Modeling of Neutral Beam Ion Absorption of High Harmonic ICRF Waves in the DIII-D Tokamak

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The absorption of ion cyclotron radio frequency (ICRF) wave by neutral beam injected ion species at high ion cyclotron harmonics ($\omega=n\Omega$, $n\geq2$) has been observed experimentally in the DIII-D tokamak during the 1999 experimental campaign. Anomalously peaked pressure profile was reported in the central region of plasma with a significant enhancement of the measured neutron rate when rf pulses were applied to neutral beam (NB) heated discharges. Energy spectrum from neutral particles analyzer showed a strong enhancement of the tail energy above the NB injected energy. To understand and quantify this phenomenon of energetic beam ion species-wave interaction, a Monte-Carlo rf orbit code, ORBIT-RF, has been upgraded to treat steady-state NB injection and ICRF absorption at higher harmonics. The first ORBIT-RF results for the interaction study of 80 keV D beam ion and 60 MHz ICRF wave at 4th harmonic resonance surface show that several experimental observations are reproduced in the simulations within reasonable agreement using an estimated magnitude of $|E_+|$ based on a simple model: (1) the extended tail energies of beam ions above the injected beam energy are found in the central region of plasma, and (2) about 20%-30% enhanced D-D reaction rate is also calculated due to the interaction of ICRF and beam ions. Additional DIII-D experimental results on the damping of wave on H(He^3) beam ion at 2nd(3rd) harmonic resonance are being simulated and will be reported at the meeting. For quantitative comparisons and predictions, a more accurate wave model will be implemented to estimate the magnitude of $|E_+|$.

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