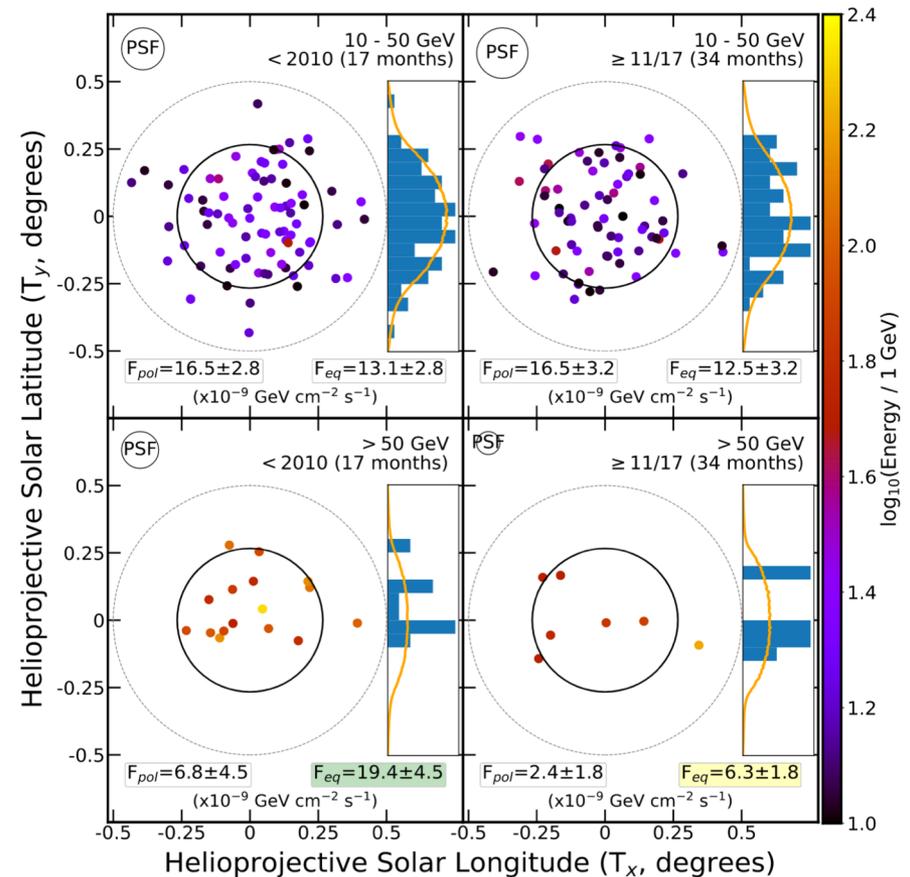
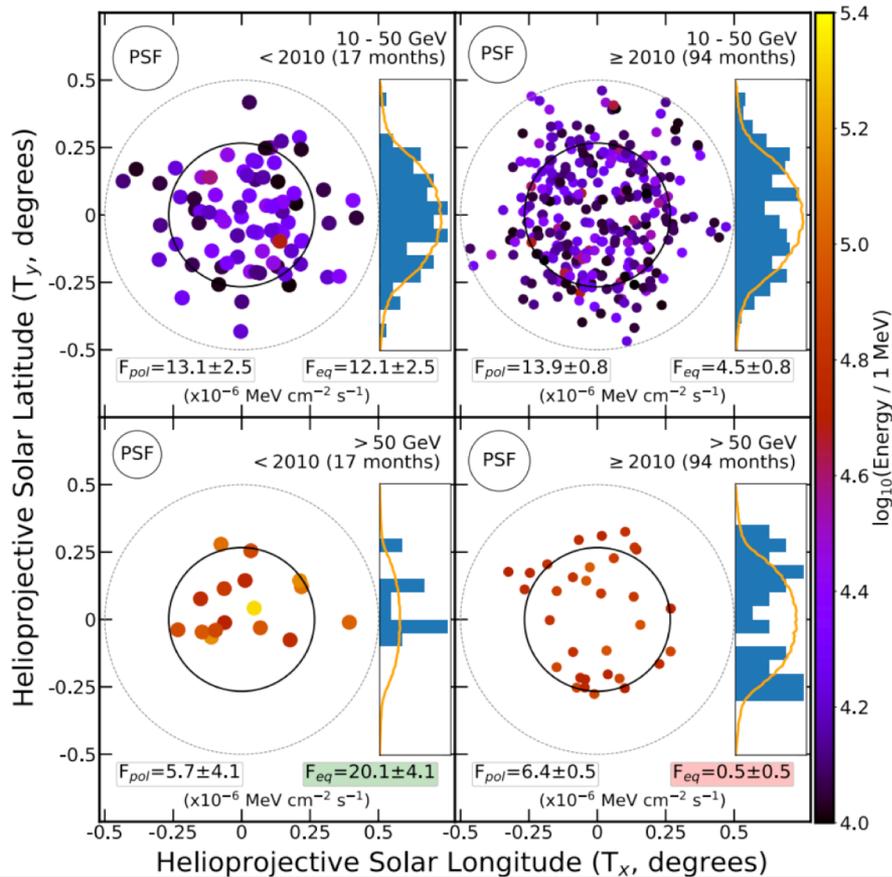
Tang et al. (2018) Phys.Rev.D 98, 063019



