Investigating the Properties of Dark Matter

Mintzer, Gabriel

In indirect detection experiments, the photon flux expected from dark matter annihilations in the Milky Way halo depends strongly on the distribution of dark matter in the halo. The effect of having a varying density of dark matter along each line of sight is typically encapsulated in a single factor, the J-factor, which averages over the squared density of dark matter for the line. For annihilations with velocity-dependent cross-sections, however, the variation of dispersion velocity along each line-of-sight needs to be accounted for as well. In this paper, we develop, calculate, and investigate a new J-factor that incorporates velocity dependence of dark matter annihilation rate to improve on the predictions for the theoretical photon flux received on Earth. We find that including the velocity dependence affects the photon flux expected from near the galactic center by 20-80% and affects the photon flux expected from opposite the galactic center by 10-20%. We recompute previous p-wave annihilation bounds for the dark matter velocity-averaged annihilation cross-section and find that they are reduced by up to 39% with the inclusion of the velocity-dependent J-factor.