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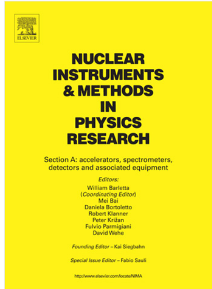

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Near-Space Operation of Compact CsI, CLYC, and $CeBr_3$ Sensors: Results from Two High-Altitude Balloon Flights

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Abstract

Three different types of gamma-ray sensors (CsI, CLYC, and $CeBr_3$) were flown on balloon flights as hosted payloads. Two CsI sensors were flown from a September 2014 flight from Fort Sumner, New Mexico for 18 hours; CLYC and $CeBr_3$ sensors were flown from Antarctica in December 2016 for 22 days. The data from these flights were used to test and characterize the operation of these sensors in a near-space environment. All sensors returned excellent data. Gamma rays, neutrons, and energetic galactic cosmic rays (GCRs) were measured. Expected atmospheric features, such as the Regener-Pfotzer maximum, were observed, and gamma-ray line emission from materials near the sensors, as well as atmospheric oxygen and nitrogen, were detected. The measured data were compared to simulations of energetic protons, neutrons, and 0.511 MeV gamma rays produced by GCR interactions with the atmosphere. While the simulated protons and neutrons generally matched the data, there were fewer simulated 0.511 MeV gamma rays than measured with the data. This mismatch is likely due to additional 0.511 MeV gamma rays produced in material near the sensors that were not taken into account in the simulations. Discussion is provided for how these types of measurements in space-based missions can be used to characterize upper atmospheric densities at planets with dense atmospheres like the Earth.

1. Introduction

Planetary gamma-ray spectroscopy is a standard technique for measuring the elemental abundances of airless or nearly airless planetary bodies. Galactic cosmic rays (GCRs), which are predominantly energetic protons with energies in the range of hundreds of MeV