Lunar Habitat Radiation: Quantification, Mitigation, and Simulation

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Understanding the radiation environment on the lunar surface is vital to lunar habitation. At least three types of ionizing radiation bombard the moon and provide a significant threat to astronauts. The Cosmic Ray Telescope for the Effects of Radiation (CRaTER) has gathered radiation data since 2009.

Quantification

Types of Radiation
- Galactic Cosmic Rays (GCR)
- Solar Particle Events (SPE)
- Albedo Neutrons


Mitigation

In order to mitigate the hazard, a shielding material must be selected. Using Geant4 Beamline, simulations have shown that certain materials and combinations of materials are effective at reducing the absorbed radiation. SPE are highly variable in their intensity and frequency, and shielding may not be an effective strategy. The energy and flux of protons in GCR is well understood and considered in this project. Dose limits are shown below for reference with cumulative doses.

<table>
<thead>
<tr>
<th>Age</th>
<th>Male (Sv)</th>
<th>Female (Sv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.7</td>
<td>0.4</td>
</tr>
<tr>
<td>35</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>45</td>
<td>1.5</td>
<td>0.9</td>
</tr>
<tr>
<td>55</td>
<td>3.0</td>
<td>1.7</td>
</tr>
</tbody>
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Career Dose Limits (in Sieverts) Corresponding to a 3% Excess Cancer Mortality for 10-year Careers as a Function of Age and Sex, as Recommended by the NCRP (NCRP, 1989; 2000)

Mitigation

A comparison of initial materials showed that each reached a peak effectiveness at 50% reduction. As such, more simulations were needed to find effective material combinations.

Simulation

A typical terrestrial dose is 0.05 Sv every three years!

Citations


Acknowledgments

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