

The gamma-ray Moon seen by the Fermi LAT over a full solar cycle

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The Moon is among the brightest gamma-ray sources in the sky. Indeed, high-energy gamma rays emitted from the Moon are produced in inelastic collisions of cosmic-ray nuclei (CRs) with the lunar surface. We have reconstructed the Moon gamma-ray spectrum in the energy range from 30 MeV up to a few GeV using the data collected by the Fermi Large Area Telescope during its first 12.5 years of operation since its launch in 2008, a period covering the duration of a whole solar cycle. The analysis procedure is the same as in PRD93, 082001, with an update in the calculation of the Moon position. We have also studied the evolution of the lunar gamma-ray emission by measuring the spectra in 6 months time intervals. The data show a strong correlation with the solar activity. Gamma rays produced on the lunar surface are in fact originated in the interactions of cosmic rays (mainly proton and helium), whose fluxes are affected by solar modulation. We have also developed a model based on the FLUKA simulation code to evaluate the yields of photons produced by cosmic-ray protons and helium nuclei impinging on the Moon. We have then folded the gamma-ray yields obtained from the model with the primary proton and helium spectra measured by the AMS02 and PAMELA experiments in different time intervals and we have compared the simulation results with the experimental data, showing that the simulation reproduces correctly the time evolution of the lunar gamma-ray flux.

*37th International Cosmic Ray Conference (ICRC 2021)
July 12th – 23rd, 2021
Online – Berlin, Germany*

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