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An indirect dark matter search using cosmic ray antiparticles with GAPS

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Experiments aiming to directly detect dark matter (DM) particles have yet to make robust detections, thus underscoring the need for complementary approaches such as searches for new particles at colliders, and indirect searches of DM decay or annihilation signatures in photon and cosmic ray spectra. In particular, low energy (< 0.25 GeV/n) cosmic ray antiparticles such as antideuterons are strong candidates for probing various DM models, as the yield of these particles from DM processes can exceed the conventional astrophysical background by up to two orders of magnitude. The General Antiparticle Spectrometer (GAPS), a balloon borne cosmic ray detector, will exploit this idea and perform a virtually background-free measurement of the cosmic antideuteron flux in the regime < 0.25 GeV/n, which will constrain a wide range of viable DM models. Additionally, GAPS will detect approximately 1500 antiprotons in an unexplored energy range throughout one long duration balloon (LDB) flight, which will constrain < 10 GeV DM models as well as validate the GAPS detection technique. Unlike magnetic spectrometers, GAPS relies on the formation of an exotic atom within the tracker in order to reliably identify antiparticles. The GAPS tracker consists of ten layers of lithium-drifted silicon detectors which record dE/dx deposits from primary and nuclear annihilation product tracks, as well as measure the energy of the exotic atom deexcitation X-rays. A two-layer, plastic scintillator time of flight (TOF) system surrounds the tracker and measures the particle velocity, dE/dx deposits, and provides a fast trigger to the tracker. The nuclear annihilation product multiplicity, deexcitation X-ray energies, TOF, and stopping depth are all used together to discern between antiparticle species. In this presentation, I will give a progress update on the construction of the silicon tracker and TOF system, as well as an update on the simulated performance of the GAPS experiment in light of the upcoming LDB flight from McMurdo Station, Antarctica in 2020.

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