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Reconnection Outflow Measurement in Tokamak Merging Experiment

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We investigate dynamics of reconnection outflow in tokamak merging experiment using Doppler probe arrays[1] and 2D magnetic probe arrays[2]. The Doppler probe arrays are installed in two thin glass tubes to measure the radial profiles of ion velocity. The high-resolution 2D magnetic probe arrays are used to measure the local magnetic field distribution. Applying these diagnostics in the merging experiments of two tokamak plasmas conducted in the TS-6 device[3], we observed a bi-directional ion outflow on the midplane. The maximum outflow velocity reached approximately 70% of the Alfven velocity, defined by the upstream poloidal field. Our analysis of the velocity profile revealed a correlation between the rapid increase in magnetic field pressure at downstream region and the characteristics of the outflow velocity profile, as well as the density profile.

Fig. 1(a) shows radial profiles of ion velocity (red arrows), the poloidal flux contours and a color map of the toroidal magnetic field at t=475μs during merging of two tokamak plasmas. Poloidal magnetic field lines approach vertically the mid-plane (Z=0) and reconnect with a bi-directional ion outflow which is about 70% of Alfven velocity defined by the upstream poloidal field. Fig. 1(b) shows radial profiles of ion velocity (red curve) and magnetic pressure (blue curve) at t=475μs. From these results, the rapid increase in the magnetic field and plasma density in downstream region corresponds to the rapid decrease in the ion outflow velocity profile, in rough agreement with the Rankine–Hugoniot relationship. Our tokamak merging experiment reveals the fast shock-like structures of ion flow and magnetic field at downstream region, as a damping mechanism of reconnection outflow.

References

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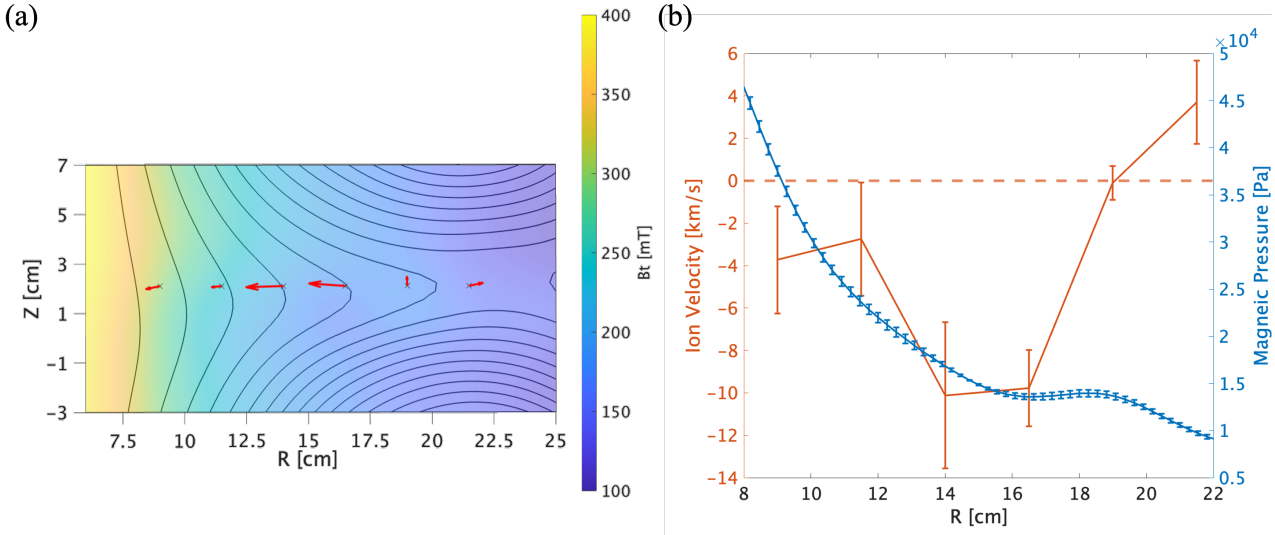

Figure 1 (a) Radial profiles of ion velocity (red arrows) measured by Doppler probe arrays, poloidal flux contours and color map of toroidal magnetic field measured by magnetic probe arrays, (b) radial profiles of ion velocity (red curve) and radial profile of magnetic pressure (blue curve).