# §10. Whistler Wave Plasma Production in CHS

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## Introduction

Whistler wave discharges in MHz range of frequency have the notable feature of producing plasmas in low magnetic field strengths of kG range, which is important in the high beta and some Alfvén wave related studies of helical systems. The RF plasma production in a range of ion cyclotron frequency ($\omega_{ci}/2\pi$) has been studied by using the Nagoya Type III antenna [1-2] and the plasma density as high as $\langle n_e\rangle = 5\times10^{12}\mathrm{cm}^{-3}$ was produced. However, the RF plasma production in the frequency range $\omega/\omega_{ci} > 1$ (Whistler waves range) has not been well studied in CHS. Here, we report the initial results of the waves and the plasma production characteristics for the Whistler wave discharge.

## Whistler wave plasma production

The RF power of 500kW, pulse duration of 10msec and the frequency of 9MHz are used in this experiment. The antenna is Nagoya type III. The plasma density, electron temperature and the wave magnetic fields are measured by the microwave interferometer, Langmuir probe and the magnetic probes located 180 degrees away from the antenna in toroidal direction, respectively. In Fig. 1, the line averaged density, $\langle n_e\rangle$, is shown as a function of the RF power for the He plasmas, where the toroidal magnetic field strength Bt=0.8kG. $\langle n_e\rangle$ is found to increase monotonically with the RF power up to 170kW. The electron temperature measured at plasma periphery is about 20eV. $\langle n_e\rangle$ is almost constant in the region Bt>0.5kG and linearly decrease below 0.5kG. The plasma density produced here is factor ~5 smaller than the one at $\omega/\omega_{ci}$ ~0.8 (slow waves) with the similar RF power. This may be attributable to the poor efficiency of the Whistler wave excitation for the Nagoya Type III antenna. The wave magnetic field strength $B_{wave}$ measured at the plasma periphery is plotted as a function of Bt. During the RF pulse, the plasma density changes in time and $B_{wave}$ has maximum at the density $\langle n_e\rangle_{peak}$. It is found that $\langle n_e\rangle_{peak}$, increases with Bt as shown in Fig. 2(a). Because of less damping of the wave expected from Landau and collisional dampings, the waves may propagate around the torus to form toroidal eigenmodes. The toroidal eigenmodes (mode number=N) of the Whistler waves are calculated and shown in Fig.2 (b). The $\langle n_e\rangle_{peak}$ obtained in this experiment stays in the same range of the appearance of the toroidal eigenmodes.

Reference
1) Shoji, T., Nishimura, K, et al., Nagoya Univ. Ann. Report **6** (1989) 1
2) Nishimura, K., Shoji, T., et al., Fusion Tech. **17** (1990) 86

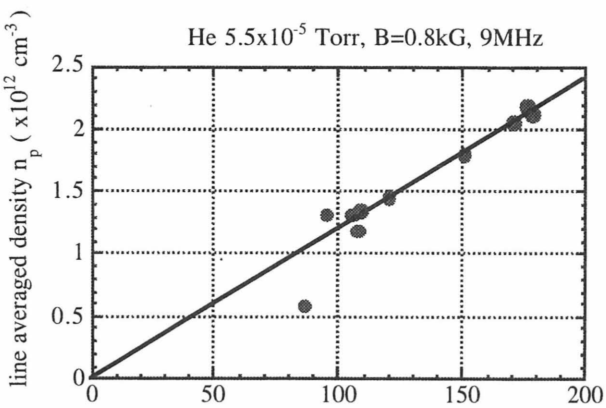


Fig. 1. < $n_e$ > versus RF input power for He plasma. F=9MHz..

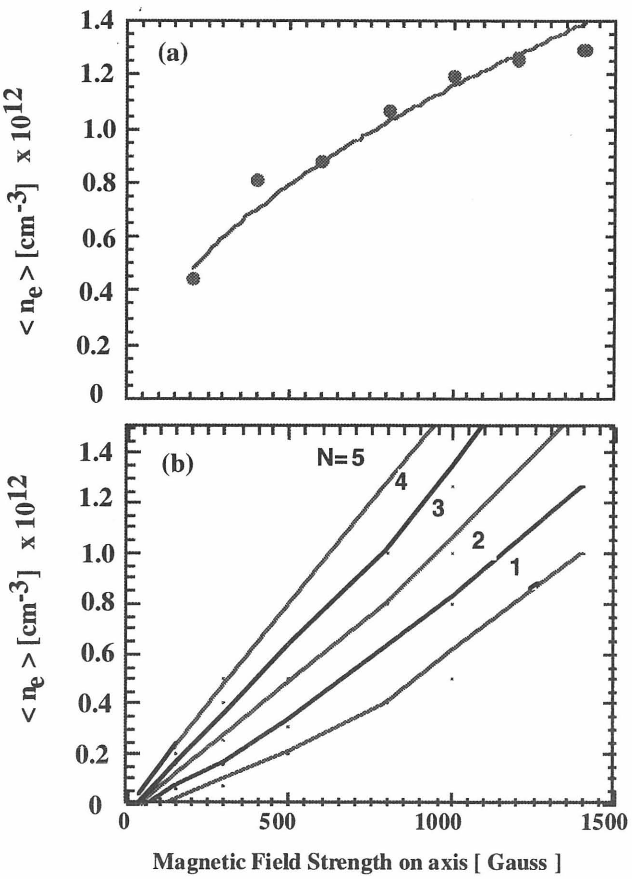


Fig. 2. (a) The density where the wave magnetic field strength peaks as a function of Bt. (b) The relation between plasma density and Bt for toroidal eigenmodes (N) of Whistler waves.