Morphology

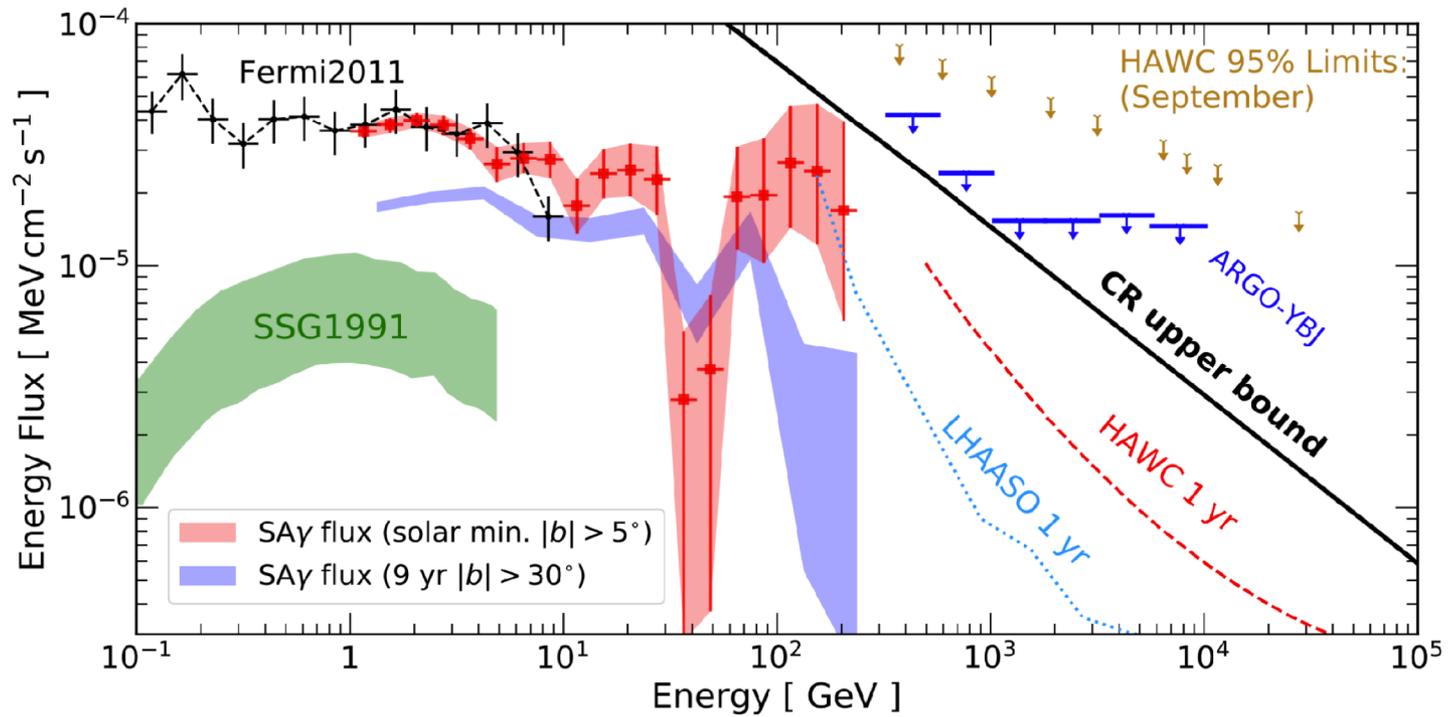
Tang et al. (2018) Phys.Rev.D 98, 063019
Linden et al. (2018) Phys.Rev.L 121, 131103

