26aD20P

ヘリコン源を用いた高ベータプラズマ特性
Characteristics of High-Beta Plasma using Helicon Sources

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A helicon plasma is high density (~10^{13} cm^{-3}) and high ionization ratio plasma, which is produced by a radio frequency (rf) wave in a wide range of external control parameters. Therefore, the helicon plasma is promising for many application fields. For example, in order to develop a long lifetime electric thruster, the helicon plasma is used as a source dense plasma [1].

Helicon plasma can generate a high-beta plasma because it can produce a high-density plasma even in the low magnetic field. Here, this beta "β" is a ratio of the particle pressure to the external magnetic field pressure. The high-beta plasma exclude the external magnetic field from the interior of the plasma to the outside region by inducing an azimuthal current j_θ (diamagnetism). The decrease of magnetic field, depression ratio, is shown by $\Delta B/B_0 = 1-\sqrt{1-\beta}$ from the total pressure balance. Here, ΔB is a change of the magnetic field and B_0 is the vacuum field without a plasma. Note that this equation does not include the effect of a neutral-gas pressure.

Here, a high-density and high-beta plasma shows various interesting performances of a strong diamagnetism and associated instabilities in the space and nuclear fusion fields. However, a relationship between the diamagnetism and plasma parameter including an operating pressure have not been fully clarified [2]. Therefore, this study aims to study these characteristics using the Large Helicon Plasma Device (LHPD) in ISAS (Fig. 1) [3].

Figure 2 shows β and $\Delta B/B_0$ from the measured electron density, its temperature and the magnetic field as function of B_0. The behavior of $\Delta B/B_0$ and $1-\sqrt{1-\beta}$ are similar, and the beta was increased up to 115 %. For a magnetic field of 0.8 G and argon pressure of 0.16 Pa, the maximum beta was ~ 450 % near the plasma center. In the presentation, more details of experimental setup and results will be shown.

References

[1] S. Shinohara *et al.*, *IEEE Trans. Plasma Sci.*, **42** (2014) 1245.

[2] S. Shinohara *et al.*, *Plasma Sources Sci., Technol.*, **19** (2010) 034018.

[3] S. Shinohara and T. Tanikawa. *Rev. Sci. Instrum.* **75** (2004) 1941.

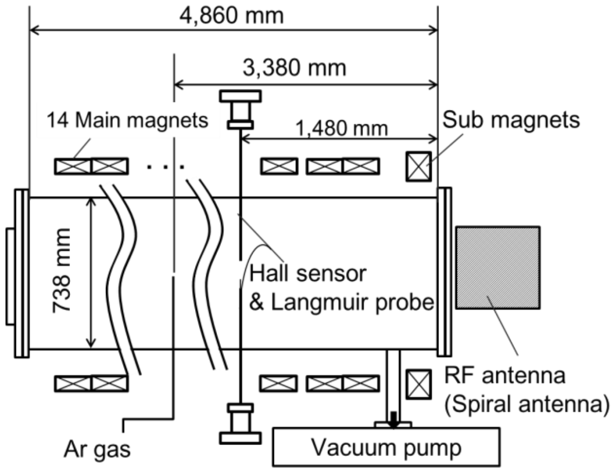

Fig. 1 Experimental device (LHPD) [3].

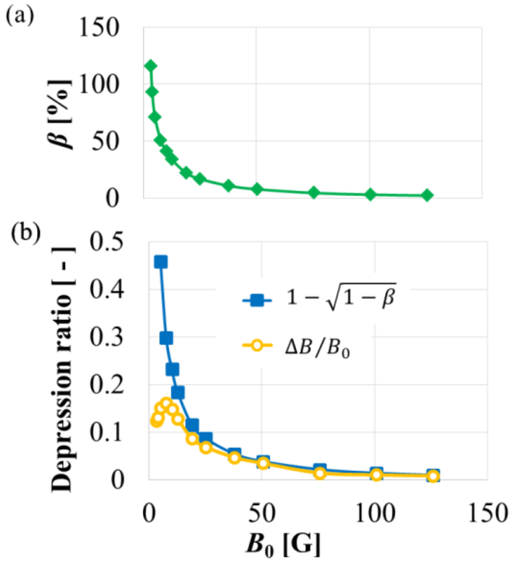

Fig. 2 Dependences of (a) β and (b) field depression ratio on B_0 with argon pressure of 0.08 Pa .