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Leptonic emission from star-forming galaxies

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Cosmic rays are a crucial component of the interstellar medium. Measurements of cosmic ray composition in our Galaxy has shown that they are primarily composed of relativistic protons, with only a subdominant contribution from leptons to the total cosmic ray energy budget. Although the precise origins of cosmic rays are still uncertain, it is widely believed that the interaction of massive stars with the surrounding medium, both during their lifetimes and at their end, is the main mechanism for cosmic ray acceleration on galactic scales. Consequently, star-forming galaxies are expected to contain significant amounts of cosmic rays. These galaxies are notable sources of gamma-ray radiation, with around a dozen detected directly and others possibly contributing collectively to the diffuse gamma-ray background. Contrary to previous expectations, we find that the gamma-ray emission of star-forming galaxies is primarily driven by leptons. We suggest that the commonly accepted dominance of protons over leptons in cosmic ray composition is due to the faster cooling of electrons rather than a fundamental characteristic of cosmic ray accelerators.

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