The Quiet Sun in Gamma Rays: Modeling Cosmic Ray Electrons in the Inner Heliosphere

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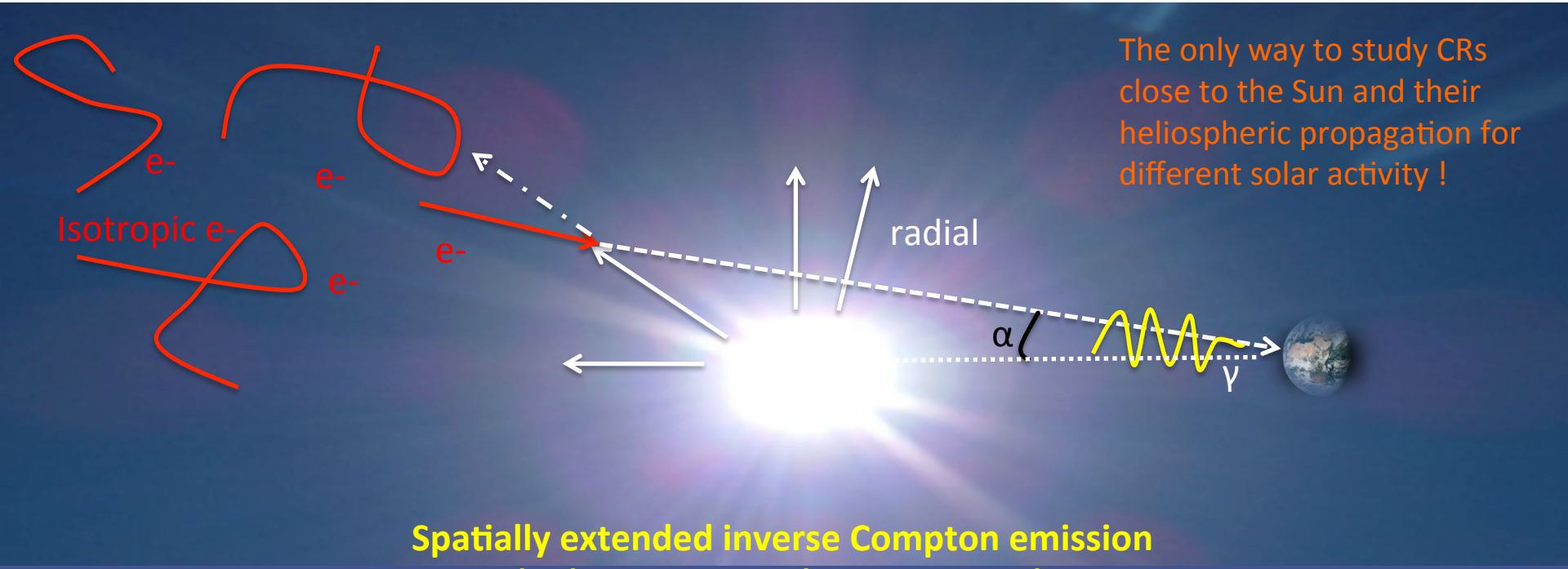


The only way to study CRs close to the Sun and their heliospheric propagation for different solar activity !

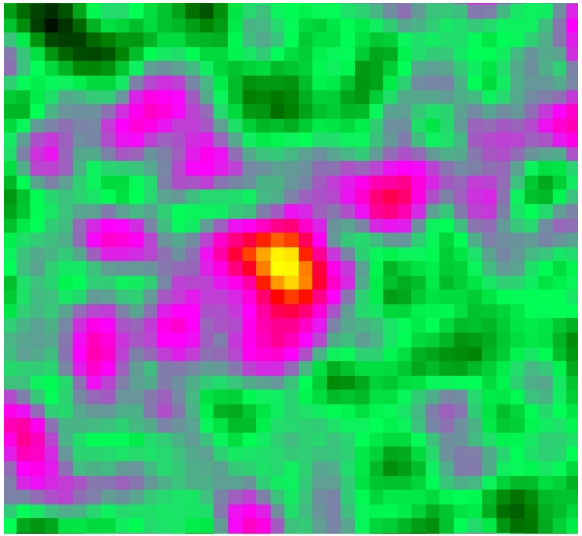
Spatially extended inverse Compton emission

GeV electrons (CR) + eV photon (solar photons)→ gamma rays

First theory: *Orlando & Strong, 2006 arXiv:astro-ph/0607563; 2007 Ap&SS, 309, 59; Moskalenko, Porter & Digel, 2006 ApJ 652, L65*

Detection of the quiet sun in gamma rays and of its extended inverse Compton (IC) emission

Orlando & Strong (2008) A&A, 480, 847, with EGRET: FIRST DETECTION !

