A self-consistent simulation of proton acceleration and transport near a high-speed solar wind stream

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Solar wind stream interaction regions (SIRs) are often characterised by energetic ion enhancements. The mechanisms accelerating these particles as well as the locations where the acceleration occurs, remains debated. Here, we report the findings of a simulation of a SIR-event observed by Parker Solar Probe at 0.56 au and the Solar Terrestrial Relations Observatory-Ahead at 0.96 au in September 2019 when both spacecraft were approximately radially aligned with the Sun. The simulation reproduces the solar wind configuration and the energetic particle enhancements observed by both spacecraft. Our results show that the energetic particles are produced at the compression waves associated with the SIR and that the suprathermal tail of the solar wind is a good candidate to provide the seed population for particle acceleration. The simulation confirms that the acceleration process does not require shock waves and can already commence within Earth’s orbit, with an energy dependence on the precise location where particles are accelerated. The three-dimensional configuration of the solar wind streams strongly modulates the energetic particle distributions, illustrating the necessity of advanced models to understand these particle events.

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