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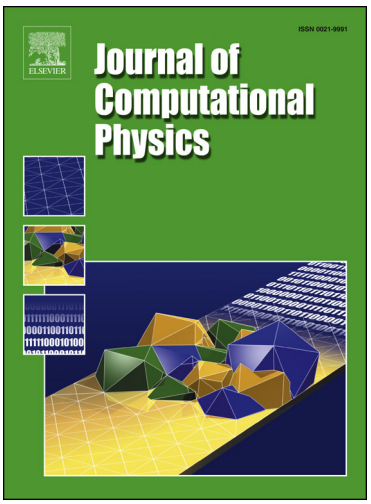

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Validation of Radiative Transfer Computation with Monte Carlo Method for Ultra-Relativistic Background Flow

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Abstract

We developed a three-dimensional radiative transfer code for an ultra-relativistic background flow-field by using the Monte Carlo (MC) method in the context of gamma-ray burst (GRB) emission. For obtaining reliable simulation results in the coupled computation of MC radiation transport with relativistic hydrodynamics which can reproduce GRB emission, we validated radiative transfer computation in the ultra-relativistic regime and assessed the appropriate simulation conditions. The radiative transfer code was validated through two test calculations: (1) computing in different inertial frames and (2) computing in flow-fields with discontinuous and smeared shock fronts. The simulation results of the angular distribution and spectrum were compared among three different inertial frames and in good agreement with each other. If the time duration for updating the flow-field was sufficiently small to resolve a mean free path of a photon into ten steps, the results were thoroughly converged. The spectrum computed in the flow-field with a discontinuous shock front obeyed a power-law in frequency whose index was positive in the range from 1 to 10 MeV. The number of photons in the high-energy side decreased with the smeared shock front because the photons were