Contribution ID: 6

Type: not specified

Cosmic ray - dark matter scattering

We consider the process of scattering of Galactic cosmic-ray electrons and protons off of dark matter with the radiation of a final-state photon. This process provides a novel way to search for Galactic dark matter with gamma rays. We argue that for a generic weakly interacting massive particle, barring effects such as co-annihilation or a velocity-dependent cross section, the gamma-ray emission from cosmic-ray scattering off of dark matter is typically smaller than that from dark matter pair-annihilation. However, if dark matter particles cannot pair-annihilate, as is the case for example in asymmetric dark matter scenarios, cosmic-ray scattering with final state photon emission provides a unique window to detect a signal from dark matter with gamma rays. We estimate the expected flux level and its spectral features for a generic supersymmetric setup, and we also discuss dipolar and luminous dark matter. We show that in some cases the gamma-ray emission might be large enough to be detectable with the Fermi Large Area Telescope.

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