§22. Toroidal Eigenmode in ICRF Heating

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High power ICRF heating experiment has been carried out with loop antennas in CHS. The antenna excites a fast wave in the CHS plasma. The fast wave propagates in the toroidal direction, when its damping is so weak. Eigenmode resonance occurs when the fast wave has a special wave number along magnetic field line, $k_{//}$, that depends on the plasma parameters such as the electron density. The eigenmode resonance will be observed in ICRF heating experiment where the electron density changes with time. The eigenmode resonance can be measured as a large plasma loading resistance in RF antenna because RF electric field of the fast wave becomes large at the antenna. The plasma loading resistance measurement is described in the previous section.

Figure 1 shows the plasma loading resistances as a function of an electron density at the magnetic axis. The electron density changed from $2.8\mathrm{x}10^{13}\mathrm{cm}^{-3}$ to $3.3\mathrm{x}10^{13}\mathrm{cm}^{-3}$ and decreased back to $2.5\mathrm{x}10^{13}\mathrm{cm}^{-3}$ during ICRF heating pulse. The plasma loading resistance in figure 1 is plotted only in the density rising phase because it was the same value in the density decaying phase. Its profile has two peaks, which changes from 3Ω to 5Ω at n_e=$2.87\mathrm{x}10^{13}\mathrm{cm}^{-3}$ and $3.15\mathrm{x}10^{13}\mathrm{cm}^{-3}$. These peaks correspond to the toroidal eigenmode resonances. The calculation of the plasma loading resistance has been carried out by K2FHM code[1], which uses a linear helical model including a finite Larmor radius effect. The plasma density and the temperature profiles are used in parabolic ones. The calculated loading resistance is the summation integrating over the toroidal wave number, kz($\approx k_{//}$), from 0 to 8 /m with weighting the radiated power spectrum from antenna. kz=0 /m and kz=1 /m dominate over the other higher wave number mode. These eigenmodes always appear in a pair. These two neighboring peaks have the same poloidal and radial wave number. These experimental loading resistance peaks agree qualitatively with the calculated values. Furthermore, figure 2 shows the dependence of the plasma loading resistance on the toroidal magnetic field strength. The peaks shift to higher electron density with an increase in the magnetic field strength. This experimental result is reasonable since Alfven wave phase velocity is proportional to the magnetic field strength and is inversely proportional to square root of the plasma density.

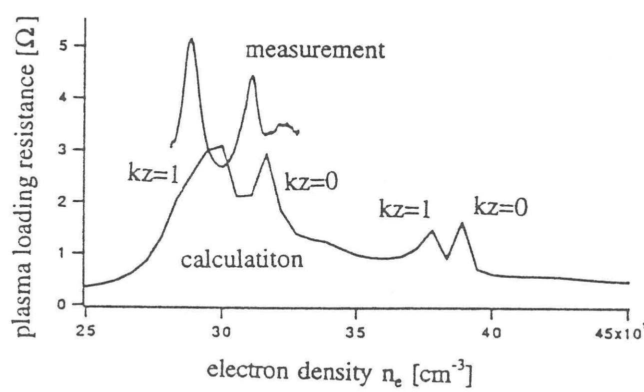

Fig. 1 Plasma loading resistances obtained from ICRF heating experiment operated with U antenna in D + H(7%) plasma and calculated result integrated over k_z from 0 to 8 /m weighting the power spectrum from antenna.

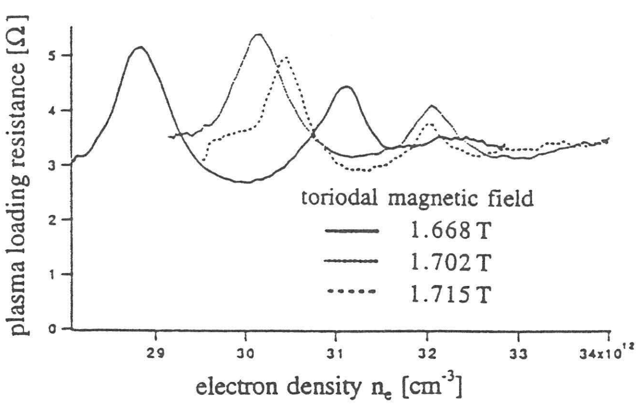

Fig. 2 Toroidal magnetic field strength dependence of the plasma loading resistance.

1) Fukuyama. A., Okazaki, N., Goto, A., Itoh, S-I., Itoh, K., Nucl. Fusion 26 (1986) 151.