Linden et al. (2022) Phys.Rev.D 105,063013



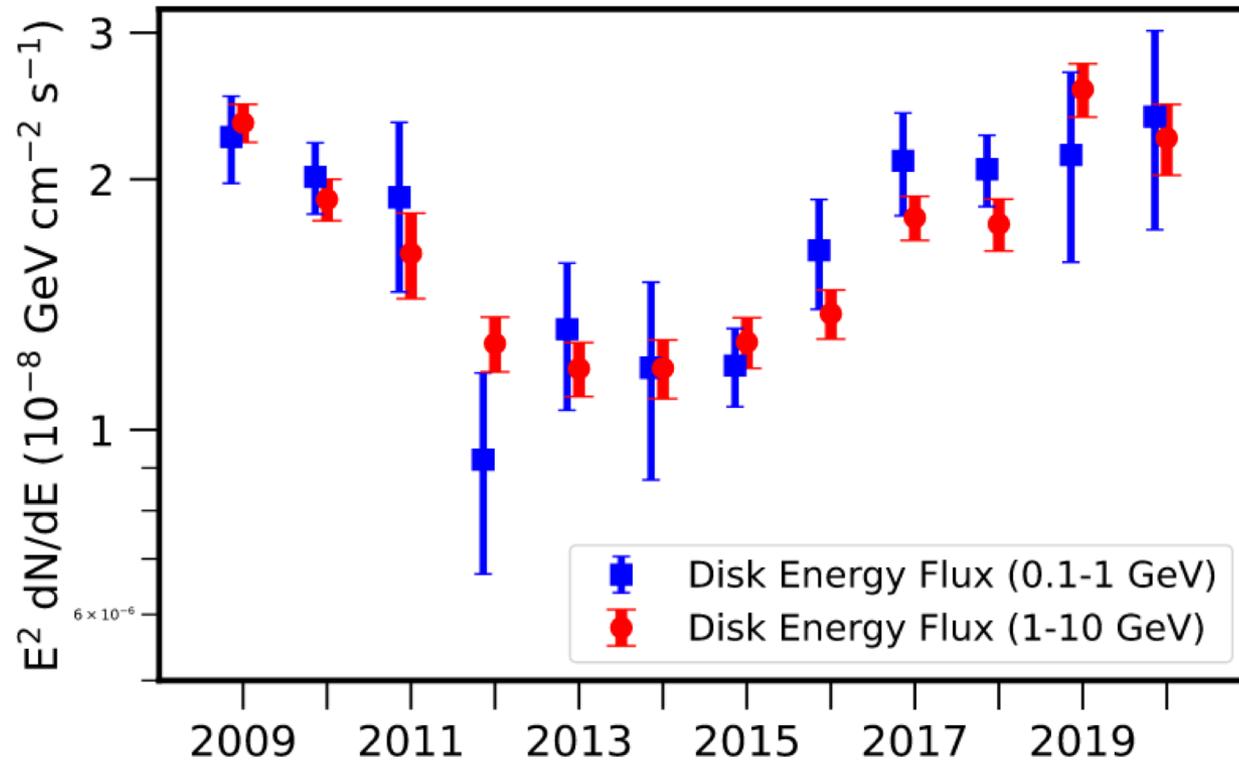
Spectral Deep?

