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The GeV Galactic Center Excess in 2022

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The Galactic center excess (GCE) remains one of the most intriguing discoveries from the Fermi Large Area Telescope (LAT) observations. I will revisit characteristics of the GCE tested under an updated set of high-resolution galactic diffuse gamma-ray emission templates. This diffuse emission, which accounts for the bulk of the observed gamma rays, is ultimately due to cosmic-ray interactions with the interstellar medium. Using recent high-precision cosmic-ray observations, in addition to the continuing Fermi-LAT observations and observations from lower energy photons, we constrain the properties of the galactic diffuse emission. A large set of diffuse gamma-ray emission templates has been used which account for a very wide range of initial assumptions on the physical conditions in the inner galaxy. In addition, I will present how wavelet-based techniques allow us to probe and remove the emission form sub-threshold point sources at low latitudes. I will give an update on the spectral and morphological properties of the GCE and their physical implications. In particular, a high-energy tail is found at a higher significance than previously reported. This tail is very prominent in the northern hemisphere, and less so in the southern hemisphere. This strongly affects one prominent interpretation of the excess: known millisecond pulsars are incapable of producing this high-energy emission, even in the relatively softer southern hemisphere, and are therefore disfavored as the sole explanation of the GCE. The annihilation of dark matter particles of mass 40^{+10}_{-7} GeV (95% CL) to b quarks with a cross-section of $\sigma v = 1.4^{+0.6}_{-0.3} \times 10^{-26}$ cm^3 s^{-1} provides a good fit to the excess especially in the relatively cleaner southern sky. Dark matter of the same mass range annihilating to b quarks or heavier dark matter particles annihilating to heavier Standard Model bosons can combine with millisecond pulsars to provide a good fit to the southern hemisphere emission as well, as can a broken power-law spectrum which would be related to recent cosmic-ray burst activity.

Track

Dark Matter

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