

MYSTERIES OF THE 17 MAY 2012 SOLAR EVENT RESPONSIBLE FOR GLE71: CME AND SHOCK WAVE DEVELOPMENT AND STATISTICAL HINTS FROM THE SPECTRA OF NEAR-EARTH PROTONS

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The event of the 17 May 2012 caused the first of two ground level enhancements (GLE71) in Solar Cycle 24. Despite all the efforts spent studying this solar event, there is no clarity on either of the two possible solar-proton accelerators. Neither the development of the coronal mass ejection (CME), nor the shock-wave history, nor the flare is clear. We have established the following. Two successive eruptions occurred with an interval of about 1.5 minutes. The expansion of each of the erupting structures caused a disturbance that accelerated all structures in its path as it propagated outward. This led to complex kinematic characteristics of the erupting structures that eventually formed a self-similarly expanding CME. Both disturbances became piston shocks and merged into a single, stronger shock. Signs of the piston-shock transformation into a bow shock were identified at distances exceeding 10 solar radii. We reconstructed the proton-fluence spectrum from fractions of MeV to 1 GeV and compared the slopes in different energy ranges with the results of statistical analysis of other proton events. The slope of the integral proton-fluence spectrum at energies < 2 MeV correlates with the CME speed, and the slope at energies 20–300 MeV correlates with the photon index of the hard X-ray flare emission. No correlation has been found between the slope of the proton spectrum at highest energies and the CME acceleration, which characterizes the initial piston shock. These circumstances indicate a statistical predominance at low energies of the contribution of the acceleration by bow shocks formed ahead of CMEs at distances of the order of 10 solar radii. On the other hand, the contribution of flare processes to the acceleration of protons seems to predominate at higher energies.

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