Tang et al. (2018) Phys.Rev.D 98, 063019



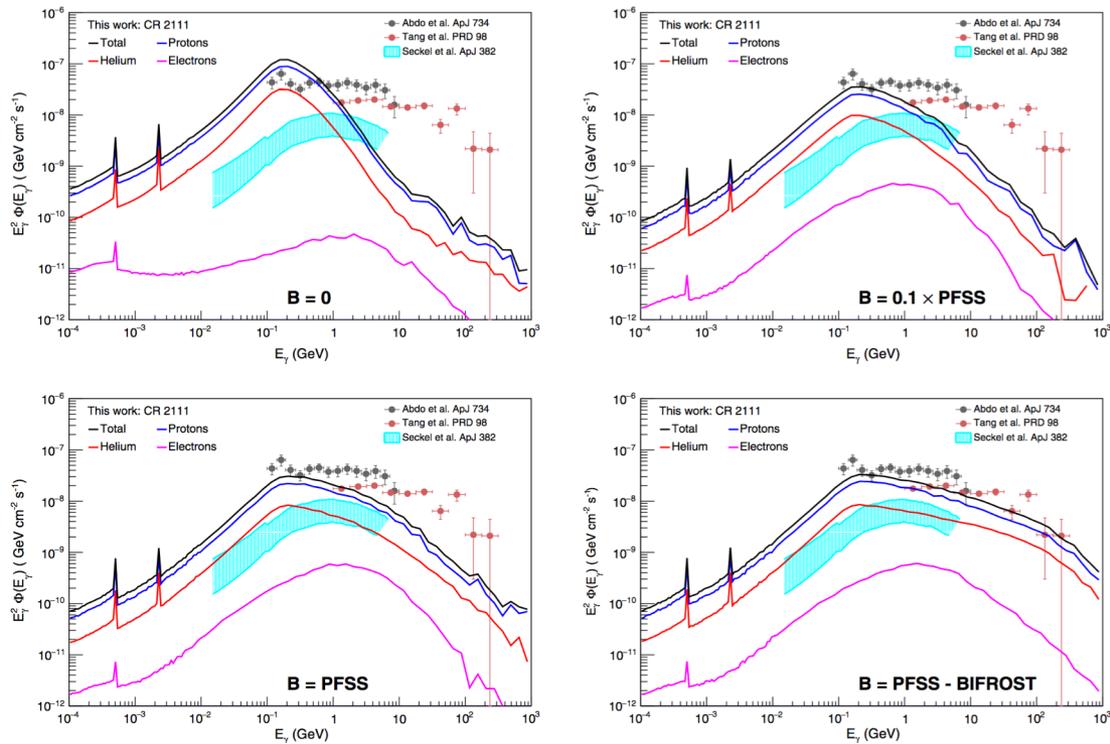
Disk Time Variability of over the entire Cycle 24

Linden et al (2022) Phys.Rev.D 105,063013

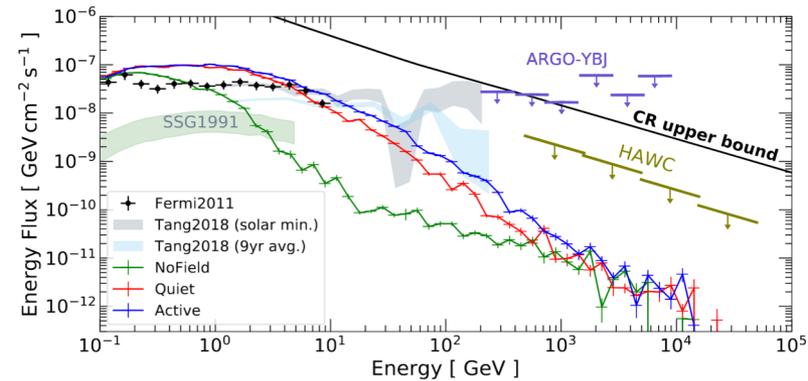


Disk Modeling Updates

Mazziotta et al. (2020) Phys.Rev.D 101, 083011



*Zhe Li et al (2020)
arXiv:2009.03888*



IC Modeling Updates

Journal of Cosmology and Astroparticle Physics

PAPER

StellarICS: inverse Compton emission from the quiet Sun and stars from keV to TeV

