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Probing the Puzzle of Fermi Long-Duration Gamma-Ray Flares by Data-driven Global MHD Simulations

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With the increasing number of long-duration gamma-ray solar flares >100 MeV observed by Fermi/LAT, it poses a puzzle on the particle acceleration and transport mechanisms. The recent detections of behind-the-limb (BTL) solar flares (e.g., 2014 September 1 event), in which the gamma-ray emission region is located away from the BTL flare site by up to tens of degrees in heliographic longitude, and on-disk flares with migration of gamma-ray emission centroid hours past the impulsive phase (e.g., 2012 March 7 event), present further new challenges on the theoretical models for interpreting the observations. Since most of the long-duration events are associated with fast CMEs, it is therefore intriguing to understand the role of CMEs and CME-driven shocks in these events. To probe this puzzle, we perform data-driven, global magnetohydrodynamics simulations of the CMEs associated with the long-duration gamma-ray flares and investigate the magnetic connectivity and evolution of the CME-driven shock, and their relationship, in both space and time, with the observed gamma-ray emission. Specifically, we derive and track the time-varying shock parameters over the area that is magnetically connected to gamma-ray emission region. Based on the modeling results, we discuss the causes and implications of Fermi long-duration gamma-ray events, in the framework of a potential shift of paradigm on particle acceleration in solar flares and CMEs.

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