Particle accelerations by shock waves in magnetized electron-positron plasmas

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Simultaneous accelerations of electron and positron by the plasma shock wave propagating perpendicular to the uniform magnetic field are analyzed in the electron-positron plasma. Electrons and positrons colliding head-on with the shock wave generate a current flow along the shock front. A magnetic pulse with large amplitude is induced by the current, and thus two magnetic neutral sheets are created behind the magnetic pulse as shown in Fig.1. Both electrons and positrons are trapped by the same sheet (left-hand side) and accelerated indefinitely (see Fig.2) parallel to it with the accelerating directions are opposite to each other. This mechanism is explained as Magnetic Trapping Acceleration and proposed as a new type of particle trapping and acceleration [1].

Fig.1 Schematic diagram of the Magnetic Trapping Acceleration by the shock wave in the magnetized electron-positron plasma (on the wave frame). The dotted curve indicates the initial magnetic field profile of the shock.

Fig.2 Time evolution of the (energy) gain of the test particle trapped by the magnetic neutral sheet located behind the magnetic pulse.