Statistical Analysis of the Relation between Coronal Mass Ejections and Solar Energetic Particles

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Solar energetic particles (SEPs), which originate in powerful eruptions in the solar corona, give rise to critical radiation hazards for astronauts and airline passengers, causing damages to satellites, which result in serious societal impacts. Although past studies show some relations between coronal mass ejections (CMEs) and SEP events, they have considerable scatters and it suggests that there are some unknown factors between them. In order to advance our understandings of how the properties of CMEs affect that of SEPs, we have conducted a statistical study of the relation between CMEs and SEP events. Instead of correlating SEP properties with CMEs as conduced in a majority of past studies, we started from all the 257 fast ($v > 900$ km/s) and wide (Angular width $> 60^\circ$) CMEs that occurred between December 2006 and October 2017. We detected their associated SEP events in >10 MeV protons from the three directions, GOES, STEREO-A, and STEREO-B. For the detected CME-SEP pairs, we computed three timescales of SEP events, onset time (TO), rise time (TR), and duration (TD), and correlated them with the CME speed and the longitude of the CME source location relative to the Parker spiral footpoint ($\Delta\Phi$). It is found that near the Parker spiral footpoint ($|\Delta\Phi| < 60^\circ$), TO tends to be short and negatively correlates with CME speed. The correlation between TO, TR and $\Delta\Phi$is weaker than TO, but TD and CME speeds have a positive correlation.

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