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On GLE71 Concurrent CME-driven Shock Wave

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Recent studies, which were carried out based on both temporal and spatial evolutions, on the first GLE event of the solar cycle 24 (GLE71 17 May 2012) suggested that the CME-driven shock played the principal role to cause the event. To verify the claim, it is essential to illustrate the shock wave. For this purpose, we have carried out an investigation by using the spectral data of Wind-WAVES (NASA) for solar radio bursts while temporal data of cosmic ray intensity from SOPO and SOPB Neutron Monitors for GLE. To comprehend the particle acceleration in shock wave, we have exploited the concurrent electron fluxes from Wind spacecraft (NASA) and solar radio fluxes from NoRH (JAXA). When the temporal profiles are shifted necessarily at $\sim$ 1 AU, the onset of the type II burst is observed nearly simultaneous with the onsets of the impulsive phases of the particle intensity, and the frequency drift follows the trends of decreasing electron density whereas the frequency drift rate follows the trends of increasing electron density. This extends the idea to study the polynomial correlations. It is found that there are strong correlations between frequency drift rate of type II burst and concurrent electron fluxes. The intensive particle accelerations occurred in between $\sim$ 0.80 Rs and $\sim$ 1.10 Rs altitude of the solar corona. Key results of the study are noted as follows.

1. Extreme emission phase of high frequency solar flux component is earlier than that of the low frequency solar flux while the flash phase of high energy flare component is earlier than that of low energy flare component.

2. Some of the high-energy flare components maintained very good correlations with fundamental phase of the type II burst, indicating that the flare flash phase was associated with the onset of the shock. This was further corroborated by the evidence that the principal drifting bands of the type II burst appeared as a continuous succession of type III burst, and some of the peaks of SFU components are coincidence with the onset of type II burst. This makes sense that the preceding flare might have scope to contribute any fractional amount of energy to the shock wave.

3. Although blast wave might be capable to produce GLE (presumably prompt event), the energy contribution of the preceding flare components to the shock wave did not expose any evidence to believe that the shock wave was turned into a blast wave. This was further realized by the fact that the low frequency spectral evolution in type II bursts has strong correlations with the concurrent particle fluxes, inferring that the strongest particle acceleration might have taken place at any higher altitude of the corona.