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Modelling the acceleration of energetic particles at travelling heliospheric shocks

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Propagating shocks are observed to form ahead of the solar material expelled into interplanetary space following coronal mass ejections (CMEs). During the passage of these CME-driven shocks, spacecraft often observe energetic particle enhancements commonly associated with particle acceleration. In this study, the acceleration of energetic particles at halo-CME-driven shocks is investigated, with a particular focus on the acceleration of particles from the suprathermal solar wind (SW). A set of stochastic differential equations, derived from the Parker transport equation and including the effects of diffusive shock acceleration (DSA), is solved numerically to model this process. The SW particle velocity distribution is described by a Kappa distribution in the solar wind frame and prescribed as a source function at the shock. The injection energy is calculated from first principles, but can also be changed to investigate the effect thereof on model solutions. With the further application of physically representative transport coefficients, the model results are presented and their accuracy evaluated against how well they reproduce observations of protons and heavier ions during selected shock passage events. The results illustrate the significance of the DSA mechanism in accelerating energetic particle populations in the near-Earth environment.

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