EXPERIMENTAL AND NUMERICAL STUDIES ON PLASMA BEHAVIOR FLOWING ACROSS PERPENDICULAR MAGNETIC FIELD

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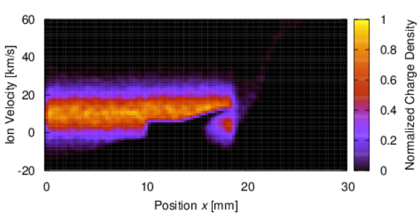
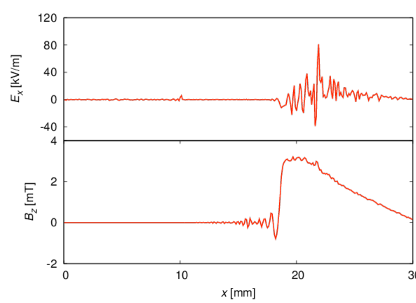
A collisionless shock, which is one of the astrophysical phenomena, has unclear processes such as energy dissipation at the shock surface and generation of highly energetic particles. These processes occur through diffusive interaction with magnetohydrodynamic turbulence. The perturbation of the magnetic field is induced by the plasma flow across the perpendicular magnetic field. Therefore it is required to clarify the plasma behavior in the perpendicular magnetic field.

To generate the collisionless shock in laboratory scale experiments, we have proposed a taper-cone-shaped plasma focus device [1]. The experimental results showed the deceleration of the plasma flow velocity even in sufficiently high plasma beta. In this study, to understand the processes of the collisionless shock, we investigated the plasma behavior in the perpendicular magnetic field with experiments and numerical simulations.

Numerical simulation based on a hybrid particle-in-cell method [2] was employed to study the plasma behavior in the perpendicular magnetic field. The numerical simulation was carried out in one-dimensional space with three-dimensional velocity. To simulate the experiment, the ions, the temperature and the average velocity of which were respectively 9000 K and 10 km/s, were set from 0 mm to 10 mm in the initial condition. The ion number density was decided by the initial gas pressure of 0.01 Pa. Figure 1 shows the phase space of ion and the electromagnetic fields at 600 ns. Figure 1(a) shows the accelerated and decelerated ions on the shock surface at 17 mm. From the electromagnetic fields shown in Fig. 1(b), the perturbation of the electric field induced from the magnetic field compressed by the plasma flow occurs in front of the shock surface. We will try to observe the signal from accelerated particles by using a faraday cup in the experiment.



(a) Ion phase space x-v_x



(b) Electric field E_x and the magnetic field B_z

Fig. 1. Ion behavior and electromagnetic fields at 600 ns

[1] T. Sasaki, *et. al.*, "Laboratory Scale Experiments for Collisionless Shock Generated by Taper-cone-shaped Plasma Focus Device", J. Phys. Soc. Proc. **1**, 015096 (2014).
[2] S. Tsuno, *et. al.*, "Numerical Study on Acceleration and Deceleration Mechanism of Weakly Ionized Plasma Flowing Supersonically through Open Field Line", IEEE Trans. Plasma Sci. **42**, 3732-3741 (2014).