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The Structure of the Compression Front in Carrington Class CMEs

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The canonical model of an energetic space weather event is a fast shock preceding the arrival of a large rapidly expanding magnetic rope. The shock front contributes to the high fluxes of energetic particles by further accelerating the energetic particles generated in the initial launch of the magnetic rope. The 1859 Carrington event is popularly portrayed as not simply being the first major space weather event recorded by terrestrial observers, but being the largest recorded event. However, if we quantify the Carrington event in the only parameter that was accurately determined for the event, its transit time, we find that we have modern events with the same transit time and at least one with a faster time. Hence we can probe Carrington-class events with today's fleet of space weather probes. Our best observed event occurred on August 23, 2012, at STEREO A, well away from the Earth-Sun line. We find that this event does not have the classic fast-mode shock ahead of the flux rope, but that the compression is a slow-mode wave. This discovery alters the simple model of shock acceleration proposed for producing the particles accompanying strong coronal mass ejections.