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Properties of cosmic ray test particles in global MHD simulation of the heliosphere

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Heliosphere is a bubble occupied by the solar wind plasma and magnetic field in the local interstellar space. The motion of galactic cosmic rays (GCRs) invading into the heliosphere are strongly affected by the electromagnetic structures of the heliosphere. The statistical behavior of the GCRs near and inside the heliosphere have been conventionally studied by many authors using the diffusion convection model [e.g., Moraal (2013)].

In this study we investigate the behavior of GCRs invading into the heliosphere in the level of particle trajectory. We conduct test particle simulations of GCRs by using the electromagnetic fields obtained from a global MHD simulation of the heliosphere. The MHD simulation assumes steady solar wind and interstellar wind. GCR protons are initially distributed outside the heliosphere and their motions in the steady virtual heliosphere are calculated by using the Buneman-Boris method. Depending on their initial energy, various types of particle motions, current sheet drift, polar drift, spiral motion, shock drift, Fermi-like acceleration, linear motion, resonantly scattered motion, mirror reflection by bottleneck interstellar field, are observed. We further discuss some statistics of the particles reached at the inner boundary (=50AU from the sun) of the simulation domain.