Large amplitude bidirectional anisotropy of cosmic-ray intensity observed in November, 2021

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We analyze the cosmic-ray variations during a significant Forbush decrease observed with world-wide networks of ground-based muon detectors and neutron monitors including detectors at Syowa Station in November 3-5, 2021. Utilizing the difference between primary cosmic-ray rigidities monitored by neutron monitors and muon detectors, we deduce the rigidity spectra of the cosmic-ray density (or omnidirectional intensity) and the first- and second-order anisotropies separately, for each hour of data. A clear two-step decrease is seen in the cosmic-ray density with the first ~2 % decrease after the interplanetary shock arrival followed by the second ~5 % decrease inside the magnetic flux rope (MFR) at 15 GV. Most strikingly, a large bidirectional streaming along the magnetic field is observed in the MFR with a peak amplitude of ~5 % at 15 GV which is comparable to the total density decrease inside the MFR. The bidirectional streaming could be explained by adiabatic deceleration and/or focusing in the expanding MFR, which have stronger effects for pitch angles near 90 degree, or by selective entry of GCRs along a leg of the MFR. The peak anisotropy and density depression in the flux rope both decrease with increasing rigidity. The spectra vary dynamically indicating that the temporal variations of density and anisotropy appear different in neutron monitor and muon detector data. We demonstrate the significance of simultaneous observations with a neutron monitor and a muon detector at the same location.

References

Munakata, K., et al. 2022, http://arxiv.org/abs/2209.05743 *ApJ* 2022 *inpress.*

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