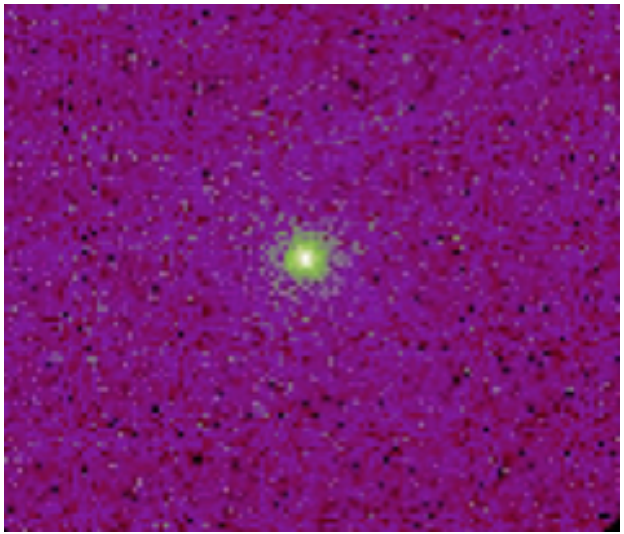


Entire mission of EGRET including both solar minimum and maximum activity

Count maps
>100 MeV
in sun-centred
system

The IC emission is an important MOVING foreground component of the diffuse emission that has to be properly accounted for in other studies.

Abdo et al. ApJ. (2011) 734, 116, with FERMI LAT



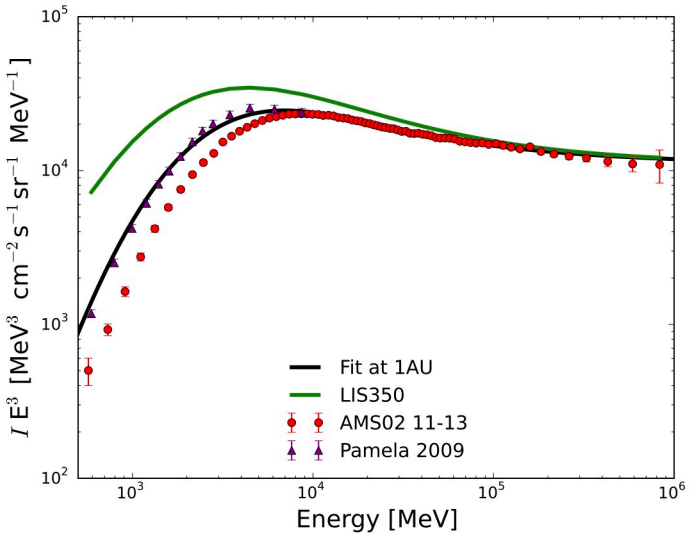
First 18 months of the LAT mission during solar minimum activity

For updated LAT analysis see also poster by Raino' et al. this conference

Observations of the Inverse Compton emission in agreement with predictions!

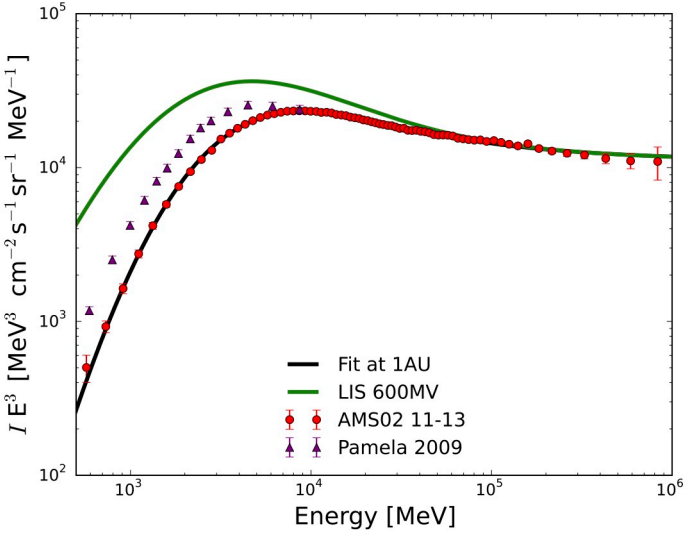
Inverse Compton model updates: the electron spectrum

Electron spectrum: fit to the PAMELA 2009 at 1AU. The LIS is also shown.



The IC model generated with the spectrum at 1 AU that fits Pamela 2009 electron and positron measurements can be the reference model for Fermi LAT observations during solar minimum.

