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The Remarkable Influence of Corona Field on Solar Gamma Ray

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The Sun shines bright as a gamma ray source, caused by hadronic galactic cosmic ray interactions in the photosphere and chromosphere. Fermi-LAT and HAWC have observed these so-called solar disk gamma rays in GeV to TeV energy range, and discovered many oddities, including high flux, anti-correlation to solar activity cycle, and time dependent morphology.
Solar magnetic field plays a key role in affecting the gamma ray emission. The field in corona, the Sun's outer atmosphere, can change the isotropy of galactic cosmic ray. In the inner atmosphere, the field can increase the yield of escaped gamma ray per cosmic ray interaction. However, due to the complexity of the Solar magnetic field, simple analytical calculations have been insufficient and the exact mechanism that connects solar cycle to gamma ray flux is uncertain.
Here we report the result of our simulation, G4SOLAR2, on CR interaction with Sun atmosphere and magnetic field. We investigate a couple of well tested corona field models: PFSS and MHD, for a variety of time periods during solar cycle.
Our simulation shows that corona field is the major component that affects GeV gamma ray. Specifically, the area of open corona field is directly correlated with < 10 GeV gamma ray flux, and the changes throughout solar cycle explains the time variation in gamma ray flux. Further more, gamma ray telescopes with enough angular resolution can verify the validity of solar corona field models.

Collaboration you are representing

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