

Search for GeV Gamma-Ray Emission from SPT-SZ selected Galaxy Clusters with 15 years of Fermi-LAT data

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Galaxy clusters could produce gamma rays from inverse Compton scattering of cosmic ray electrons or hadronic interactions of cosmic ray protons with the intracluster medium. It is still an open question on whether gamma-ray emission ($> \text{GeV}$ energies) has been detected from galaxy clusters. We carry out a systematic search for gamma-ray emission based on 300 galaxy clusters selected from the 2500 deg^2 SPT-SZ survey after sorting them in descending order of M_{500}/z^2 , using about 15 years of Fermi-LAT data in the energy range between 1-300 GeV. We were able to detect gamma-ray emission with significance of about 6.1σ from one cluster, viz SPT-CL J2012-5649. The estimated photon energy flux from this cluster is approximately equal to $1.3 \times 10^{-6} \text{ MeV cm}^{-2} \text{ s}^{-1}$. The gamma-ray signal is observed between 1–10 GeV with the best-fit spectral index equal to -3.61 ± 0.33 . However, since there are six radio galaxies spatially coincident with SPT-CL J2012-5649 within the Fermi-LAT PSF, we cannot rule out the possibility this signal could be caused by some of these radio galaxies. Six other SPT-SZ clusters show evidence for gamma-ray emission with significance between $3\text{--}5\sigma$. None of the remaining clusters show statistically significant evidence for gamma-ray emission.

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