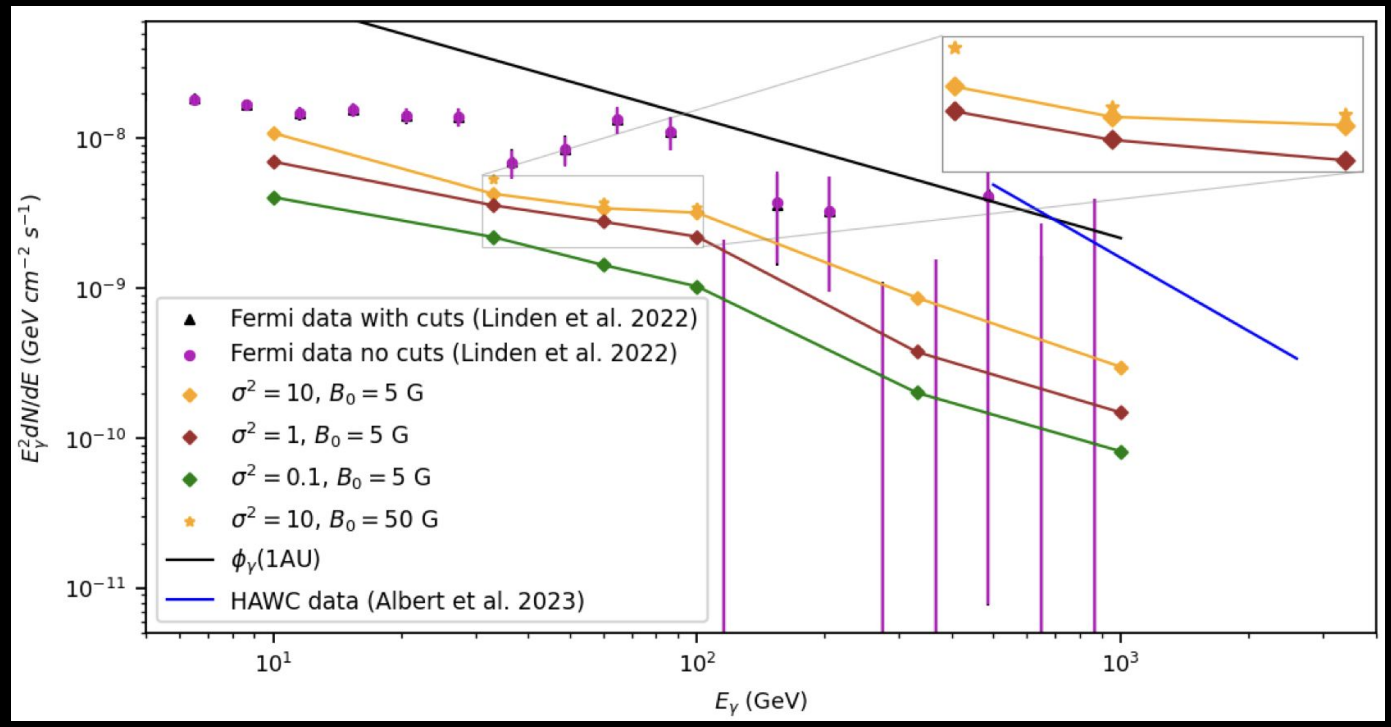
Solar Disk Gamma-Ray Emission via Synthetic Magnetic Field from Photosphere to Low Corona

High-energy gamma rays from the **solar disk** likely arise from collisions of galactic cosmic rays (**GCRs**) with solar atmospheric plasma, yet current models fail to reproduce key Fermi-LAT and HAWC features.

We model a **synthetic magnetic field** with **open**, **laminar** lines that become **increasingly braided** near the solar surface, as suggested by observations and MHD simulations. Using **3D test-particle simulations**, we study how magnetic distortion affects gamma-ray production by injecting GeV–TeV protons, for different scale heights of the horizontal magnetic structures.

Our model can account for the **>10 GeV gamma-ray spectrum** observed by Fermi/HAWC. We found a **rebrightening** (30–100 GeV) following the spectral dip (~30 GeV) indicating **enhanced particle confinement** due to **stronger magnetic braiding**, an effect missed in previous models.



Solar disk–averaged gamma-ray spectra from Fermi-LAT (purple: with flares; black: without; from *Linden at al. 2022*) and HAWC (blue; *Albert et al. 2023*) compared with our simulations at different σ² (relative magnetic turbulence energy density to the average field energy density). Solid black line: estimated flux for 100% GCR–gamma conversion.

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