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# Multi-dimensional effects on electron acceleration in an oblique shock wave

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Particle simulations have revealed [1] that prompt electron acceleration to ultrarelativistic energies can occur in a magnetosonic shock wave propagating obliquely to a strong external magnetic field. The acceleration is extremely strong when the propagation speed of the shock wave is close to c cos A, where c is the light speed and A is the propagation angle of the shock wave. In such a wave, some electrons are reflected near the end of the main pulse of the shock wave and get trapped and are energized in the main pulse region. Under the assumption that the wave is one-dimensional, the electrons cannot readily escape from the wave and are deeply trapped in the main pulse region, which indicates that the number of trapped electrons increases continually with time [2].

In this study, we perform two-dimensional (two space coordinates and three velocities), electromagnetic particle simulations in order to investigate multi-dimensional effects on electron motion in an oblique shock wave. The simulations demonstrate that after trapping and energization in the main pulse, some electrons are detrapped from it with keeping with their ultrarelativistic energies. The detrapping is caused by magnetic fluctuations propagating along the wave front. The amplitudes of fluctuations grow with time owing to the relative motion between trapped and passing electrons. Furthermore, it is found that some of the detrapped electrons can be accelerated by the shock wave to much higher energies because they can stay near the shock front even after the detrapping and can enter the shock wave several times owing to their gyromotions.

[1] N. Bessho and Y. Ohsawa, Phys. Plasmas Vol. 6 3076 (1999).
[2] A. Zindo, Y. Ohsawa, N. Bessho, and R. Sydora, Phys. Plasmas Vol. 12 052321 (2005) .

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