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Geomagnetic Cutoff Rigidity Values are a Valuable Tool in Analyzing Cosmic Radiation Measurements on the Earth and in Near-Earth Space

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Values of the Geomagnetic Cutoff Rigidity for locations on the Earth and in near-Earth space are a valuable tool for the analysis of cosmic radiation data. This paper presents an historical summary of the identification of cutoff rigidity values at the earth from the original Stormer theory to the determination of these values by the now accepted method of tracing cosmic ray trajectories through a mathematical model of the geomagnetic field. The initial calculations provided insight into a very complex array of allowed and forbidden particle paths from outer space to a specific location on the earth. While many individuals think there is a unique cutoff rigidity value for a location and direction in space, this is far from reality. There is an upper cutoff rigidity above which all particles are allowed and a lower cutoff rigidity below which all particles are forbidden. Between these values is the "penumbral region" - a chaotic structure of alternating allowed and forbidden orbits which can extend over several GV in rigidity particularly at mid latitudes. There is the additional complication that the geomagnetic center and geographic center of the earth are offset by ˜430 km. The east-west effect provides an insight to the importance of knowing both the directional characteristics of a particle detector and its orientation with respect to the geomagnetic field.
The extension of the particle-tracing technique to include near-Earth space and the inclusion of magnetospheric models to the quiescent internal field representation was a normal evolution of the entire cutoff rigidity determination process. As a result of the magnetospheric configuration there are variations in the cutoff values and penumbral structure over the course of a day. These changes can be relatively dynamic during strong geomagnetic storms with the cutoff rigidity boundaries changing as much as approximately three quarters of a degree in latitude with each increment of Kp value. Finally, while a secondary effect, the long term secular variation of the geomagnetic field must be considered for extremely precise measurements. The standard cosmic ray trajectory program for particle tracing through an internal model of the geomagnetic field has been deposited in the NASA data center and can be downloaded.

Author: SHEA, Margaret (SSSRC)

Co-author: Dr SMART, Don (SSSRC)

Presenter: SHEA, Margaret (SSSRC)

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