Particle acceleration by a relativistic collisionless shock with alternating magnetic field inflow

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The spectrum of the Crab Nebula exhibits highly non-thermal features which is indicative for the presence of some particle acceleration process. An essential point is that the toroidal magnetic field is perpendicular to the direction of the plasma flow. The perpendicular components of the magnetic field are relativistically boosted, and the magnetic field must be parallel to shock surface. In this case Fermi acceleration is not an efficient mechanism of particle acceleration. Another important characteristic is that the magnetic field polarity is alternating around the equatorial plane due to the magnetic pole precession of the pulsar.

One of the solutions to this problem is to investigate the shock direct acceleration. We investigate the particle acceleration by taking into account the upstream alternating magnetic field in particle simulations. The magnetic field and the current sheet structures are prescribed within the constraints of the Harris solution. We find that the acceleration is stronger in comparison to the non-alternating case in certain parameter ranges. We present simulation results and the acceleration mechanism caused by the interaction between the Harris current sheet and the shock, respectively.