Development of electromagnetic Vlasov code and application to perpendicular shock

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Collisionless shock waves are believed to be a strong `particle accelerator', thus a lot of work have been done to study the particle acceleration mechanism at shock waves until now. Not only this shock wave probrem, but most of self-consistent numerical calculation of collisionless plasma are performed using particle-in-cell(PIC) method. This method is quite stable, and can

describe plasma kinetics even when only few particles are used.

However, it seems to be impossible to obtain a sufficient accuracy of non-thermal particle distribution even with the most powerfull super computer at present. On the other hand, Eulerian grid-based Vlasov solver

becomes realistic with such super computers. The advangages of this method are, no statistical noise which is intrinsic in PIC, and high accuracy. These lead to a accurate

discription of non-thermal particle distribution.

For these reasons, we employ this method to investigate non-thermal production at collisionless shock waves. We developed a one-dimensional electromagnetic code using CIP scheme. We are going to report the result of parpendicular shock wave simulation with this code. The comparison with the full particle simulation will also be reported.

The most crucial probrem of the code, when applied to the shock wave, is the dynamic range of velocity space. It is hard to obtain the sufficient resolution with fixed grid both upstream cold distrubution and hotter downstream, especially at high Mach number shocks.

Furthermore, the unphysical negative distribution value could occure by the numerical oscillation, and conservative property is not necessarily satisfied. We would like to argue the answer to these probrems.