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Dark Matter Interpretation of the Fermi-LAT Observations Toward the Outer Halo of M31

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An excess γ-ray signal toward the outer halo of M31 has recently been reported. Although other explanations are plausible, the possibility that it arises from dark matter (DM) is valid. In this talk I will first briefly review the Fermi-LAT observations toward the outer halo of M31. I will then present results for a DM interpretation of the observed excess. We use as our representative case WIMP DM annihilating to bottom quarks, and we make a detailed study of the systematic uncertainty in the J-factor for the M31 field. We find that the signal favors a DM particle with a mass of $\sim$50$-$90 GeV. The full systematic uncertainty in the cross-section currently spans roughly three orders of magnitude, ranging from $\sim 4\times10^{-27} - 4\times10^{-24}$ cm^3 s^{-1}. This high uncertainty is due to two main factors, namely, an uncertainty in the substructure nature of M31's DM halo, as well as an uncertainty in the contribution to the signal from the Milky Way's DM halo along the line of sight. However, apart from the extreme ends in the uncertainty, we show that the median uncertainty range has a large overlap with the DM interpretations of both the Galactic center (GC) excess and the antiproton excess. More generally, we summarize the current state of DM indirect detection in the energy range 10 GeV - 300 GeV corresponding to the GC excess and identify a region in parameter space that still remains viable for discovery of the DM particle.

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