Change of Zonal Flow Spectra in the JIPP T-IIU Tokamak Plasmas

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When Ohmically-heated low-density plasmas are heated by NBI or higher-harmonics ICRF heating or strongly gas-puffed, the drift wave spectrum in the core plasma (r/a_p=0.2), measured by a heavy ion beam probe, changes drastically, the decrease of intensity of the mode propagating in the electron-diamagnetic-drift direction (TEM) and the increase of the mode of ion diamagnetic drift direction. At low-density OH plasma, the turbulence is rather bimodal [1] in terms of TEM mode (fast electron mode) and edge ion mode. At heated core plasma, TEM mode becomes weaker, edge ion mode disappears and the ITG mode becomes stronger. In half-radius region, the TEM mode decreases only slightly and ITG mode grows. These changes are roughly in agreement with the linear gyrokinetic stability calculations.

Zonal flow spectrum also changes drastically in low-density OH and NBI heated plasmas. In the core, high-frequency zonal flow in GAM frequency range is much more strong compared with low-frequency zonal flow, in low-frequency OH plasmas [2]. In heated plasmas, low-frequency zonal flows (10 Hz to 1 kHz) increase significantly and the intensity of high-frequency zonal flow in GAM frequency range, decreases to about 1/10 and weaker than low-frequency zonal flow. At half-radius region, the intensity of high-frequency zonal flows nearly the same, while low-frequency zonal flows drastically grows to comparable level with high-frequency zonal flows.

The changes of drift wave turbulence and zonal flows in these four cases, in the core and half-radius, in low-density OH and heated plasmas, suggest that

1) TEM mode is not capable to generate intense low-frequency zonal flows, since when ITG is strong, we have strong low-frequency zonal flows.
2) Damping of high-frequency zonal flow in high-Ti- plasmas may be dominant and the capability of the generation of high-frequency zonal flow by TEM and ITG plasma may be comparable.

[1] R.D.Durst et al., Phys. Rev> Lett., 71 (1993) 3135.
[2] Y. Hamada et al, PPCF, 48 (2006) S177.