§12. Creation of Super Ion Acousic Double Layer

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It has been well established that the magneto-hydrodynamic (MHD) plasma is a good medium in which self-organization takes place. The idea of "self-organization" which was shown in those previous works is: The parallel plasma current provides a free magnetic energy by which a current-driven kink instability (global instability) is excited to give rise to a global toporogical change in magnetic field configuration, whereby a nonlinear rapid energy dissipation takes place. On top of the above conditions, if a superfluous entropy (thermal energy) produced during the process is swiftly removed from the system to an ambient world, a new stable ordered structure is established.

In this work, we attempt to investigate a self-organization process in a kinetic plasma. As a candidate for such a process, an ion-acoustric double layer is chosen. We have developed a suitable numerical model for open system in which fresh external particles can continuously come in the system and disturbed particles can be swept out toward the surrounding regime in a consistent manner without causing any numerical noise[1]. By applying our new numerical procedure, it is found that a "super" ion acoustic double layer is formed[2,3]. By changing the drift speed of the shifted Maxwellian in the range from $v_d = 0.3$ to $0.7 v_{th}^e$, we have definitely confirmed so far that the self-breeding excitation of the "super" ion acoustic double layer is really a physical phenomenon. The results are summarized as follows:

1) First, in the early phase of evolution, week ion acoustic double layers are generated in a stairs-like form. The evolution is neither a monotone nor a single-shot. It is repetitive. Secondly and most importantly, during the repetitive evolution of week double layers, it happens that a two-stream like distribution of electrons and ions is met somewhere in the system. Then, self-feeding condition , or self-breeding condition, is satisfied there and a "super" ion acoustic double layer is created. The maximum potential difference reaches to a much higher level than the electron thermal energy, say, 15 times in the case of $v_d = 0.6 v_{th}^e$. This super structure does not persist long but eventually subsides with leaving a highly disturbed structure behind.

2) ion acoustic double layers are generated when $v_d \gtrsim 0.4 v_{th}^e$

3) a super ion acoustic double layer is self-excited when $v_d \gtrsim 0.5\ v_{th}^e$

4) the maximum amplitude of the super ion acoustic double layer is much, by order of magnitude or more, larger than the electron thermal energy or drifting electron energy and becomes larger as the drift speed becomes larger.

Reference

1) Takamaru,H. Sato,T., Horiuchi,R., Watanabe, K. and the Complexity Simulation Group NIFS report No.335(1995)

2) Takamaru,H. Sato,T., Horiuchi,R. and Watanabe,K. NIFS report No.282(1994)

3) Sato,T., Takamaru,H. and the Complexity Simulation Group, Phys.Plasmas **2** (1995)