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An Optimized Search for Dark Matter in the Galactic Halo with HAWC

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With a mass of approximately $\sim 10^{12}$ solar masses, the Galactic Halo is the closest known large dark matter halo and a prime candidate for indirect dark matter detection. The High Altitude Water Cherenkov Observatory (HAWC) is a high energy (300 GeV to 100 TeV) gamma ray detector located in central Mexico. HAWC operates via the water Cherenkov technique and has both a wide field of view of ~2 sr and a >95% duty cycle, making it ideal for analysis of highly extended sources. We made use of these properties of HAWC and a new background-estimation technique optimized for extended sources to probe a large region of the Galactic Halo for dark matter signals. With this approach and taking into account electroweak corrections to the gamma-ray spectra, we set improved constraints on dark matter annihilation and decay between masses of 10 and 100 TeV. Our constraints also take into account detector simulation systematics and are robust against uncertainties in the Galactic dark matter spatial profile.

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The Milky Way Galactic Halo (GH) is known to contain a large density of dark matter (DM). Furthermore, because the Earth is located within it and therefore the distance to this concentration of DM is small, the GH is expected to yield an extremely high flux of DM annihilation or decay by-products and is a promising region for probing WIMP signals. Most DM analyses of the GH look in the few degrees around the Galactic Center. However, such searches depend on an assumed steepening of the DM density toward the Galactic Center, which is currently being debated in the modeling community. Searches in the GH further from the Galactic Center, such as the one presented here, avoid this by looking at regions where all DM density profiles have similar densities. This allows for a more robust set of constraints to be produced, which have smaller systematic uncertainties from DM theory.

To perform a search of DM annihilation or decay in the GH, we use the High Altitude Water Cherenkov (HAWC) detector. HAWC is a gamma-ray observatory located at Sierra Negra, Mexico which is sensitive to gamma rays from 300 GeV to greater than 100 TeV [1]. HAWC observes 1/6 of the sky at any one time, and observes 2/3 of the sky each day, which makes it ideal for searches of large, faint, emission such as those from the GH. Because the GH is tens of degrees across, we employ a newer method of HAWC background rejection which was developed specifically to work well for large sources [2].

No significant emission was found for any DM spectrum, so 95% CL upper limits on the cross-section $\langle \sigma v \rangle$ and 95% CL lower limits on the decay lifetime τ were derived. In this contribution, we show the derived limits on DM cross-section and lifetime and show that they are among the strongest limits derived for mutli-TeV DM masses. The results included in this proceeding and shown in this presentation can be found in [3] and will be submitted for publication soon [4]. The details about this analysis can be found in the aforementioned references.

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