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20 GeV halo-like gamma-ray excess: dark matter annihilation?

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Fifteen years of the Fermi Large Area Telescope (LAT) data in the halo region of the Milky Way (MW) are analyzed to search for gamma rays from dark matter annihilation. Gamma-ray maps within the region of interest (|l| < 60 deg, 10 < |b| < 60 deg) are modeled using point sources, the GALPROP models of cosmic-ray interactions, isotropic background, and templates of Loop I and the Fermi bubbles, and then the presence of a halo-like component is further examined. A statistically significant halo-like excess is found with a sharp peak around 20 GeV, while its flux is consistent with zero below 2 GeV and above 200 GeV. Examination of the fit residual maps indicates that a spherically symmetric halo component fits the map data well. The radial profile agrees with annihilation by the smooth NFW density profile, and may be slightly shallower than this, especially in the central region. Various systematic uncertainties are investigated, but the 20 GeV peak remains significant. In particular, the halo excess with a similar spectrum is detected even relative to the LAT standard background model, which does not depend on GALPROP or other model templates. The halo excess can be fitted by the annihilation spectrum with a mass m_χ~ 0.5-0.8 TeV and annihilation cross section <sigma v> ~ (5-8)×10^{-25} cm^3 s^{-1} for the bb$^-$ channel. This cross section is larger than the upper limits from dwarf galaxies and the canonical thermal relic value, but considering various uncertainties, especially the density profile of the MW halo, the dark matter interpretation of the 20 GeV “Fermi halo” remains feasible. The prospects for verification through future observations are briefly discussed. (preprint: arXiv:2507.07209, JCAP in press)

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