Abstract for an Invited Paper
for the DPP08 Meeting of
The American Physical Society

Observation of ICRF Mode Conversion Plasma Flow Drive on Alcator C-Mod

YIJUN LIN, MIT Plasma Science and Fusion Center

Plasma flow driven by externally launched rf waves could be important in stabilizing micro- and macro-instabilities in tokamaks. We report the first observation of both toroidal ($V_{\phi}$) and poloidal ($V_{\theta}$) flows driven via an ICRF mode conversion (MC) process in D($^3$He) plasmas. At modest $^3$He levels ($n_{^3He}/n_e \sim 8\%$), in relatively low density plasmas, $\langle n_e \rangle \leq 1.3 \times 10^{20} \text{m}^{-3}$, heated with 50 MHz rf power ($B_{t0} \sim 5.1 \text{ T}$), strong $V_{\phi}$ in the co-current direction is observed by high-resolution x-ray spectroscopy. The central $V_{\phi}$ scales with the applied rf power ($\leq 30 \text{ km/s per MW}$), and is at least a factor of 2 more than the empirically determined intrinsic plasma rotation [1]. The rotation near the plasma center ($r/a < 0.3$) responds more quickly to the applied rf power than the outer region, indicative of a local flow drive source. Localized poloidal rotation ($0.3 \leq r/a \leq 0.5$) in the ion diamagnetic drift direction is observed when $P_{rf} \geq 1.5 \text{ MW}$ and increases with power ($\sim 2 \text{ km/s at 3 MW}$). Turbulence spectrum broadening seen by a phase contrast imaging (PCI) system indicates strong flow also exists in the main ions. The mode converted ion cyclotron wave (MC ICW) is observed by PCI and confirmed by 2-D full wave TORIC code simulation. The simulation result shows that due to the up-shifted $k_{||}$, the MC ICW is strongly damped on $^3$He ions in the vicinity of the MC layer, approximately on the same flux surfaces where poloidal flow is observed. The involvement of ion heating and short-wavelength slow wave is consistent with theoretical considerations for efficient rf flow drive. Our experimental results are comparable to the predictions [2], assuming similar ion interaction mechanism for the MC ICW and direct launch ion Bernstein wave. The feasibility of ICRF flow drive on ITER will be discussed. [1] J. E. Rice, et al, Nucl. Fusion 47, 1618 (2007). [2] J. R. Myra and D. A. D’Ippolito, Phys. Plasmas 9, 3867 (2002).

$^1$Work supported by US DoE Coop. Agreement No. DE-FC02-99ER54512.