Energetic ions accelerated at the Earth's bow shock during CME event

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The energetic particles up to ˜2 MeV are at times observed in the upstream region of the Earth's bow shock during CME and CIR events. These energetic particles are thought to be accelerated at the Earth's bow shock. Recently, energetic backstreaming ions in the upstream region of the Earth's bow shock were observed by the Geotail spacecraft. In addition to field-aligned beams that often exist in the upstream region of the bow shock, we found loss cone distribution of backstreaming ions whose energy is between 30 keV and ˜several hundred keV. Although the shock acceleration mechanism is well studied, our understanding on the acceleration process of these particles at the bow shock is not enough. We note that test particle simulation is a useful analysis tool for following the particle dynamics at shock front. Previous studies performed test particle simulations for specular reflection of ions, supposing that shock front is planar and stationary. However, recent simulation studies indicate that shock front shows non-stationary behavior with temporary variation and stationary variation, which are known as re-formation and ripple, respectively. These results imply that the non-stationary structures significantly affect the particle trajectory around the shock front. Here we notice the acceleration mechanisms under the non-stationary shock structure that can effect on particle dynamics. In order to investigate the acceleration mechanisms in the non-stationary shock transition region, we perform 1-D test particle simulations, aiming at reproducing energetic particles with several hundred keV under non-stationary shock structures of bow shock. To generate non-stationary shock condition, we set the shock angle in the simulation to be 70-85 degrees and fluctuate the tangential component of upstream magnetic field. We show that such non-stationary shock condition can indeed generate energetic particles that are never seen in the stationary shock condition. We will discuss the acceleration mechanism at the non-stationary perpendicular shocks.