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SOLAR COSMIC RAY GROUND-LEVEL EVENT (GLE) ANISOTROPY

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The Archimedean spiral configuration in the interplanetary magnetic field controls the energetic particle flow out from the sun. Since it is much easier for a charged particle to propagate along a magnetic field than to cross a magnetic field, solar particle events from solar longitudes that are "well connected"to Earth via this Archimedean spiral path generally have prompt onsets and large anisotropies, whereas events from solar longitudes that are not "well connected"typically have longer onset delays and smaller anisotropies.

Irregularities in the interplanetary magnetic field and variability in the solar wind density and speed result in particle anisotropies that are extremely variable. When the mean free path of particle propagation between the Sun and Earth is deduced from the particle anisotropy, the computed mean free path is often of the order of 0.1 AU, but with an order of magnitude variation. The degree of particle anisotropy is time dependent. The most anisotropic values are observed during the event onset to the event maximum; the anisotropy decreases during the decline of the event. In the case of interplanetary shock dominated events, the anisotropy direction at low energies may actually reverse as the interplanetary shock passes the observer.

The most common method of observing particle anisotropy is by using a detector on a spinning satellite. Multiple sensors on a stabilized satellite can also be used to compute the particle anisotropy. In the case of using the Earth as a sensor platform, the analysis of data from multiple cosmic ray detectors at different longitudes (preferably in the polar regions) can determine the anisotropy during a solar cosmic ray ground-level event (GLE). After the anisotropy has been determined, the analysis of data from multiple cosmic ray detectors at different latitudes (cutoff rigidities) can be used to determine the GLE spectra.

There are measurements of very short duration transients (with time scales of the order of minutes) in the anisotropy during the rising phase of the event that probably relate to the acceleration source regions. The most anisotropic GLE on record occurred on 20 January 2005. It is possible, however, that the determination of this remarkable anisotropy was the result of improvements in detector technology and temporal resolution. If instrumentation of the same quality had been in operation during the large GLEs of the 17th-19th solar cycles some of those events such as the largest event in modern record on 23 February 1956 might have had similar anisotropies. Examples of the anisotropy of recent large GLEs will be presented.

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