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A study of super-luminous stars with the Fermi Large Area Telescope

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The gamma-ray emission from stars is induced by the interaction of cosmic rays with stellar atmospheres and photon fields. This emission is expected to come in two components: a stellar disk emission, where gamma-rays are mainly produced in atmospheric showers generated by hadronic cosmic rays, and an extended halo emission, where the high density of soft photons in the surroundings of stars create a suitable environment for gamma-ray production via inverse Compton (IC) scattering by cosmic ray leptons. Besides the Sun, no other isolated star has ever been detected in gamma-rays. However, by assuming a cosmic ray distribution similar to that observed on Earth, the predicted gamma-ray emission of super-luminous stars, like e.g. Betelgeuse and Rigel, should be high enough to be detected by the Fermi Large Area Telescope (LAT) after its first decade of operations. In this work, we use 12 years of Fermi-LAT observations along with IC models to study 9 luminous nearby stars, both individually and via stacking analysis. Our results show no significant gamma-ray emission from any of the targets, but allow us to derive gamma-ray flux upper limits and to use them to constrain the local density of electrons in different places of the Galaxy.

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