

## Solar Energetic Particle Events with Delayed Onsets

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Solar energetic particles (SEPs) give rise to critical radiation hazards for astronauts and airline passengers and cause damages to satellites. They have a significant impact on the social infrastructure and are an important subject in space weather. One of the major origins of SEPs is considered to be coronal mass ejections (CMEs), and the shocks at the fronts accelerate the charged particles to be SEPs. In order to understand how SEPs are accelerated by CMEs and reach the Earth, we conducted a statistical study of the relation between CMEs and SEP events. We measured the onset time (TO), defined as the time from the CME launch to the proton arrival in Earth orbit, and studied the relation between CME or SEP parameters. Our study showed that TO tends to be shorter if the source CMEs erupt near the nominal footpoints of Parker spiral magnetic fields connecting to the instrument. The relation between the speed of CMEs and TO is negative in that longitude. On the other hand, even if the source and speed of CMEs are similar, the distribution of TO is slightly dispersed. Therefore, we now focus on the SEP events that occurred on July 14, 2017, which has a relatively long TO among those events, and are conducting a detailed analysis. We extracted a total of 4 events that have long and short TO originating from similar CMEs, including this event. This analysis has shown that the characteristics of the accompanying flares were significantly different between long and short TO events. Furthermore, we compared the time of type II radio burst, which is considered to be an indicator of particle acceleration in coronal shock waves, with that of particle release measured by velocity dispersion analysis and found that the interval between them is longer in the long TO event on July 14, 2017.

Keywords: Solar Energetic Particles, Coronal Mass Ejections, Solar Radio Burst, Space Weather