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Cosmic-Ray Propagation Models Elucidate the Prospects for Antinuclei Detection

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Tentative observations of cosmic-ray antihelium by the AMS-02 collaboration have re-energized the quest to use antinuclei to search for physics beyond the standard model. However, our transition to a data-driven era requires more accurate models of the expected astrophysical antinuclei fluxes. We use a state-of-the-art cosmic-ray propagation model, fit to high-precision antiproton and cosmic-ray nuclei (B, Be, Li) data, to constrain the antinuclei flux from both astrophysical and dark matter annihilation models. We show that astro-physical sources are capable of producing O(1) antideuteron events and O(0.1) antihelium-3 events over 15 years of AMS-02 observations. Standard dark matter models could potentially produce higher levels of these antinuclei, but showing a different energy-dependence. Given the uncertainties in these models, dark matter annihilation is still the most promising candidate to explain preliminary AMS-02 results. Meanwhile, any robust detection of antihelium-4 events would require more novel dark matter model building or a new astrophisical production mechanism.

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