

Hourly measurement of cosmic ray anisotropy by WCDA around and above 1 TeV: Transient effects of an interplanetary flux rope during 2021 November

Interplanetary coronal mass ejections (ICMEs) are known to affect the intensity and large-scale anisotropy of Galactic cosmic rays of energies up to ~ 100 GeV, but such effects at higher energies have never been reported. Here we analyze data from LHAASO-WCDA since its full operation began in March 2021. We select events within 45 degrees of the zenith and normalize cosmic ray skymaps at each zenith range relative to a monthly average. We calculate and subtract out the known sidereal anisotropy and calculated Compton-Getting effect as transformed to horizontal coordinates. The excess anisotropy relative to these known effects is interpreted as a transient anisotropy. For each hour of data, we express the transient cosmic ray anisotropy in terms of the gradient of the excess cosmic ray rate over the FOV. For the ICME passage of 2021 Nov 4-5, a strong anisotropy was recently reported in data from muon detectors and neutron monitors. We present evidence for an enhanced anisotropy in LHAASO-WCDA data during that time period, for primary cosmic ray energy ranges both around and above 1 TeV.

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