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The Radiation Environment on the Martian Surface and during MSL's Cruise to Mars

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An important part of assessing present and past habitability of Mars is to understand and characterize "life limiting factors" on the surface, such as the radiation environment. Radiation exposure is also a major concern for future human missions and characterizing the radiation environment, both on the surface of Mars and inside the spacecraft during the cruise to Mars, provides critical information to aid in the planning for future human exploration of Mars.

RAD was the first MSL instrument to start collecting data, beginning its science investigation during cruise (10 days after launch) and making the first ever measurements of the radiation environment on another planet. RAD is an energetic particle analyzer designed to characterize a broad spectrum of energetic particle radiation including galactic cosmic rays, solar energetic particles, and secondary neutrons created both in the Mars atmosphere and regolith. RAD observations consist of a time series of periodic (typically hourly) measurements of charged particles from protons (Z=1) up to iron (Z=26) for energies above >10 MeV/nucleon, as well as neutrons from 10 to $\sim$ 100 MeV. These synoptic observations are designed to characterize both the short term variability associated with the onset of solar energetic particle events as well as the long term variability of galactic cosmic rays over the solar cycle.

RAD measurements will also be used to quantify the flux of biologically hazardous radiation at the surface of Mars today, and determine how these fluxes vary on diurnal, seasonal, solar cycle and episodic (flare, storm) timescales. These measurements will allow calculations of the depth in rock or soil to which this flux, when integrated over long timescales, provides a lethal dose for known terrestrial organisms. Through such measurements, we can learn how deep below the surface life would have to be, or have been in the past, to be protected.

This talk will discuss the results obtained during the $\sim$7 months of cruise observations, which included good characterization of the radiation dose inside MSL. The radiation environment inside the MSL spacecraft is not unlike that expected inside a future manned spacecraft in deep space. Modeling of the effective shielding inside the MSL spacecraft (backshell, heat shield, descent stage, etc.) shows that the average shielding provided by MSL is similar to that of the International Space Station, as well as that being assumed for future manned vehicles. During the 221 days of cruise observations, RAD measured the charged particle flux and dose from galactic cosmic rays as well as significant dose enhancements from 5 solar energetic particle events observed during this period. Even with the level of shielding inside MSL, these solar energetic particle events contributed significantly to the cumulative dose and dose equivalent.

Finally, we will present the first-ever measurements of the radiation environment on the surface of Mars. With increased solar activity as we approach the next solar maximum (expected in 2013), direct measurements of the contribution from solar energetic particle events to the total effective dose on the surface of Mars, as well as the contribution from atmospheric and albedo neutrons, will be increasingly important.

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