Electron spectrum for the LIS and for the AMS02 fit at 1AU. The LIS is also shown

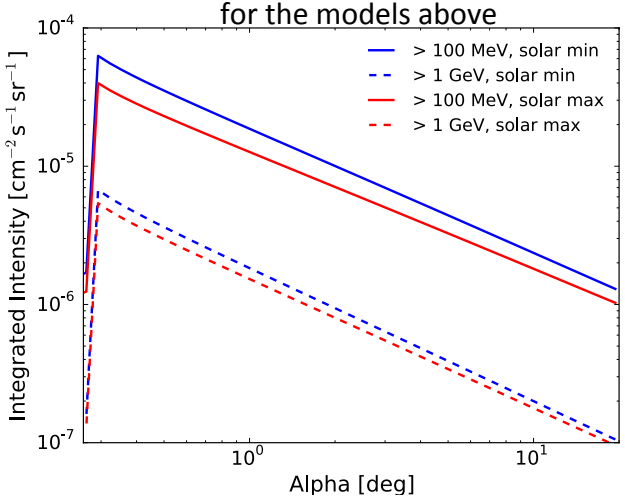


The IC model generated with the spectrum at 1 AU that fits AMS02 2013 electron and positron measurements can be the reference model for Fermi LAT observations during solar maximum.

Inverse Compton model updates: angular profile & SED. & predictions for e-ASTROGAM & AMEGO

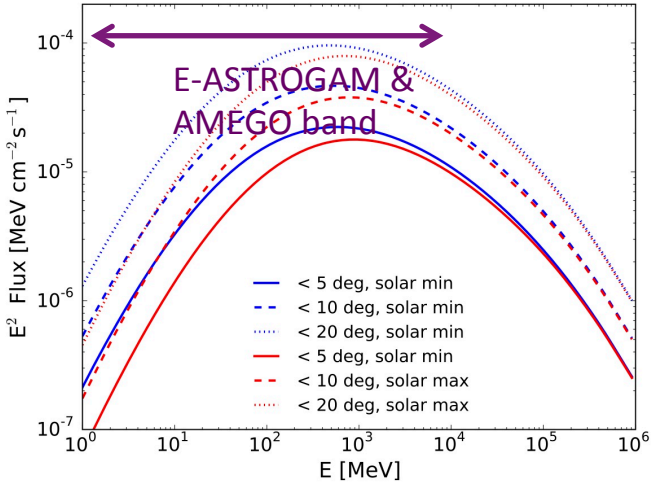
ANGULAR PROFILE

for integrated energy >100MeV and >1GeV for the models above



Calculations done with the StellarICs code

SED integrated in various angles for the models above



REFERENCES: - **Abdo**, A. A., et al. 2011, " Fermi Large Area Telescope Observations of Two Gamma-Ray Emission Components from the Quiescent Sun" ApJ, 734, 116; - **Adriani**, O., et al. 2015, "Time Dependence of the e- Flux Measured by PAMELA during the July 2006-December 2009 Solar Minimum." ApJ, 810, 142; - **Aguilar**, M., et al. 2014, "Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station" Physical Review Letters, 113, 121102; - **De Angelis, A.**, et al. 2017, "The e-ASTROGAM mission. Exploring the extreme Universe with gamma rays in the MeV - GeV range" Experimental Astronomy; - **Johanesson, G., & Orlando, E.**, 2013, "Accounting for the Sun and the Moon in Fermi-LAT Analysis" Proc. 33rd ICRC, p.0957 (arXiv:1307.0197); - **Moskalenko, I. V., Porter, T. A., & Digel, S. W.** 2006, " Inverse Compton Scattering on Solar Photons, Heliospheric Modulation, and Neutrino Astrophysics" ApJL, 652, L65; - **Ng, K. C. Y.**, et al. 2016, "First observation of time variation in the solar-disk gamma-ray flux with Fermi" PhRvD, 94, 023004; - **Orlando, E., & Strong, A. W.** 2006, 2007 "Gamma rays from halos around stars and the Sun" arXiv:astro-ph/0607563, Ap&SS, 309, 359; **Orlando, E., & Strong, A. W.** 2008, "Gamma-ray emission from the solar halo and disk: a study with EGRET data" A&A, 480, 847; **- Orlando, E., & Strong, A.** 2013, "A software package for Stellar and solar Inverse Compton emission: StellarICs" Nuclear Physics B Proceedings Supplements, 239, 266; - **Orlando, E.,** et al 2017 "Cosmic rays and their modulation in the inner heliosphere by looking at the gamma-ray sun" Proc. 35th ICRC, PoS(ICRC2017)693 - **Seckel, D., Stanev, T., & Gaisser, T. K.** 1991,,"Signatures of cosmic-ray interactions on the solar surface" ApJ, 382, 652; - **Thompson, D. J.**, etal. 1997, "Energetic gamma ray experiment telescope high-energy gamma ray observations of the Moon and quiet Sun " JGR, 102, 14735

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