論文内容の要旨

論文題目

A Study of the High Harmonic Fast Wave in Spherical Tokamak Plasmas

(球状トカマクプラズマにおける高次高調速波の研究)

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A degradation of heating efficiency was observed during high-harmonic fast wave (HHFW) heating of spherical tokamak plasmas when parametric decay instability (PDI) occurred. Suppression of PDI is necessary to make HHFW a reliable heating and current drive tool in high β plasmas. In order to understand PDI, measurements were made using a radially movable electrostatic probe (ion saturation current and floating potential), arrays of RF magnetic probes distributed both toroidally and poloidally, microwave reflectometry, and fast optical diagnostics in TST-2. The frequency spectrum usually has peaks at $f_0 - nf_{ci}$ and nf_{ci}. PDI becomes stronger at lower densities, and much weaker when the plasma is far away from the antenna. The lower sideband power was found to increase approximately quadratically with the local pump wave power. The lower sideband power relative to the local pump wave power was larger for reflectometer data compared to either electrostatic or magnetic probes. The radial decay of the pump wave amplitude in the SOL was much faster for the ion saturation current than for the floating potential. These results are consistent with the HHFW pump wave decaying into the HHFW or ion Bernstein wave (IBW) sideband at $f_0 - nf_{ci}$ and the low-frequency ion-cyclotron quasi-mode (ICQM) at nf_{ci}. Two additional peaks were discovered between the fundamental lower sideband and the pump wave in hydrogen plasmas. The frequency differences of these peaks from the pump wave increase with the magnetic field. These decay modes may involve molecular ions or partially ionized impurity ions. When PDI is occurred, Soft-Xray signal gets lower than that in no PDI and ion temperature rise. HHFW heating loss is considered to be occurred by PDI.

On the UTST HHFW experiments, UTST is skewered with glass tube and pickup probes

are installed inside tube. Direct measurement of derivation of RF magnetic field is possible by this signal being connected with fast digitizing ADC or RF detector. By this methods, direct measurements of launched HHFW was tried. It was successful to measure the HHFW magnetic field.