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Prediction of Solar Energetic Particle Peak Intensity using CME Speed and Direction in Solar Cycles 23 and 24

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From a survey of solar energetic particle events observed by both the STEREO spacecraft and at the Earth in 2009-2012 during solar cycle 24, Richardson et al. (Solar Physics, 289,3059, 2014) obtained a formula relating the SEP peak intensity at 14-24 MeV with the speed of the associated coronal mass ejection and its direction with respect to the observing spacecraft. This suggests that the formula might in turn be used, if the CME parameters are known, to "predict"the intensity of the related SEP event. However, since only a small fraction of CMEs are actually associated with SEPs at this energy, many "false alarms"occur. These may be reduced by, for example, considering a minimum CME width or other phenomena, such as type II and type III radio emissions accompanying the CME. For a subset of cycle 24 CMEs, in around three quarters of cases where the observed proton intensity at 14-24 MeV was above 0.1 $(cm^2\ sr\ s\ MeV)^{-1}$, the predicted intensity was within an order of magnitude of the observed intensity in $\sim 75\%$ of cases. However, since cycle 24 SEP events were used to generate the formula, it is also possible that this contributes the good agreement between observed and predicted SEP intensities. We have therefore applied it to CMEs in solar cycle 23, using CME speeds from the CDAW catalog and directions inferred from the location of the associated flare, and find that there is a similar level of agreement. For earlier cycles, we use CME observations from the Solwind and SMM coronagraphs associated with SEP events. In addition, for SEP events in earlier cycles where the SEP intensity and flare location are known, the speed of the associated CME might be estimated using the formula, assuming that it also holds for these earlier cycles, thereby indicating the speeds of SEP-associated CMEs even if there are no coronagraph observations.

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