§29. Radial Density Profiles of Microwave and Whistler Wave Discharges

Shoji, T., Sakawa, Y. (Dept. Energy Eng. and Sci., Nagoya Univ.)
Suzuki, C., Takeuchi, M., Ikeda, R., Toi, K.

Whistler wave discharges in MHz range of frequency studied in CHS[1-2] have the notable feature of producing plasmas in a low magnetic field strengths of kG range, which is important in the high beta and some Alfven wave related studies of helical systems. We compare the density profiles of the plasma production by the Whistler wave discharge and 2.45GHz microwave discharges.

The perpendicular propagation region of Whistler waves (fast wave) for 13MHz in density n and toroidal field B_t space is shown in Fig1. Above 400G where the lower hybrid resonance takes place, there exists the evanescent region (hatched area) of the waves but there is no density limit for the fast wave propagation. An example of the radial propagation in this region is shown in Fig1 for the parabolic density and CHS B_t profiles. The evanescent region (R cut off) appears at the plasma periphery, so if the fast waves are excited through this region, high density plasmas can be produced by the fast waves.

The maximum power of 500kW, pulse width of 10msec and the frequency of 9MHz is used for Whistler wave discharge. The 2.45GHz power of 50kW (200msec) is used for microvave plasma production and heating of the rf plasmas. The antenna for the wave exciter is Nagoya type III. The plasma density is measured by Langmuir probe near the antenna. In Fig. 2, the radial profiles of the electron density n_e (He plasma) where the radius ρ is normalized by the outmost flux surface are shown.

The microwave plasma can make an over dense plasma (cutoff plasma density is $7.4 \times 10^{10} cm^{-3}$) by some mode conversion process but tends to make hollow density profile. When rf power is superimposed on the microwave plasma, the central density increases and the profile changes to be more flat. This is due to the fact that there is no density limit for the Whistler wave propagation as is shown in Fig.1 and the wave can penetrate deep in the core plasma. The electron temperature for both rf and microwave plasmas is ~8eV.

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

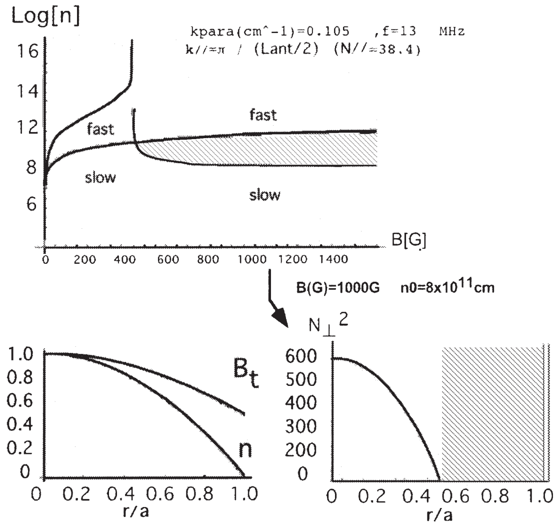

Fig. 1 Perpendicular wave propagation of Whistler (fast) and slow waves in plasma density n and toroidal field B space. The rf frequency f=13MHz and parallel wave number $k_{//}=0.105\ cm^{-1}$. Example of radial profile of perpendicular refractive index $N_{\perp}$ for the Whistler wave.

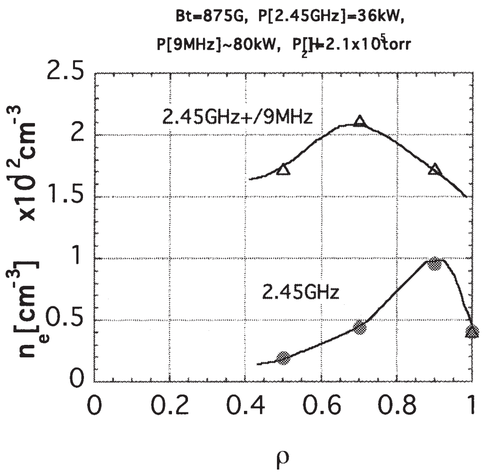

Fig. 2 Radial profile of the density profiles for microwave and rf+microwave plasmas (He). B=875G, f=9MHz, Prf=80kW and Pmicrowave=36kW.