PROCEEDINGS OF SCIENCE

Tera-electron-Volt pulsed emission from the Crab detected by MAGIC

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Where and how pulsars accelerate particles in their relativistic environments are still open questions that have recently been addressed by measuring spectral and timing properties of very-high-energy gamma rays. We report the most energetic, ever detected, pulsed gamma rays from an astrophysical source, namely the Crab pulsar, with energies reaching the Tera-electron-Volt scale. The MAGIC telescopes measured the photon spectrum of the pulsed emission, extending up to approximately 2 Tera-electron-Volts. Such energetic photons require a parent population of electrons with a Lorentz factor of at least 5×10^6. The pulse profile shows two narrow peaks. The measured time delay between the peak positions in the GeV and TeV regime is $62 \pm 34 \mu$s and $157 \pm 101 \mu$s. The spectra of the two peaks follow two different power-law functions from 100 Giga-electron-Volts to $\sim$2 Tera-electron-Volts and connect smoothly with the spectra measured above 10 Giga-electron-Volts by the Large Area Telescope (LAT) telescope on board of the Fermi satellite. When making a joint fit of the LAT and MAGIC data the photon indices of the spectra differ by 0.4 ± 0.1. These results reveal the inverse Compton scattering off low energy photons as emission mechanism and suggest a gamma-ray production region in the vicinity of the termination of the magnetosphere. The exact site of gamma-ray production still cannot be unequivocally claimed, given that none of the existing theories can reproduce all aspects of the observed pulse emission.

The 34th International Cosmic Ray Conference,
30 July- 6 August, 2015
The Hague, The Netherlands

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PoS(ICRC2015)746