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On the origin of relativistic solar particle events: interplanetary transport modelling and radio emission

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The highest energies of solar energetic nucleons detected in space or through gamma-ray emission in the solar atmosphere are in the GeV range. Where and how these particles are accelerated is still controversial. The candidate processes are related to magnetic reconnection in a flare or a coronal mass ejection (CME), and to the shock wave driven by a fast CME. We search for observational indications on the acceleration site, via comparative analyses of the timing of relativistic solar protons, observed by neutron monitors on the Earth, and electromagnetic emissions of the associated eruptive solar activity. The microwave emission, at frequencies above 10 GHz, emphasises the impulsive flare phase, while emissions at lower frequencies (hundreds of MHz to a few GHz) reveal both the impulsive flare and post-impulsive particle acceleration. We use different time profiles of the radio emission to describe the solar injection function and model the interplanetary particle transport taking into account the effects of focusing by an average Archimedean magnetic field, and scattering by its fluctuations. The predicted time profiles of the relativistic protons at 1 AU are confronted with neutron monitor observations of events from solar cycle 23. We use the results to discuss the nature of the prompt and delayed relativistic proton releases that have been identified in neutron monitor recordings of relativistic solar particle events.

Collaboration

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