Impulsive Energy Relaxation in MHD Driven Magnetic Reconnection

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In order to investigate the energy relaxation process through driven magnetic reconnection in the open system, we carried out some long Calculations. The framework is 2-D compressible resistive magnetohydrodynamic theory. It is our purpose to clarify not only the dynamic process of magnetic reconnection which is a localized process, but also how the free magnetic energy stored in the global configuration may be released and affect the global topology in the system.

The simulation codes are MHD one with second order accuracy in space and forth order in time, and the region in the calculations is a rectangular in the x-y plane, d/dz.=zero is assumed. The initial condition we adopt is Harris-Type equilibrium that is anti-parallel magnetic type, and resistivity is assumed to be uniform and vertical magnetic field is added uniformly.

By making long time scale calculations compared with the conventional simulations, It is found that the energy relaxation processes in the system are intermittent and impulsive. Figure 1 shows the temporal evolutions of the rate of energy change of the total magnetic energy stored in the system. It appears to five pairs repeatedly which consist of the exponential increasing phase and the impulsive decreasing phase. In the earlier stage, magnetic reconnection is induced by the external driving plasma flow, the free magnetic energy stored in the system is released rapidly by converting to the energy of the acceleration and the heating of plasma. In the second stage, tearing instability grows up near the X-point in the diffusion region, it leads to the development of magnetic island, which involves system. During the development of the island, two X-point happen at both edges of the island. At time = 1100, the crush of the magnetic island start suddenly, whereby new X-point takes place at the center of the island. Then, the second pair of islands that is formed by splitting the large central island run away toward the outflow region. Note that immediately after the crush, the anomalous acceleration and heating occur the same time the abrupt increasing of current happens.{Fig.2}.

After the impulsive dissipation, tearing instability takes place in the diffusion region again, the process of the second stage is repeated intermittently.

Thus in uniform resistivity model, we can find the intermittent and impulsive relaxation processes, and dynamic phenomena such as the burst with high velocity, and the anomalous heating.

Fig.1. Rate of Energy Change (1)
Total magnetic energy

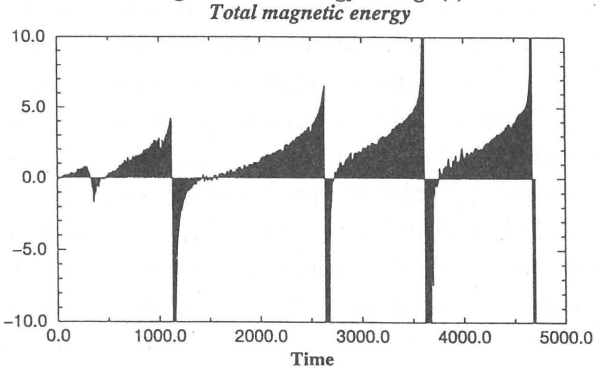

Fig.2. Rate of Energy Change (2)
Joule heating (dash), Acceleration (grey)