AN EFFICIENT MONTE CARLO SCHEME FOR RELATIVISTIC SHOCK ACCELERATION

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To obtain good statistics for accelerated spectra, angular and time distributions by simple Monte Carlo techniques is inefficient in relativistic shock acceleration because simulation of diffusion in the downstream region is very time-consuming. The approach we use is to consider particles of one particular energy injected from upstream to downstream at the shock at a particular angle θ_1 to the shock normal and obtain: (1) the probability of returning to the shock ${\rm Prob.(return}, \theta_1)$, (2) The angular distribution of particles crossing the shock from downstream to upstream at a particular angle θ_2 to the shock normal $p(\theta_2,\theta_1)$, (3) the distribution of time spent downstream t_d before returning for angles θ_1 and θ_2, $p(t_d,\theta_2,\theta_1)$. These distributions are given for a simple plain relativistic shock for the case of hard sphere scattering of the relativistic particles, and a simple parametrization which scales with the downstream scattering mean free path has been obtained. This enables the downstream part of shock acceleration to be simulated quickly and efficiently by sampling (a) θ_2 from $p(\theta_2,\theta_1)$, (b) t_d from $p(t_d,\theta_2,\theta_1)$ for a particle crossing from upstream to downstream at angle θ_1.