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Diffusive shock acceleration of cosmic rays: dependence to the scattering models

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It is widely recognized that the diffusive shock acceleration (DSA) is the most likely acceleration process responsible for producing the observed power law cosmic ray spectrum, at least up to the so-called knee energies. One of the key elements of the DSA is the scattering of the cosmic rays by MHD turbulence, which is believed to exist both shock upstream and downstream. As the cosmic rays are repeatedly scattered by the MHD turbulence, they travel back and forth across the shock and energized by effectively compressed by the convergent background plasma flow. While the majority of past studies on the DSA employ quasi-linear type model for the cosmic ray diffusion, actual transport of the cosmic rays in a plasma with MHD turbulence can be qualitatively different. In the quasi-perpendicular shock geometry, the cosmic ray diffusion may be sub-diffusive as the particles are trapped by the guiding field (Kirk et al., 1996). In contrast, parallel diffusion of the cosmic rays may be considered super-diffusive when a time scale considered is less than the mixing (reflection) time scale. In the presentation, we discuss results of our test particle simulations of the DSA in which the scattering of particles is specified by several different diffusion models. Cosmic ray spectrum index as well as spatial profile of the cosmic ray intensity are evaluated and discussed for both sub-diffusive and super-diffusive cases.