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Effects of Synchrotron-Weibel Instabilities on Relativistic Perpendicular Shock Acceleration in Pair-Ion Plasmas

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The shock waves are very important structure which may be associated with particle acceleration in magnetosphere and heliosphere, astrophysical sources, and so on. The acceleration of relativistic particles in astrophysical sources of synchrotron emission is one of long-lived unsolved problems. Most of those non-thermal astrophysical sources have shock structures. So collision-less shock waves in relativistic flow have been implicated to energize particles. However, the particle acceleration processes in collision-less shocks have not fully understood yet. The problems are not simply addressed by the macroscopic view point of MHD framework, and we need to approach these questions by microscopic view point.

In order to study these unresolved issues of collision-less shocks, particle-in-cell (PIC) simulation have been recently used as a useful tool to investigate the micro- scopic acceleration mechanisms. For example, Hoshino et al.(1992) and Amato & Arons (2006) have studied the structure of relativistic perpendicular shock wave in electron-positron-ion plasma by PIC simulation, and concluded that the pair plasmas can be efficiently accelerated by the synchrotron instability.

In this presentation, we introduce the effect of two-dimensional structures on the pair plasma acceleration in the relativistic shocks in pair-ion plasmas by using 2D PIC simulation. For sigma value less than 1 plasma, both of the synchrotron instability and the Weibel instability play important roles on high energy pair plasma acceleration. So, we investigate the behavior of above two mechanisms and particle accelerations in both case in which the direction of background magnetic field set to out of plane and in the plane. We find that in the 2D simulation, the synchrotron instability is dominant in out of plane case and the Weibel instability is dominant in the in the plane case. However we can find that the synchrotron instability still work in sigma(elec)= 0.01 case.