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Entropy problem in the quasi-linear theory

\# Masahide Iizima[1]

[1] Geophysical Inst., Tohoku Univ.

Wave-particle interactions have been believed to play important roles in the anomalous trasport in a plasma. Anomalous diffusion or anomalous resistivity dominate the classical ones even in the collisional plasma. In the collision free plasma like the space plasma, trasport phenomena have been thought to be governed by the wave-particle interactions and have been well formulated in the quasi-linear theory, which is sometimes reffered as the effect of 'turbulent collission'. Recent most interesting application is to the rapid reformation of radiation belt electrons in the recovery phase of the geomagnetic storm.

In the present study, we will first review the quasi-linear theory, and then clarify the required conditions to justify its application by considering the Langmuir-Poisson system, which is the most simple one but the best example to understand its physical propaties. Finally, we would like to discuss the Coulomb collision in the 'collision free' plasma and point out that Coulomb collision is important for the plasma to reach the final state of the relaxation even in the collision free plasma.