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Large-area Si(Li) detectors for X-ray spectrometry and particle tracking for the GAPS experiment

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Large-area lithium-drifted silicon (Si(Li)) detectors, operable 150°C above liquid nitrogen temperature, have been developed for the General Antiparticle Spectrometer (GAPS) Antarctic balloon mission. GAPS is designed to look for possible signatures of dark matter annihilation or decay in low-energy (kinetic energy < 0.25 GeV/n) cosmic antinuclei, with particle identification based on exotic atom formation and decay. We demonstrate here that these 10 cm-diameter, 2.5 mm-thick, 8-strip detectors can provide the <4 keV (FWHM) energy resolution for X-rays and <10% energy resolution for heavy particle tracks necessary for GAPS to identify cosmic antinuclei, while operating in conditions (˜-40°C and a ˜1 Pa) achievable on a long-duration balloon carrying a large-acceptance detector payload. This will be the first large-area, high-temperature Si(Li) detector system suitable for X-ray spectrometry to operate in a space mission. Mass production and calibration of ˜1000 detectors has begun for the first GAPS flight, scheduled for late 2021. The detectors, while developed specifically for GAPS, may have other applications, e.g., in heavy nuclei identification at rare isotope facilities.

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