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Neutron-Decay Protons from Solar Flares as Seed Particles for CME-Shock Acceleration in the Inner Heliosphere

The protons in large solar energetic particle events are accelerated in the inner heliosphere by fast shocks produced by coronal mass ejections. Unless there are other sources, the protons these shocks act upon would be the solar wind. The efficiency of the acceleration depends on the kinetic energy of the protons. For 1 - 2 thousand km/s shocks, the most effective proton energies would be 10 - 50 keV; i.e, within the suprathermal tail component of the solar wind. We investigate one possible additional source of such protons: those resulting from the decay of solar-flare-produced neutrons that escape from the Sun into the low corona. The neutrons are produced by interactions of flare-accelerated ions with the solar atmosphere. We discuss the production of low-energy neutrons in flares and their decay along a Parker-spiral field line near the Sun. We find that, even when the flaring conditions are optimal, the 10 - 50 keV neutron-decay proton density produced by even a very large solar flare would amount to less than 1% of that of the 10 - 50 keV solar-wind suprathermal tail. We discuss the implication for a seed particle source of more-frequent, small flares.

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