Comparisons between Model Predictions and Spectral Measurements of Charged and Neutral Particles on the Martian Surface

Myung-Hee Y. Kim[1], Francis A. Cucinotta[2], Cary Zeitlin[3], Donald M. Hassler[4],
Bent Ehresmann[4], Scot C. R. Rafkin[4], Robert F. Wimmer-Schweingruber[5], Stephan Böttcher[5],
Eckart Böhm[5], Jingnan Guo[5], Jan Köhler[5], Cesar Martin[5], Guenther Reitz[6], and Arik Posner[7]

[1]Universities Space Research Association, Houston, TX, USA
[2]University of Nevada Las Vegas, Las Vegas, NV, USA
[3]Southwest Research Institute, Durham, NH, USA
[4]Southwest Research Institute, Boulder, CO, USA
[5]Christian Albrechts University, Kiel, Germany
[6]German Aerospace Center (DLR), Cologne, Germany
[7]NASA Headquarters, Washington, DC, USA

Abstract

Detailed measurements of the energetic particle radiation environment on the surface of Mars have been made by the Radiation Assessment Detector (RAD) on the *Curiosity* rover since August 2012. RAD is a particle detector that measures the energy spectrum of charged particles (10 to ~200 MeV/u) and high energy neutrons (~8 to 200 MeV). The data obtained on the surface of Mars for 300 sols are compared to the simulation results using the Badhwar–O'Neill galactic cosmic ray (GCR) environment model and the high-charge and energy transport (HZETRN) code. For the nuclear interactions of primary GCR through Mars atmosphere and *Curiosity* rover, the quantum multiple scattering theory of nuclear fragmentation (QMSFRG) is used. For describing the daily column depth of atmosphere, daily atmospheric pressure measurements at Gale Crater by the MSL Rover Environmental Monitoring Station (REMS) are implemented into transport calculations. Particle flux at RAD after traversing varying depths of atmosphere depends on the slant angles, and the model accounts for shielding of the RAD "*E*" dosimetry detector by the rest of the instrument. Detailed comparisons between model predictions and spectral data of various particle types provide the validation of radiation transport models, and suggest that future radiation environments on Mars can be predicted accurately. These contributions lend support to the understanding of radiation health risks to astronauts for the planning of various mission scenarios.