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Implementation of Two Galactic Cosmic Rays Cutoff Rigidity Models

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Within the Earth geomagnetic field, the computation of Galactic Cosmic Rays (GCR) cutoff rigidity is a necessary step in modulating the magnitude of free space GCR ions that reach Low Earth Orbit (LEO). Traditionally, the cutoff rigidity calculation has been carried out using a computationally efficient approximation named Stormer which models the Earth geomagnetic field as a simple dipole. However, for a geodetic point in space defined by the triplet (longitude, latitude, altitude), the Stormer model is limited in that it can only estimate the cutoff rigidity within a narrow field of view known as the allowed cone. That is, it cannot account for the complicated motion of an ion in directions outside this cone.
A second approach, based on following the trajectory of an ion within the geomagnetic field, attempts to trace out the complicated ion specific trajectory in all directions by solving the three dimensional Newton equation of motion in spherical coordinates. This approach inherently carries all the needed physical details of an ion cutoff rigidity during its motion in the magnetic field. However, it suffers from slow computational time as the numerical integration process involves keeping track of complicated trajectories near the cutoff rigidity, and many numerical trajectories are needed to be traced in order to find the proper cutoff.
In this talk, the trajectory tracing methodology is visited for a target point within the US-Lab module of the International Space Station (ISS). At this target point, dosimetric quantities are computed at several selected ISS orbital positions to assess the computational accuracy and efficiency of the trajectory tracing versus Stormer for cutoff rigidity calculation. These calculations, inherently carry information on the computational time to perform trajectory tracing, ion transport, and interpolation on the realistic precomputed ISS geometry (i.e. mass model). Therefore, it provides a realistic assessment of the amount of time it takes to perform an end-to-end calculation which is of primary interest to the ISS radiation assessment operations.

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