
Contribution ID: **160** Contribution code: **S4 High Energy and Particle Physics** Type: **Oral Presentation**

# A Study of Unidirectional Gradient of Galactic Cosmic Ray Intensity at Different Cut-off Rigidities and Solar Magnetic Polarities

*Friday 24 June 2022 13:00 (15 minutes)*

Galactic cosmic rays (GCRs) are energetic charged particles, mainly protons originated in supernova remnants. Near Earth, GCR intensity ($n$) is subjected by modulation mechanisms in the solar wind, which are changed along the solar cycles (SCs) indicated by heliospheric magnetic field (HMF). We have used GCR count rates as observed by neutron monitors at low-to-high cut-off rigidities ($P_c$) and polarity states ($A$) of the HMF to determine the North-South (NS) asymmetry of the $n$. The study times span the SCs 22/23, 23, and 24 during periods 1996–1998 ($A > 0$), 2004–2008 ($A < 0$), and 2015–2019 ($A > 0$), respectively. By using a new simple correction method for secular changes for $n$, we calculated the NS asymmetry of $n$ denoted as $\delta n_{\mathrm{S-N}}/n$ with respect to the heliospheric current sheet (HCS) which is a thin region with large-scale wavy structure separating the north and south HMFs. The NS differences of corrected HCS tilt angle [$\alpha$] for Earth's excursions in helio-latitude denoted as $\Delta\alpha^{\mathrm{E}}_{\mathrm{N-S}}$ show a comparably consistence and anti-correlation with the corrected $\delta n_{\mathrm{S-N}}/n$ particularly during $A < 0$ epoch (2004-2008) and $A > 0$ epoch (2015-2019 not 1996-1998). The aspect suggests the importance of heliospheric drift on asymmetric modulation and latitudinal gradient of GCRs in both periods. The unidirectional latitude gradient [$G_\perp$] derived from the relation of the consistencies between corrected $\delta n_{S-N}/n$ and $\Delta\alpha^{\mathrm{E}}_{\mathrm{N-S}}$. We found a strong positive correlation between $\delta n_{\mathrm{S-N}}/n$ and $G_\perp$ for all epochs and $P_c$ .

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**Session Classification:** S5 Quantum Technology

**Track Classification:** High Energy and Particle Physics