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Investigating the millisecond pulsar and dark matter interpretations of the gamma ray excess of the Andromeda Galaxy

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There has been a recent discovery of an excess in the gamma ray emission from the Andromeda Galaxy (M31) observed with the Fermi Large Area Telescope. The origin of this excess, however, is completely unknown. The goals of this work are (1) to show that the excess is indeed real and not due to improper treatment of the back-/foreground models; (2) to analyze the morphology and spectrum of the signal with robust statistical methods; and (3) to test different source models (either astrophysical or exotic), which could explain this excess.
The first goal is accomplished by using different combinations of the individual back-/foreground components, constructed to trace hydrogen gas or emission due to Inverse Compton scattering. The region around M31 was excised from these maps and inpainted over with machine learning techniques. With these different templates and multiple inpainting algorithms, these back-/foreground models are used to get to the systematic uncertainties, to ultimately see how significant the excess really is.
We achieve the second and third goals by testing a variety of spatial and spectral models, both accounting for point-like and extended source signals.
Furthermore, we constructed more sophisticated stellar maps containing old populations of red giants, serving as tracers for pulsars. This serves to contribute to a long-standing debate, whether the signal could come from an unresolved population of millisecond pulsars. Finally, the more exotic but exciting claim, that the signal could come from dark matter annihilation is tested with a variety of spatial density profiles.

Keywords

Gamma Rays; Andromeda; Inpainting; millisecond pulsar

Collaboration

other Collaboration

Subcategory

Theoretical Results

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