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The Energy-dependent γ-ray Morphology of the Crab Nebula Observed with the $Fermi$ Large Area Telescope

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Abstract content

The Crab nebula is a bright emitter of non-thermal radiation across the entire accessible range of wavelengths. The spatial and spectral structures of the synchrotron nebula are well-resolved from radio to hard X-ray emission. The un-pulsed emission at GeV to TeV energies is mostly produced via inverse-Compton scattering of energetic electrons with the synchrotron-emitted photons. The spatial structure observed at these energies provides insights into the distribution of electrons and indirectly constrains the so-far unknown structure of the magnetic field in the nebula. Analyzing the LAT data accumulated over ∼9.1 years with a properly refined model for the Crab pulsar's spectrum, we determined the uniform-disk radius of the Crab Nebula to be $0.040^\circ \pm 0.002^\circ$ ($2.40' \pm 0.12'$) in the 5–500 GeV band. We report that the systematic uncertainties associated with the PSF are not a serious issue, based on our evaluation of it with the point-like source Mkn 421. By comparison between $Fermi$ LAT and H.E.S.S. results, we find evidence for an energy-dependent shrinking of the Crab Nebula's γ-ray extension.

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