Abstract

Supernova remnants (SNRs) are one of the most energetic astrophysical events and are thought to be the dominant source of Galactic cosmic rays (CRs). A recent report on observations from the Fermi satellite has shown a signature of pion decay in the gamma-ray spectra of SNRs. This provides strong evidence that high-energy protons are accelerated in SNRs. The actual gamma-ray emission from pion decay should depend on the diffusion of CRs in the interstellar medium. In order to quantitatively analyze the diffusion of high-energy CRs from acceleration sites, we have performed test particle numerical simulations of CR protons using a three-dimensional magnetohydrodynamics (MHD) simulation of an interstellar medium swept-up by a blast wave. We analyze the diffusion of CRs at a length scale of order a few pc in our simulated SNR, and find the diffusion of CRs is approximately described by a Bohm diffusion coefficient at least for particles with energies above 10 TeV for a realistic interstellar medium. We also investigate the possibility of a superdiffusive process in CR propagation and acceleration in SNRs. Although we find evidence of superdiffusion (travel distance $\propto t^{0.75}$) in our simulations, its effect on CR diffusion at the length scale of the turbulence in the SNR is limited.