

Modeling of Particle Acceleration in Shock-Shock Interaction

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It is known that collisionless shocks produce high energetic particles (cosmic rays). Most of the past studies have been dedicated to discussing particle acceleration in a single shock system. Particle acceleration in multiple shocks, however, is considered to be highly efficient[Gieseler and Jones, 2000, Melrose and Pope, 1993]. In space, two shocks are frequently come close to and even collide with each other. For instance, it is observed that a coronal mass ejection(CME) driven shock collides with the earth's bow shock[Hietala et al., 2011, Concharov et al., 2014], or interplanetary shocks pass through the heliospheric termination shock[Lu et al., 1999].

To investigate the shock-shock interaction, we perform one-dimensional full particle-in-cell simulation in which two identical shocks collide. We found that electrons are accelerated through multiple reflection between the two shocks(Fermi acceleration). These electrons excite large amplitude waves between the two shocks and are scattered in their pitch angles. The scattering results in that some electrons can have sufficiently large pitch angles so that they are easily reflected when they reach at a shock next time. We model the acceleration process and discuss the suitable condition for particle acceleration.

Keywords: Collisionless Shocks, Shock-Shock Interaction, Particle Acceleration