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Author: Mr. Akshat Mohite
India

Ms. Samruddhi Bhute
India
Ms. Tanaya Katke
India
Ms. Vaishnavi Dhamdhere
India
Ms. Sai Prashant Bhosale
MIT Art, Design and Technology University, India

MODEL DEVELOPMENT AND VALIDATION OF THE MOON'S RADIATION ENVIRONMENT AT THE SURFACE AND SUBSURFACE

Abstract

A thorough understanding of the lunar radiation environment is required in order to plan for future human exploration of the Moon. The radiation environment on the Moon consists of both primary space radiation and secondary radiation caused by the lunar soil. Both primary and secondary radiation may offer serious health risks to future Moon astronauts. In this paper, we create a thorough radiation environment model for the lunar surface and subsurface called "Radiation Environment and Dose at the Moon (REDMoon)." We determine type-, energy-, angular-, depth-, and time-dependent particle spectra caused by galactic cosmic rays at the Moon's surface and subsurface using the GEANT4 (GEometry ANd Tracking) Monte-Carlo code and "response function" technique. The calculated radiation particle fluxes on and under the surface accord well with prior experimental and computational results, while also providing additional information on the lunar radiation fields, such as angle and depth information. Depending on particle type and energy, the depth profile of secondary particle spectra in lunar soil reaches a maximum between 0.5 and 1 m below the surface. Secondary particles (particularly neutrons, gamma rays, and electrons) with energies of 1 MeV have a fairly isotropic angular distribution, but higher energy particles preferentially travel downward. Our model gives complete coverage of the radiation field's spatial, directional, and energetic information at the Moon's surface and subsurface, which may be used to construct future human bases on the Moon.