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On the Upper Limiting Energy of the Solar Diurnal Anisotropy of Galactic Cosmic Ray Intensity

K. Munakata[1], S. Yasue[1], S. Mori[1], H. Onuma[2], and A. A. Darwish[3]

[1]*Physics Department, Shinshu University, 3-1-1 Asahi, Matsumoto, Nagano, Japan*

[2]*Department of Physics, Saitama University, Saitama, Japan* [3]*Department of Physics, Faculty of Science, Alexandria University, Alexandria, Egypt*

By analyzing the galactic cosmic ray (GCR) intensity observed by an underground muon detector at Matsushiro for six years, Yasue et al. (1991) first suggested the solar diurnal anisotropy of ~700 GeV GCR intensity changing in a correlation with the solar activity [1]. The anisotropy during the solar minimum period was consistent with the Compton-Getting (CG) anisotropy due to the orbital motion of Earth around Sun, while it contained a significant contribution from the solar modulation effect superposed on the CG anisotropy. An air shower experiment carried out in Tibet has recently reported the highest-precision measurement of the CG anisotropy [2]. The average solar daily variations of the GCR intensity observed by the experiment during four years around the last solar maximum period were in a fairly good agreement with the CG anisotropy in the higher-energy (12 and 6.2 TeV) event samples, while the variation in the lower-energy (4.2 TeV) event samples was inconsistent. In the present paper, we reveal the dependence of the solar diurnal anisotropy on the solar activity, by analyzing the data recorded with an underground muon detector at Zohzan over the last 20 years. We show the observed diurnal anisotropy changing in a clear correlation with the solar activity. The phase and the amplitude of the anisotropy are both fairly consistent with the CG anisotropy during the solar minimum period, while they deviate significantly from the CG anisotropy during the solar maximum period including four years covered by the Tibet experiment. We analyze these results quantitatively aiming to derive the upper limiting energy of the solar modulation effect in the heliosphere.

References

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