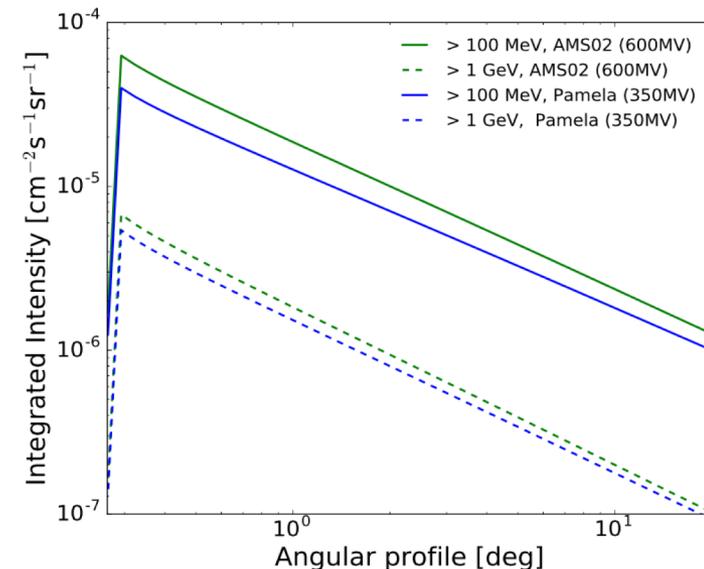
Elena Orlando^{1,2} and Andrew Strong³

Published 1 April 2021 • © 2021 IOP Publishing Ltd and Sissa Medialab

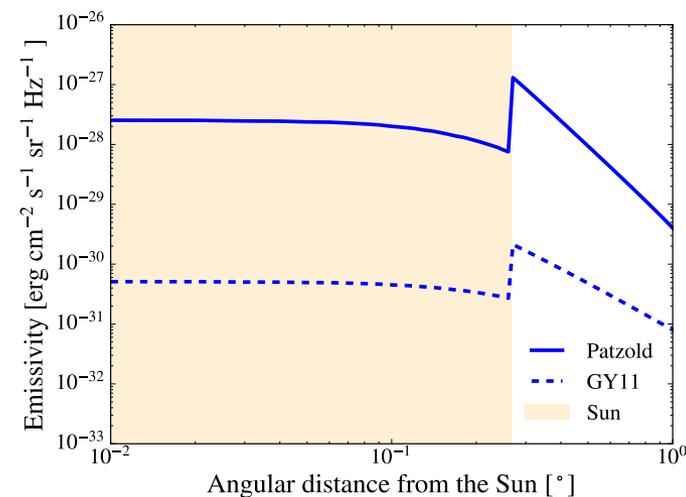
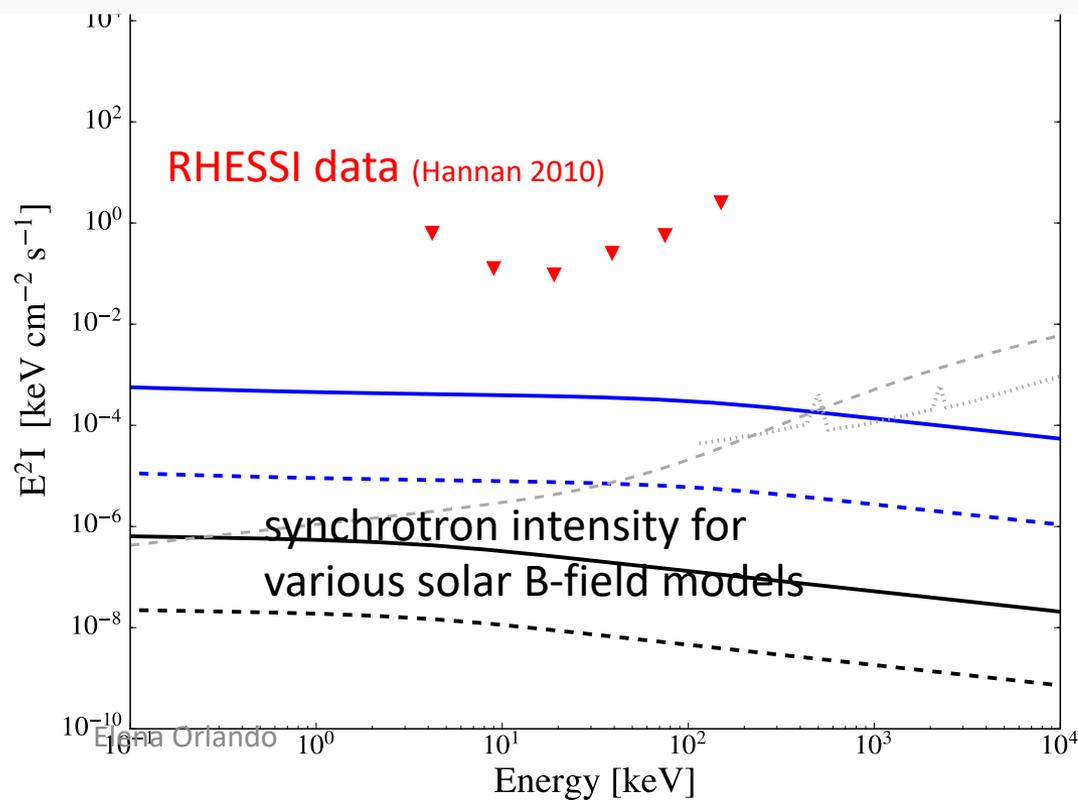
[Journal of Cosmology and Astroparticle Physics, Volume 2021, April 2021](#)

Citation Elena Orlando and Andrew Strong JCAP04(2021)004

Orlando & Strong (2021) JCAP 04, 004



The Quiet Sun: Synchrotron Emission from Galactic Cosmic Rays as a New Component



*Orlando, Petrosian, and Strong
in preparation*

Summary

- Current observations are challenging present models
- Need more data to understand and interpret unexplained features
- High-energy observations opened a new promising window to study the physics of the Sun and the solar activity

