§24. Relationship between Particle Trajectories and Magnetic Reconnection

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Magnetic reconnection is widely considered to play an important role in energetically active phenomena in high temperature plasmas. In spite of intensive research, many basic questions about the details of mechanisms of reconnection still remain poorly understood. Ions become un-magnetized and execute a complex thermal motion called meandering in the ion dissipation region. The complex meandering motion leads to the growth of off-diagonal components of the pressure tensor term, which is one of main causes to break ion frozen-in condition in the vicinity of magnetic neutral sheet [1-4]. It is important to clarify the relationship between the role of meandering particles and physical quantities such as temperature and magnetic field structure in order to understand the magnetic reconnection phenomenon. In this paper, we report an analysis result about the relationship by means of the immersive virtual reality (VR) system "CompleXcope."

Simulation data of a collisionless driven reconnection is obtained by the 3-D PArticle Simulation code for Magnetic reconnection in an Open system (PASMO). The initial condition is given by a one-dimensional Harris-type equilibrium, in which the magnetic field is parallel to the x-axis and a function of the y-coordinate. At the upstream boundary (y boundary), ions and electrons enter the system by $\boldsymbol{E} \times \boldsymbol{B}$ drift due to a driving electric field E_{z0}, whereas at the downstream boundary (x boundary), particles exit and enter the system under the free boundary condition[5].

In order to analysis the particle trajectories in the electromagnetic field obtained by PASMO, we improve VFIVE (Virtual Reality Visualization Software for CAVE Systems) to trace the trajectories of plasma particles in the VR world [6]. VFIVE is one of the general purpose VR visualization softwares developed by Kageyama and Ohno [7-8]. This software can show the vector fields as lines, arrows and so on, and the scalar fields as isosurface, contour and volume rendering.

Figure 1 displays magnetic structure (lines and contours in the xy plane), ion temperature (contours in the xy plane), and trajectories of ions (white lines) near the reconnection region at $t\omega_{ce} = 1312$. The contours of the reconnection component of the magnetic field $B_x^2 + B_y^2$ show that a low-frequency electromagnetic instability is excited near the central region [9,10]. Ions coming from upstream execute a meandering motion around the magnetic neutral sheet. The amplitude of the meandering motion corresponds to the width of the high-temperature region. The strong relationship is clearly shown between the ion meandering orbit amplitude and the high-temperatre region by scientific visualization by VR in the CompleXcope.

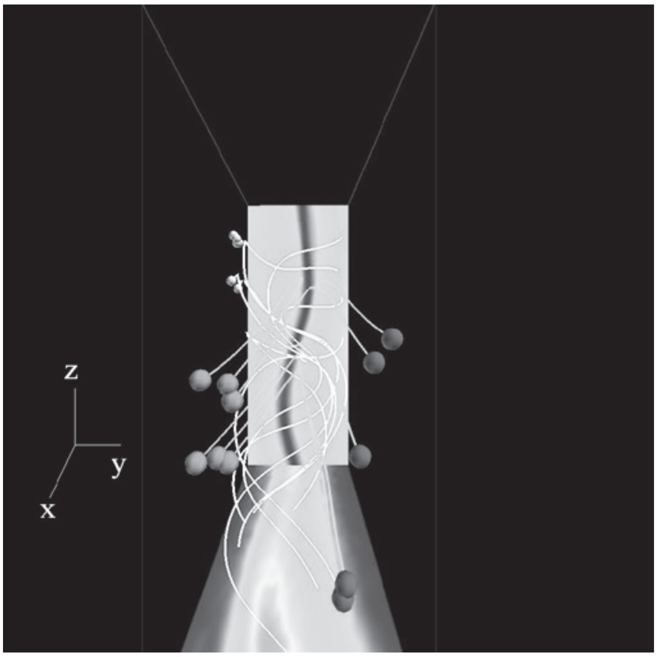

Fig. 1. Visualization of magnetic structure (blue lines and color contours), ion temperature profile (color contours) and trajectories of ions (white lines).

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