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# Is There a Relationship Between Asymmetries in Solar Particle Events, Dimming Regions and CME propagation directions?

Studies of the longitudinal distribution of solar energetic particles generally use the location of the related solar flare as a reference longitude. In particular, particle intensities are typically found to fall off with increasing "connection angle"–the longitudinal separation between the flare and the footpoint of the field line passing the observing spacecraft –and are often fitted by Gaussians in connection angle. Although the peak of the Gaussian is often close to zero connection angle, i.e., on field lines connecting close to the flare longitude, some ˜25 MeV proton events observed by both STEREO spacecraft and at the Earth show clear asymmetries, either to the east or west, relative to the flare longitude, in their early stages. There are various possible reasons for such asymmetries, one being that the flare longitude may not represent the expansion direction of the coronal mass ejection and associated shock, which may accelerate the particles. We examine this possible cause for the asymmetry by comparing the longitudinal offsets relative to the flare of the connection angle of the SEP peak, the centroid of the dimming region below the related CME, and the CME propagation direction inferred using a compound geometric model which fits an ellipsoid shape to multi-spacecraft observations of the shock front, for ˜40 "three-spacecraft"proton events.

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