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回転磁場によって維持されるFRCプラズマの平衡における バイアス磁場形状の影響

Influence of Bias Magnetic Field Configuration on Equilibrium of FRC Plasma Maintained by Rotating Magnetic Field

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Field-reversed configuration (FRC) is a compact toroidal plasma which is sustained solely by poloidal magnetic field and thus has extremely high-β value [1]. FRCs have so far been formed mainly by field-reversed theta-pinch (FRTP) and plasma merging. In these cases, plasma current is induced in the timescale of microsecond and then the current decays monotonically. Recently, quasi-stationary FRC is formed and sustained in an axial bias field by the rotating transverse magnetic field (RMF) [2,3]. Such FRC (RMF-FRC) has the lifetime of longer than 1 ms and has density and temperature of lower than those of the FRC plasmas produced by the FRTP and the plasma merging, enabling detailed spatiotemporal measurement by electrostatic probes and magnetic probes [4]. In this study, we have measured detailed axial profiles of electron density, floating potential and axial magnetic field of the RMF-FRC. We will compare the axial profiles of the FRC plasmas sustained in straight bias magnetic field (purely solenoidal) and mirror bias magnetic field [5]. Experiments have been carried out on the FRC injection experiment (FIX) [3]. The vacuum vessel of the FIX is made of stainless-steel. As the RMF antenna is in the vacuum vessel, the RMF in the FIX has high spatial harmonics [3]. Pre-ionized hydrogen gas is supplied by a washer gun. The RMF frequency is 106 kHz, which is higher than the ion-cyclotron frequency (~ 7.6 kHz). Azimuthal current consists mainly of electron current by the RMF. Measurement system is composed of radial and axial magnetic probe arrays and movable electrostatic probes.

In the mirror configuration, the lifetime of field-reversal is maintained as far as the RMF power is supplied from 0.4 to 3.1 ms and the electron density is increased from $t \sim 1.4$ ms. The axial profiles of the axial magnetic field, the electron density, and the floating potential at $t = 1.4$ ms in the mirror bias magnetic field configuration are shown in Fig. 1. The axially steeper density gradient outside the separatrix is observed and the floating potential gradient is gentle. The axially steeper density gradient is generated by the suppression of axial parallel diffusion due to the mirror configuration.

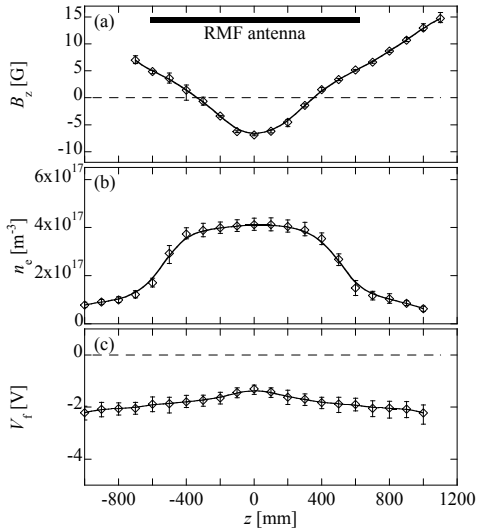

Fig. 1. Axial profiles of (a) axial magnetic field B_z, (b) electron density n_e, and (c) floating potential V_f at t = 1.4 ms in mirror configuration of bias magnetic field.

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