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Detection of a gamma-ray halo around Geminga with the Fermi-LAT and implications for the positron flux

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An excess in the flux of cosmic positrons at Earth above 10 GeV has been measured by Pamela, Fermi-LAT and with unprecedented precision by AMS-02. The observed flux cannot be explained by the production of positrons in the spallation reaction of hadronic cosmic rays (CRs) with the interstellar medium. Various interpretations have been invoked to explain this excess, such as the production in Galactic supernova remnants and pulsar wind nebulae (PWNe) or, intriguingly, in the dark matter halo of the Milky Way. However, a dominant contribution from dark matter is ruled out by the complementary bounds found in other indirect searches. Models where supernova remnants produce secondary CRs struggle to explain the other species of CR fluxes observed by AMS-02. Recently, Milagro and HAWC experiments reported the detection of an extended gamma-ray emission from Geminga and Monogem PWNe at TeV energies. These nearby and powerful PWNe have been widely considered as the main candidates to contribute to the cosmic positrons at Earth. Severe constraints for a significant PWNe contribution to the positron excess can be derived from this gamma-ray emission, which has been interpreted as coming from the electrons and positrons accelerated in the PWNe and undergoing inverse Compton scattering in the interstellar medium.
In this contribution we will report the first detection of a significant extended emission from Geminga at GeV energies in Fermi-LAT data, derived by including the proper motion of its pulsar. We will present a detailed study of the gamma-ray halo around Geminga and Monogem, and show the constraints found for the contribution of these PWNe to the positron excess, combining Milagro and HAWC data with measurements from the Fermi-LAT for the first time. Then we will demonstrate that using gamma-ray data from the LAT is of central importance to provide a precise estimate for the PWN contribution to the cosmic positron flux.

Summary

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