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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 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, intriguinly, in the dark matter halo of the Milky Way. 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. Moreover, the size of extension of these halos suggests that the diffusion around PWNe is about two orders of magnitude less intense than the value assumed to fit the cosmic-rays measured by AMS-02. In this contribution we report the first detection of a significant emission from the Geminga halo at GeV energies in Fermi-LAT data, derived by including the proper motion of its pulsar. We 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. The size of extension and the consequences for the diffusion coefficient in these halos at GeV energies are also explored. We 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.

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