

THE PROPOGATION OF SOLAR FLARE PARTICLES IN A TURBULENT CORONAL LOOP

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ABSTRACT

Energetic solar flare particles, both electrons and protons, must survive the turbulent environment of a flaring loop and propogate to the lower corona or chromosphere in order to produce hard X-ray and γ -ray bursts. This plasma turbulence, often observed in soft x-ray line widths to be in excess of 100 km/s, is presumably capable of efficiently scattering the fast flare particles. This prevents to some degree the free streaming of accelerated particles and depending on the amplitude of the turbulence, restricts the particles to diffusive propogation along the length of the loop to the target chromosphere. In addition this turbulence is capable of performing additional acceleration of the fast particles by the second order Fermi mechanism. For compact flares with rise times < 10 s, the acceleration effect is small and the propogation of the particles is governed by spatial diffusion and energy loss in the ambient medium.

The solution of the time dependent diffusion equation with velocity dependent diffusion and energy loss coefficients yields for the case of non-relativistic protons particle precipitation rates which are necessary for calculating thick target γ -ray emission and also yields the total thin target emissivity. The thick target emission is necessarily delayed with respect to the particle acceleration or injection by more than the mere travel time of the particle over the loop length. Equivalent numbers are calculated for the case of relativistic electrons where in addition the time-dependent electron population at the top of the loop is calculated. This is useful in estimating the resulting μ -wave emission. The results show relative timing differences in the different emission processes which are functions of particle species and energy and the point of injection of the particles into the coronal loop.